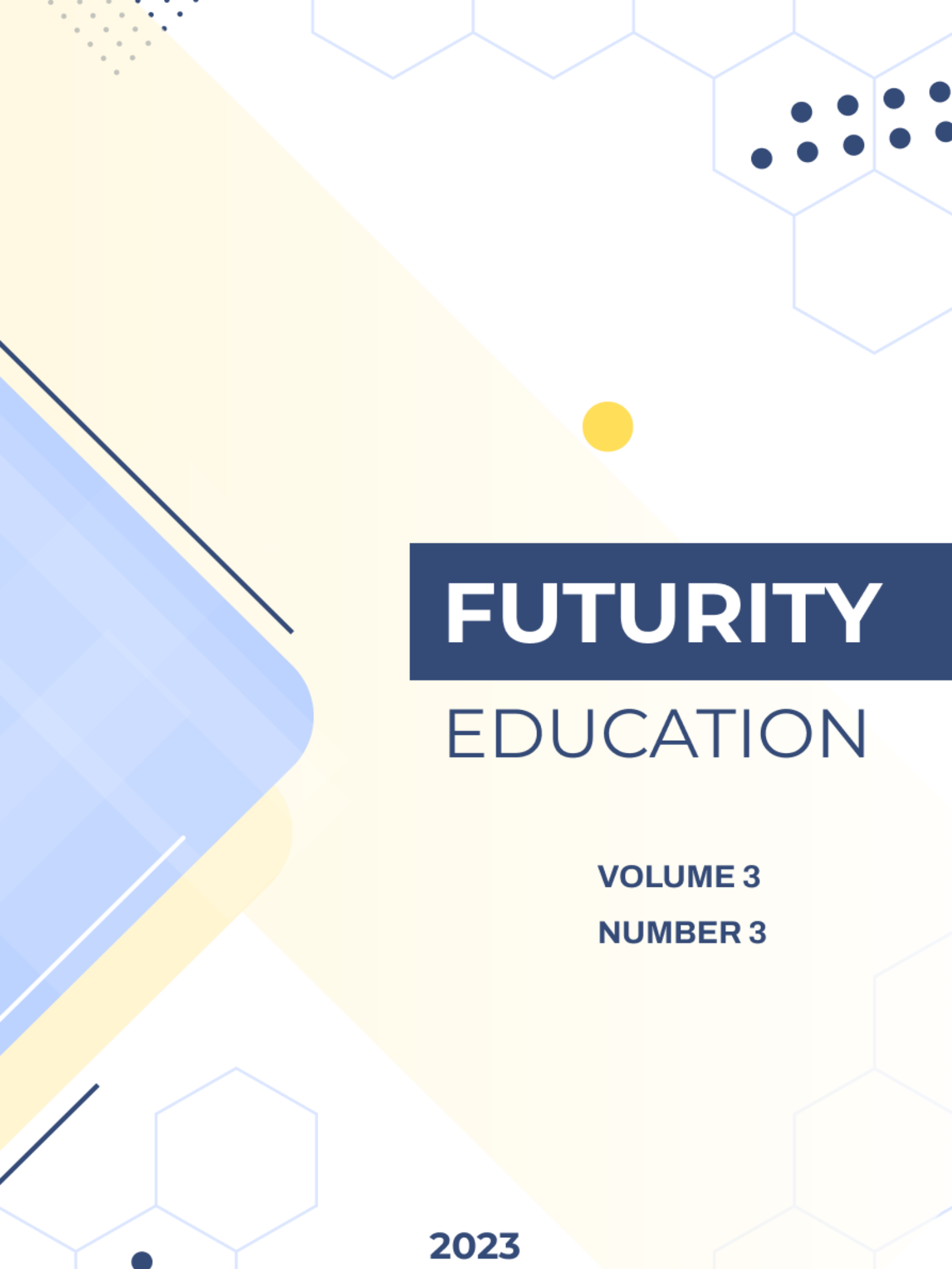




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Graduate Students' Perspectives on Their Acquired Skills Following the Erasmus+ Programme

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Abstract: Graduate skills are a key factor in their selection in a company. This research focuses on the extent to which the Erasmus+ mobility programme contributes to the development of skills required for a modern work environment. Thus, the paper examines whether the skills developed through an Erasmus+ programme are recognised as important by European employers. The results of the primary quantitative online survey showed that graduates developed adaptability, flexibility, enthusiasm, dynamism, professionalism, responsibility, commitment, and creative problem-solving skills through their participation in the Erasmus+ programme. Even if the Erasmus+ programme appears to enhance

a variety of talents, there are some others, such the improvement of interpersonal skills, which are less well-developed. An important conclusion of this study is that young people's participation in the Erasmus+ programme, in terms of study or internship, contributes to their desire to work in an international context, while a prolonged participation in the programme is positively correlated with the development of communication skills.

Keywords: Erasmus+ Programme, Employee Skills, European Employers.

Introduction

The recent studies show that the development of soft skills in students through their participation in the Erasmus programme is related to their future professional career and smooth integration into the labour market (Cairns, 2019). Soft skills, according to Marin-Zapata et al. (2021), are a set of widely used or generic skills that are non-technical in nature and can be applied in a variety of work environments. Skills are often categorised as interpersonal, people skills, and behavioural skills that emphasize personal behaviour and the management of interpersonal relationships (Hendarman & Cantner, 2018). However, in the labour market, research has shown that employers expressed a need and desire for high-quality soft skills in the modern workforce, such as good communication skills, interpersonal skills, collaboration and teamwork, as well as problem-solving skills (Ellis et al., 2014; Engel, 2010; ErasmusJobs, 2021; Ghani et al., 2018; Nickson et al., 2012).

As the Erasmus programme is the best known and most fundamental mobility program in Europe, there is a strong research interest regarding its impact and the extent to which they fulfil the original goals of the program.

Soft skills self-evaluations gained by program participants are crucial to get an initial impression of how well Erasmus is meeting its stated goals in terms of its long-term effects on young people's employability. Additionally, a comparison of the supply and demand for soft skills in the Greek labour market will show the potential gap between the two, as well as suggest ways to bridge it.

Literature Review

(Qualitative) Soft Skills

Whitmore and Fry (1974) were among the first researchers to propose a classification of skills into two categories: soft and hard skills. The first refers to work and can be applied in a variety of work environments, while the second refers to the know-how required for a job (Marin-Zapata et al., 2021). Furthermore, Succi and Canovi (2020) state that soft skills are a dynamic combination of cognitive and metacognitive, interpersonal, intellectual, and practical skills. In other words, they consider that soft skills help people positively adapting and behaving so that they can effectively manage the challenges of their professional and daily lives.

Although soft skills are important in all work contexts, previous studies have found that employers' requirements with these types of skills are not being met. These surveys have shown that employers seek employees with high-quality soft skills such as communication, interpersonal relationships, collaboration, and analytical skills (Engel, 2010; Nickson et al., 2012).

The Erasmus+ Programme structure and figures in Europe and Greece

The fundamental component of the Erasmus+ programme is students' exchanges between partner countries for duration of three to twelve months. The visiting student enrolls in a department in their area of study during this time to complete their studies in the host institution (Cairns, 2019). Since 2007,

program participants have had the option to perform a 3- to 12-month internship with a business or non-profit.

According to estimates, the program has helped at least 4 million Europeans (students and academic staff) move about throughout its 30 years of operation, making it an example of cross-border cooperation and a tool for promoting intercultural learning (Cairns, 2019). When the mobility program was first established in 1987/1988, 3,000 students from 11 other countries participated. By 2002/2003, however, that number had risen to approximately 124,000.

Since 2007, when it became possible to do an internship abroad, the number of participation significantly increased. In 2007–2008, 182,700 students participated; in 2017–2018, it nearly doubled to 347,100 (Centre for European Progression, 2017). 33 countries are already participating in the Program's execution, including non-EU nations like Turkey, Serbia, Norway, Liechtenstein and others (Centre for European Progression, 2017). The Erasmus+ program provided about 940,000 people with the opportunity to study, work, volunteer, and take part in community engagement initiatives abroad in 2019, according to more recent figures. In 2019, the program's budget totalled 3.37 billion (European Commission, 2020).

Since the beginning of the Erasmus programme in 1987, Greece has taken part in it. A total of 19,454 people benefited from the program in 2018–2019, including 10,071 higher education students who studied or completed an internship abroad. The number of Greek students traveling abroad for study and internships rose from 4,156 in 2014–2015 to 5,264 in 2016–2017 and 5,667 in 2018–2019, reflecting a gradual rise in participation in the program. As an example, Greece hosted 3,675 Erasmus students in 2014–2015 that increased to 4,759 in 2016–2017 and 5,476 in 2018–2019 (European Commission, 2021). On the other side, inbound migration is comparable to outward movement.

In Greece, the Program's budget for 2018/2019 totalled €40.9 billion. It should be noted that the expected budget for Erasmus+ for the 2021–2027 programming term is €26.2 billion, nearly twice as much as it was for the 2014–2020 programming period (European Commission, 2021).

The Erasmus Programme & Soft Skills Development

Student mobility is by far the most supported measure by European higher education policy makers in the context of promoting internationalisation processes (de Wit, 2019). Particularly, the Erasmus programme is an important milestone in the history of education policy at the European level, even though it took more than 20 years since the Treaty of Rome to give it an official supranational dimension and another 17 years to create the flagship Erasmus programme (Ribeiro, 2021).

The main element of the program is the exchange of students between countries as part of their studies, with a stay in another country and study in another college, for a period of 3 to 12 months. During this period, the visiting student is enrolled in a department of their field of study so that they can continue studies in the host country (Cairns, 2019). Since 2007, students in the program had the opportunity to complete an internship in a company or organisation for a period of 3 to 12 months. In recent years, special emphasis was placed on the skills developed through this program, as the participation of young people was a good opportunity to prepare for their integration into the globalised labour market and society (Erasmus Skills, 2021). Erasmus was created not just to unite young people but also to integrate cultural groups from various EU member states and other countries, promoting greater tolerance for other peoples' cultures and civilizations as well as greater awareness of common European ideals (Cairns et al., 2018).

Additionally, it offers the chance to gain knowledge about residing and working abroad. Young

people who travel abroad as part of the Erasmus program gain knowledge and abilities. It "opens the door" to enter the next level of school or employment. The extent of their new educational and employment prospects is expanding at the same time, both domestically and internationally (Cairns et al., 2018).

The Erasmus Impact Study offers crucial information in the impact of Erasmus Programme over Soft Skills Development (European Commission, 2019). According to the report, taking part in Erasmus+ is associated with the growth of skills necessary for employment and social cohesion. Almost 9 out of 10 participants report improvements in soft skills like adaptability, interactions with people from different cultures, communication skills, and intercultural competence, while about 5 out of 10 participants reported improvements in their digital skills because of their participation in the exchange program. Soft skills are those that are considered important for employment. More than 90% of participants assumed they increased their ability to engage with people from diverse cultures, which is considered a key component of social cohesiveness. When compared to graduates who did not engage in Erasmus+, participants showed stronger improvements in these sorts of competencies (European Commission, 2019).

The same study also shows how Erasmus+ has an effect on participants' academic growth, social involvement, personality development, and intercultural openness. Particularly for those who relocated to non-neighbouring countries from their place of origin, it was discovered that taking part in Erasmus+ strengthened participants' feelings of European identification (European Commission, 2019).

Additionally, a study by the Erasmus Student Network revealed that participating in Erasmus had a positive effect on graduates' personal development because the mobility affected their participation in society as engaged citizens as well as their social, civic, and democratic participation (Perez-Encinas et al., 2021). In particular, the study revealed that 6 out of 10 graduates were familiar with the meaning of the term "civic participation" and that 1 out of 3 was well-informed about the activities of local civil society. Additionally, the study reveals that students who have participated in an Erasmus exchange are significantly more involved in civil society organisations than the typical European young person (European Student Network, 2021b).

Students are aware that career advancement depends on personal growth and that employers may place an equal value on soft skills and academic qualifications (Cairns et al., 2018).

The Erasmus+ Programme and Employability

According to Confalonieri et al. (2016), the academic mobility is an important way for young people to improve their future employability and acquire new professional skills while developing as active citizens. Students who participate in a mobility program can develop the right combination of subject-specific skills and soft skills that enable both a successful and rapid transition into the labour market.

Participants in the program have the chance to considerably improve their CVs, increase their chances of finding future employment, and raise their level of work competence, giving them an advantage in the labour market (Deakin, 2014). Enhancing intercultural skills, through interactions with individuals or groups of individuals from diverse ethnic backgrounds, is also a key goal of the curriculum, leading to mutual tolerance for variety. Simply put, all Erasmus participants are intended to increase cultural awareness of the various facets of citizenship in Europe and build skills that will improve their employment (Cairns et al., 2018).

Rodrigues (2013) also found that student mobility was associated with a higher likelihood of going

abroad again to study or work after graduation. In addition, a study conducted by the European Commission looking at the impact of Erasmus on employability came to an important conclusion: graduates with international experience had better chances in the labour market and their unemployment rate was lower (Brandenburg et al., 2015).

In conclusion, participation in Erasmus can contribute to the development of skills and the redesign of higher education curricula to ensure that graduates have developed high-quality soft skills (van Kemenade, 2012; Cimatti, 2016).

The ErasmusJobs project's investigation concerned the skills acquired through the Erasmus+ mobility programme and the abilities required by employers as well as the coincidence and significance in terms of the Erasmus programme. A survey was conducted in late 2020 through the aforementioned project with 55 employers, HR managers, in enterprises with European headquarters. The poll was performed both online and in person.

This study's objective was to determine the essential talents that companies in Europe were looking for and compare them to the capabilities that Erasmus+ graduates had already attained. In the study, employers were asked to rate the importance of a set of transferable skills before listing the three crucial skills they believe are most important when hiring a new employee. Finally, they were asked to indicate the significance they give to a new employee candidate's international experience gained through the Erasmus program (ErasmusJobs, 2021).

According to the findings, the top three sets of soft skills that employers look for when hiring new workers were: adaptability, flexibility, and agility skills (reported by 21.2% of employers); motivation, enthusiasm, passion, positivity, drive, and dynamism (18.8%); communication skills (17.6%); and professionalism, responsibility, commitment, work ethic, and performance skills (17.6%). Other skill sets included innovative problem-solving (12.9%) and initiative (11.8%), in that order.

Significant focus has been placed on the skills obtained through the Erasmus+ programme, since young people's participation is a good opportunity to prepare for their integration into the globalised job market and society (Erasmus Skills, 2021).

Mechanisms for assessing the impact of the Erasmus+ programme on soft skill development and employability

European Skills/ Competencies, Qualifications and Occupations (ESCO), a comprehensive initiative for the classification and assessment of competencies in all sectors within the European Community, has been in development by the European Union (EU) since 2016. In accordance with the levels of the European Qualifications Framework, the ESCO classification defines groups of skills/competences and groups of qualifications.

The Erasmus Skills program has been in place since 2018 and aimed giving higher education institutions the tools they needed to enhance the educational experience of program participants. This was effectuated to better understand how Erasmus affects the development of skills. Mobility participants have the chance to assess the outcomes of their participation in terms of the skills they have acquired through the Erasmus Skills program. The main goal of the project was to increase students' understanding of the process they were participating in through the exchange and how this will affect their own personal growth and skill set as well as their role as contributing members of society. The creation of a self-assessment tool for students' mobility outcomes was part of the project in this context, and other project outputs included the delivery of online training for students on European citizenship and the Erasmus+ program, the creation of a guide for higher education professionals to assist and

support students in their personal development, and finally the introduction of a methodology to support academic staff in higher education in the development of their own research.

Students evaluated their Knowledge, Skills, and Attitudes (KSA) in the framework of their self-assessment through a platform that has been expressly built (European Student Network, 2021a). Students also evaluated the soft skills they have acquired in the context of their own skill evaluation (Erasmus Skills, 2021a).

It should be noted that the Erasmus Jobs (<https://www.erasmusjobs.org/>) initiative is expected to create an online platform to improve the employability of Erasmus graduates. On this portal, Erasmus students and alumni will be able to create an individual profile that reflects the skills they have gained through volunteering, mobility experiences, and other activities. Employers, on the other hand, will benefit from the platform's assistance in locating qualified candidates. Employers will be able to create a company profile to attract candidates. Furthermore, the platform will provide universities and career services with a one-of-a-kind tool to help students establish skill profiles and transition to the workforce (ErasmusJobs, 2021).

Research Methodology

In this paper, the primary research was conducted following a quantitative approach. Through a quantitative research, it was possible to select large samples in a short period of time, unlike qualitative methods where data collection was time consuming, and samples were small at the same time. With a larger sample, it was more likely that the research will lead to an accurate generalised conclusion and more reliable results, while at the same time it was less likely that outliers will negatively affect the results (Papageorgiou, 2015).

Considering the basic purpose of this work, a quantitative research was considered the optimal method, as it was an extension of the study conducted within the ErasmusJobs project – with Greek data – (ErasmusJobs, 2021).

Finally, many studies that have investigated the impact of the Erasmus programme on the development of students' soft skills have been quantitatively conducted (Krzaklewska & Krupnik, 2005; Brandenburg et al., 2015; Bryła, 2015; Martínez-Usarralde et al., 2017; Baranova et al., 2020; Tran et al., 2021).

Study Population

The study residents consisted of the students who participated in the Erasmus mobility programme in Greece. The number of participants was N = 150 graduates. A random sample was drawn as the survey was conducted online and the participants in this study were self-selected.

Purpose & Research Questions

The main purpose of the study was to investigate the extent to which the participation of then students in the Erasmus mobility programme and current graduates (both employed and not) contributed to the development of (qualitative) soft skills. It also aimed to measure the degree of correspondence between the soft skills that employers recognised as important for the workplace and the soft skills that graduates and Erasmus participants perceived themselves to have acquired through their participation in the programme.

Measurement Tool

In the research a structured questionnaire with closed – questions was used. The questionnaire

was designed after studying the international literature and based on the study of the ErasmusJobs project. The questionnaire was divided into the following three sections:

- i. The first section deal with the demographic and occupational characteristics of the participants in the study.
- ii. The second section deal with the basic elements for participation in the Erasmus programme.
- iii. The third section contained the basic research questions. The questions concerned the skills acquired or developed by the participants after completing the Erasmus programme.

Method of Data Collection

The research was conducted online, and the questionnaire was created on the Google Forms platform. It was then posted on selected group pages on an official social network in order to collect responses. The groups where it was posted were related to people connected to Erasmus, such as groups of Erasmus+ students and graduates in Greece. The questionnaire took no more than 10 minutes to complete. The data was collected from 03/12/2021 to 26/12/2021.

Method of Data Analysis

At the end of the period, a data file was created and analysed using the statistical programme SPSS Statistics 2.5.

Research Results

Reliability Check

The reliability of the research instrument was examined using Cronbach's Alpha reliability coefficient. The results showed that the overall reliability of the questionnaire was high for all 32 questions and is 0.950. A similar high reliability was also found in the other two sub-sections of the questionnaire where the alpha was 0.936 for a total of 30 questions and 0.909 for a total of 25 questions. These results showed that it was a reliable research instrument that could be used in other similar studies.

Demographic Characteristics of the Sample

According to the results of the 150 participants, 67.3% (N=101) of them were women and 32.7% (N=49) were men. The age group with the highest incidence rate was between 18 and 25 years old (N=89, N%=59.3%). In terms of educational level, 61.3% (N=92) had a bachelor's degree, 36.7% (N=55) had a master's degree and only 2% (N=3) had a PhD. Regarding the employment status of the participants, 68% (N=102) reported that they were employed, 22% (N=33) that they were unemployed and 10% (N=15) that they were not employed, i.e. they were not looking for work during this period. Of those who reported being employed, 90.1% (N=100) worked in a private company and 9.9% (N=11) in a public company/organisation. The academic field where 30.7% (N=46) of the participants graduated was social sciences. Then 23.3% (N=35) graduated in engineering and technology, 20.7% (N=31) in humanities and arts and 10.7% (N=16) in medicine and health sciences. The percentage of those with a degree in natural sciences (N=14, N%=9.3%) and agricultural sciences & veterinary medicine (N=8, N%=5.3%) was lower.

Data on Participation in the Erasmus Programme

Regarding the reason for participation, 66.7% (N=100) of the sample indicated that their

participation was for study, while 20.7% (N=31) wanted to do an internship. Then, the majority of the sample, i.e. 48% (N=72) answered that their participation in the programme lasted for 6 months, 41.3% (N=62) of the participants answered that their participation in the programme was shorter than 6 months, 9.3% (N=14) participated for 1 year and 1.3% (N=2) said that they participated for more than 1 year.

In addition, participants whose semester of study was shorter are expected to be less interested in learning about what is happening in the world on a daily basis ($r=-0.199$), less knowledgeable about social and political concepts such as democracy, justice, equality, citizenship, and civil rights ($r=-0.222$), and less engaged in a shared vision with others ($r=0.191$) (Table 1).

In addition, participants who have participated in the Erasmus programme for a longer period of time are expected to be able to plan and organise work-related activities ($r=0.195$), feel more able to take on professional tasks with high responsibility after their stay abroad ($r=0.181$), use the internet, social media and PC, e.g. for their studies, work and personal activities ($r=0.200$), have a clearer idea of their professional ambitions and goals ($r=0.161$), have better communication skills ($r=0.184$) than those who had a shorter participation period. Last but not least, participants who took part in the Erasmus program for a longer period of time reported feeling less European ($r=-0.203$) (Table 1).

Table 1

Investigating Correlations

	Reason for participating in the Erasmus programme	Semester of study where participation in the Erasmus programme took place	Duration of participation in the Erasmus Programme
I would like to work in an international context	0,190*		
I can plan and organise activities related to my work			0,195*
I feel more able to take on professional tasks with high responsibility after my stay abroad			0,181*
I am more interested in learning what is happening in the world everyday		-0,199*	
I use the internet, social networks and computers, e.g. for my studies, work and personal activities			0,200*
I have a clear idea of my career aspirations and goals			0,161*
I am more aware of social and political concepts such as democracy, justice, equality, citizenship and civil rights		-0,222**	
I feel more European			-0,203*
I have shared vision with others		-0,191*	
I think I have communication skills			0,184*

I think I have professionalism, responsibility, commitment, ethics, ability to perform			0,170*
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*p-level = 0.05 **p-level=0.01

Source: authors' own development.

Discussion

Soft skills are seen as essential to meet labour market challenges such as the increasing pace of globalisation, cultural diversity in organisations and the growing need to retain talent in companies (Garcia-Esteban & Jahnke, 2020; Wagenaar, 2020). Both official studies by European institutions and studies in the academic literature have found that Erasmus could have a positive impact on students' employability (Confalonieri et al., 2016; European Commission, 2019; Caparros-Ruiz, 2019).

The research explored the contribution of participation in the Erasmus programme to the development and/or enhancement of graduates' soft skills, which are considered important in the labour market and employability, in order to determine whether there may be a mismatch between the supply and demand of soft skills in the country. The study participants considered that they have developed skills such as adaptability, flexibility and resourcefulness, as well as skills such as motivation, enthusiasm, passion, positivity, drive and dynamism. After that, participants indicated that they have developed skills such as professionalism, responsibility, commitment, ethics and performance, and in similar percentages they judged that their participation in the programme has contributed to the development of creative problem-solving skills.

However, Table 2 shows that the soft skills most in demand by employers in Europe according to the ErasmusJobs Study (2021) are compared to those most developed by the participants in this study after their participation in the Erasmus programme.

Table 2

Comparison of the Skills of the Erasmus Graduates in the Sample and the Skills Required by Employers in Europe Based on the Erasmus Jobs Survey (2021)

Soft skills that employers demand	Soft skills from research participants
1. Adaptability, flexibility, nimbleness	1. Adaptability, flexibility, nimbleness
2. Motivation, enthusiasm, passion, positivity, drive, dynamism	2. Motivation, enthusiasm, passion, positivity, drive, dynamism
3. Communication skills	3. Professionalism, responsibility, commitment, ethics, ability to perform
4. Professionalism, responsibility, commitment, work ethic, ability to perform	4. Creative problem solving
5. Creative problem solving	5. Proactivity, taking initiative
6. Proactivity, taking initiative	6. Communication skills

Source: authors' own development.

So, from the above comparison, the first thing that emerges is that there is a match in the first two groups of soft skills. The employers in the ErasmusJobs Survey (2021) considered the skills adaptability, flexibility and resourcefulness to be more important, as well as the skills motivation, enthusiasm, passion, positivity, drive and dynamism, and on the other hand, the Erasmus graduates in our survey considered that the same skills have developed more through their participation in the mobility

programme. On the other hand, discrepancies between skills were also found in this survey. Communication skills were the most important, ranking third among employers but with the lowest average score among participants in this survey. The ranking of the remaining three skill groups, namely professionalism, responsibility, commitment, ethics and performance, creative problem solving, and initiative and enterprise, followed the same order of importance in the two studies.

Conclusions and Implications

The appropriate development of university students' soft skills, which are necessary in the modern labour market, is a topic that has been studied extensively in the literature in recent years. However, few studies to date have looked at the role of the Erasmus mobility programme in the development of graduate soft skills and its efficacy to fill such skills gaps in the labour market and thus improve employability. This study examined the extent to which the participation of former students and current graduates (with and without employment) in the Erasmus Mobility Programme has contributed to the development of soft skills and qualitative soft skills that are now considered essential for student employability due to the demand of employers in the labour market.

The participation in Erasmus can contribute to the development of skills and the redesign of higher education curricula to ensure that graduates have developed high-quality soft skills (van Kemenade, 2012; Cimatti, 2016).

The design of quality mobility programs is imperative to enhance the benefits of the Erasmus programme, since, for example, Confalonieri's et al. (2016) study identified some weak points that need to be improved to enhance the impact of the programme on employability. These included improving the system of recognition of study abroad and financial support, particularly for students from disadvantaged groups.

Host nations and institutions participating in the Erasmus programme should:

- 1) promote the development of peer mentoring and peer learning programs to ensure that mobile students are integrated into the host nation or institution;
- 2) promote the provision of convenient and reasonably priced facilities, such as housing, catering, and transportation for mobile students;
- 3) encourage the provision of guidance to students on the better use of learning mobility in order to develop their knowledge, skills and competences;
- 4) encourage the provision of guidance to mobile students upon their return, on how to use the competences acquired during their stay abroad;
- 5) provide assistance for the reintegration of mobile students after a long stay abroad (European Commission/EACEA/Eurydice, 2013).

These are consistent with proposals released by the European Commission and the Council of Europe highlighting priority areas for improving the quality of learning mobility. It is suggested, for example, that existing quality maps, such as the European Quality Charter for Mobility and national and regional maps, be leveraged to ensure high-quality mobility and improve quality assurance in all aspects of mobility. The Council also encourages ongoing dialogue and explicit arrangements between sending and receiving schools, such as the creation of learning agreements. Recognising the knowledge, skills, and competencies earned abroad is encouraged, as are clear selection methods, peer interchange, and structured support for students. To ensure quality, it is proposed that regular feedback mechanisms be

incorporated after the fact.

The differences in skill importance observed between this survey participants and the employers in the ErasmusJobs Survey (2021) are consistent with the findings of Mourshed et al. (2012), which involved 2,600 employers, 5,300 students, and 700 educational institutions in France, Germany, Greece, Italy, Portugal, Spain, Sweden, Germany, Italy, Portugal, Spain, and the United Kingdom, and concluded that one-third of European companies faced recruitment problems. In Greece, 45% of Greek firms reported issues due to a lack of skills among new labour market entrants. These findings are also consistent with a recent Greek study on the important soft skills required in the labour market conducted by Tsirkas et al. (2020), which discovered that workers' soft skills levels do not fulfil employers' expectations.

Given the existing gap in soft skills in the modern labour market in Greece and other European countries, it is noted that student mobility could potentially fill this gap in the future by helping HE students to develop their skills and thus contribute to their employability.

On the other hand, employers need to give regular input on the skills that university graduates need. Promoting employability and developing competencies is a one-way path for policymakers in higher education. This has caused universities to reassess their concerns about the employment of their graduates and the gaps between the competencies they acquired during their academic education and what businesses ultimately need (Urquía -Grande & Perez Estebanez, 2020).

To summarise, internationalisation of education is a significant strategy to boost graduates' employability. Erasmus is a flagship mobility program that reinforces the beneficial effects indicated above, which contribute to young people's academic and personal growth.

Limitations

Certain limitations of the research must be addressed. The first and most important of them is the representativeness of the sample, which influences the further findings' applications. Because the survey is being performed online, neither a representative nor a random sample can be chosen, raising the concern of self-selection bias. As a result, it is unknown to what extent the survey sample is typical of the population and whether the survey results may be extrapolated to the total population of Erasmus graduates in Greece. However, due to the COVID-19 outbreak that was sweeping through Greece, the survey had to be conducted online.

Online surveys are also inconvenient for reaching the entire residents. Only those with an internet connection and, in the case of this poll, access to social media were allowed to participate. For this study, the only persons who can use them are those who have access to social media and the internet. Those who do not have such access, in contrast to those who do, are not intentionally chosen to participate. This inherent bias in population coverage is a fundamental problem.

According to a study conducted by the Research and Analysis Agency (Demertzis et al., 2020), access to the internet and social networks is higher in the younger age groups (15-24, 25-34, and 35-44), compared to the older age groups (over 45), with the usage rate for 2019 being very similar (97.8% for 15-24 year old, 97.1% for 25-34 year old, and 93.1% for 35-44 year old). As a result, it is expected that this restriction had no effect on survey results.

Suggestions for Future Research

Because there are few relevant studies in Greek literature, there is a need to redo the study with more representative samples of the population of higher education graduates and Erasmus participants

in the future.

Furthermore, while the ErasmusJobs (2021) study is important for the European labour market, relevant research in Greece would be beneficial in order to better understand the needs of local employers and to more accurately compare the soft skills that prospective employees currently possess with those that they acquire through Erasmus participation.

Given Greece's recent high unemployment rates among young higher education graduates, more research into whether and to what extent this is true would be good.

References

- Baranova, T., Kobicheva, A., & Tokareva, E. (2020). The impact of Erasmus program on intercultural communication skills of students. *E3S Web of Conferences*, 164, Article 12013. https://www.e3s-conferences.org/articles/e3sconf/pdf/2020/24/e3sconf_tpacce2020_12013.pdf
- Brandenburg, U., Taboadela, O., & Vancea, M. (2015). Mobility matters: The ERASMUS impact study. *International Higher Education*, (82), 5–7. <https://doi.org/10.6017/ihe.2015.82.8863>
- Bryła, P. (2015). Self-reported Effects of and satisfaction with international student mobility: A large-scale survey among Polish former Erasmus students. *Procedia - Social and Behavioral Sciences*, 191, 2074–2082. <https://doi.org/10.1016/j.sbspro.2015.04.248>
- Cairns, D., Krzaklewska, E., Cuzzocrea, V., & Allaste, A. A. (2018). Introducing Erasmus. In *Mobility, Education and Employability in the European Union*. Cham: Palgrave Macmillan. <https://link.springer.com/book/10.1007/978-3-319-76926-4>
- Cairns, D. (2019). Researching social inclusion in student mobility: Methodological strategies in studying the Erasmus programme. *International Journal of Research & Method in Education*, 42(2), 137–147. <https://doi.org/10.1080/1743727X.2018.1446928>
- Caparros-Ruiz, A. (2019). Doctorate holders' careers in Spain: Does international mobility matter? *European Journal of Education*, 54(1), 117–136. <https://doi.org/10.1111/ejed.12326>
- Centre for European Progression. (2017, December 1). *Let there be Erasmus. 30 years of European student exchange*. <https://c4ep.eu/let-there-be-erasmus/>
- Cimatti, B. (2016). Definition, development, assessment of soft skills and their role for the quality of organizations and enterprises. *International Journal for Quality Research*, 10(1), 97–130. <http://dx.doi.org/10.18421/IJQR10.01-05>
- Confalonieri, M. A., Avezzù, C., Miano, S., & Veronese, V. (2016). International quality mobility: Validation of the intercultural experience in terms of soft skills and enhanced employability. *Journal of International Mobility*, 1(4), 129–148. <https://www.cairn.info/revue-journal-of-international-mobility-2016-1-page-129.htm>
- de Wit, H. (2019). Internationalization in higher education, a critical review. *SFU Educational Review*, 12(3), 9–17. <https://doi.org/10.21810/sfuer.v12i3.1036>
- Deakin, H. (2014). The drivers to Erasmus work placement mobility for UK students. *Children's Geographies*, 12(1), 25–39. <https://doi.org/10.1080/14733285.2013.851063>
- Demertzis, N., Mandenaki, K., & Tsekeris, C. (2020). *Private life and surveillance in the internet: The age of post-privacy* [in Greek]. Athens: EKKE.
- Ellis, M., Kisling, E., & Hackworth, R. G. (2014). Teaching soft skills employers need. *Community College Journal of Research and Practice*, 38 (5), 433–453. <https://eric.ed.gov/?id=EJ1022705>

- Engel, C. (2010). The impact of Erasmus mobility on the professional career: Empirical results of international studies on temporary student and teaching staff mobility. *Belgeo*, (4), 351–363. <https://doi.org/10.4000/belgeo.6399>
- Erasmus Skills (2021). *Flyer Erasmus Skills 2020*. https://erasmuskills.eu/eskills/Flyer_Erasmus_Skills_2020.pdf
- ErasmusJobs (2021). Report T1.6 - Skills needed by employers. https://erasmusjobs.org/docs/Skills_needed_by_employers-ERASMUSJOBS.pdf
- European Student Network. (2021a). *ESNs survey - XIV Edition: "Understanding the experiences and needs of exchange students in challenging times"*. <https://esn.org/esnsurvey>
- European Student Network. (2021b). *Skills gained through Erasmus+ Mobility*. <https://esn.org/news/erasmus-skills-closing-conference>
- European Commission. (2019). *Erasmus+ Higher Education Impact Study*. http://sepie.es/doc/comunicacion/publicaciones/2019/erasmus_higher_education_impact_study.pdf
- European Commission. (2020). *Factsheets and statistics on Erasmus+*. <https://erasmus-plus.ec.europa.eu/resources-and-tools/statistics-and-factsheets>
- European Commission. (2021). *The new SkillsMatch platform tackles skills assessment and matches your skills with training*. <https://digital-strategy.ec.europa.eu/en/news/new-skillsmatch-platform-tackles-skills-assessment-and-matches-your-skills-training>
- European Commission/EACEA/Eurydice (2013). *Towards a Mobility Scoreboard: Conditions for Learning Abroad in Europe*. Luxembourg: Publications Office of the European Union. <https://www.eurydice.si/publikacije/Towards-a-Mobility-Scoreboard-Conditions-for-Learning-Abroad-in-Europe-EN.pdf>
- Garcia-Esteban, S., & Jahnke, S. (2020). Skills in european higher education mobility programmes: Outlining a conceptual framework. *Higher Education, Skills and Work-Based Learning*, 10(3), 519–539. <https://doi.org/10.1108/HESWBL-09-2019-0111>
- Ghani, E. K., Rappa, R., & Gunardi, A. (2018). Employers perceived accounting graduate soft skills. *Academy of Accounting and Financial Studies Journal*, 22(5), 1–11. <https://www.abacademies.org/articles/Employers-Perceived-Accounting-Graduates-Soft-Skills-1528-2635-22-5-288.pdf>
- Hendarman, A. F., & Cantner, U. (2018). Soft skills, hard skills, and individual innovativeness. *Eurasian Business Review*, 8(2), 139–169. <https://doi.org/10.1007/s40821-017-0076-6>
- Krzaklewska, E., & Krupnik, S. (2005). *The experience of studying abroad for exchange students in Europe*. Erasmus Student Network. https://www.academia.edu/3698722/The_experience_of_studying_abroad_for_exchange_students_in_Europe
- Marin-Zapata, S. I., Román-Calderón, J. P., Robledo-Ardila, C., & Jaramillo-Serna, M. A. (2021). Soft skills, do we know what we are talking about? *Review of Managerial Science*, 16(4), 969–1000. <https://doi.org/10.1007/s11846-021-00474-9>
- Martínez-Usarralde, M. J., Pausá, J. M., & García-López, R. (2017). The ERASMUS experience and its capacitating potential: Analysis of adaptive capabilities. *International Journal of Educational Development*, 53, 101–109. <https://doi.org/10.1016/j.ijedudev.2017.01.001>
- Mourshed, M., Farrell, D., & Barton, D. (2012). *Education to employment: Designing a system that works*.

McKinsey Center for Government. <http://mckinseysociety.com/education-to-employment/report/>

Nickson, D., Warhurst, C., Commander, J., Hurrell, S. A., & Cullen, A. M. (2012). Soft skills and employability: Evidence from UK retail. *Economic and Industrial Democracy*, 33(1), 65–84. <https://doi.org/10.1177/0143831X11427589>

Papageorgiou, I. (2015). *Sampling theory*. Athens: Association of Greek Academic Libraries.

Perez-Encinas, A., Gabriels, W., & Ripmeester, N. (2021). Erasmus Skills: unpacking the employability benefits of mobility. *European Association for International Education*. <https://www.eaie.org/blog/erasmus-skills-employability-mobility.html>

Ribeiro, A. (2021) Erasmus at 30: Institutional mobility at higher education in perspective. In D. Cairns (Ed.), *The Palgrave handbook of youth mobility and educational migration*. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-030-99447-1_16

Rodrigues, M. (2013). *Does student mobility during higher education pay? Evidence from 16 European countries*. Luxembourg: Publications Office of the European Union. <https://dx.doi.org/10.2788/95642>

Succi, C., & Canovi, M. (2020). Soft skills to enhance graduate employability: comparing students and employers' perceptions. *Studies in Higher Education*, 45(9), 1834–1847. <https://doi.org/10.1080/03075079.2019.1585420>

Tran, L. T., Phan, H. L. T., & Bellgrove, A. (2021). There's a much bigger world of science than just Australia': Australian students' development of disciplinary knowledge, transferable skills and attributes through a New Colombo Plan short-term mobility program to Japan. *International Journal of Science Education*, 43(4), 888–905. <https://doi.org/10.1080/09500693.2021.1891322>

Tsirkas, K., Chytiri, A.-P., & Bouranta, N. (2020), The gap in soft skills perceptions: A dyadic analysis. *Education + Training*, 62(4), 357–377. <https://doi.org/10.1108/ET-03-2019-0060>

Urquía-Grande, E., & Perez Estebanez, R. (2021). Bridging the gaps between higher education and the business world: internships in a faculty of economics and business. *Education & Training*, 63(3), 490–509. <https://eric.ed.gov/?id=EJ1292994>

van Kemenade, E. (2012). Soft skills for TQM in higher education standards. *ASQ Higher Education Brief*, 5(2). https://www.academia.edu/5608289/Soft_skills_on_TQM_in_Higher_education

Wagenaar, R. (2020). *Defining, promoting and measuring transferable skills, social and civic competences: trends and challenges in higher education*. European Commission. http://obe.edu.mn/media/uploads/2020/03/16/international-tuning-academy_wagenaarpdf.pdf

Whitmore, P. G., & Fry, J. P. (1974). *Soft skills: Definition, behavioral model analysis, training procedures*. National Technical Information Service, Springfield. <https://eric.ed.gov/?id=ED158043>

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Track Prospective Mathematics Teachers' Understanding of Special Quadrilaterals: An Exploration of Level 3 of Geometric Thinking

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Abstract: Acknowledging the value of understanding defining and classifying special quadrilaterals for prospective mathematics teachers (PMTs), the present study attempts to track this understanding so that the progress of thinking from Van Hiele's level 2 to level 3 could be theorised. Thus, a bounded case study sample of PMTs, who had graduated and joined the mathematics teacher

preparation diploma at the Faculty of Education, Tanta University in Egypt, were selected and requested to (a) define trapezoid, parallelogram, rhombus, rectangle, and square, and (b) represent the relationship among these quadrilaterals. The data were collected and analysed in two cycles. During the first cycle, participants' responses were scrutinised upon Prototype 1; it was developed based on the literature review to describe levels of special quadrilaterals understanding as faulty, partitional-uneconomical, partitional-economical, hierarchical-uneconomical, and hierarchical economical. Similarly, the researchers replicated the same analytical process in the second cycle in order to validate the levels suggested in Prototype 1. Also, some clinical interviews were conducted to confirm the participants' representations of relationships among the defined quadrilaterals. The results enabled advancing the hypothetical Prototype 1 to Prototype 2. Prototype 2 reconceptualised the levels of understanding into faulty, slightly economical, fairly economical, and economical, wherein each level was determined based on (a) the economics of the concept definition and (b) the awareness of relationships among other related definitions to the concept defined (recognising subsets and supersets). These results are prospective for further investigations to sufficiently unpack all sub-levels of geometric thinking embedded in Van Hiele's fixed levels. It also provides basics on proper pedagogical approaches and corresponding interventions to train PMTs effectively teach geometric thinking.

Keywords: Definitions Understanding, Egyptian Education, Geometry Education, Quadrilaterals, Van Hiele Theory

Introduction

On the importance of definitions, De Villiers (1998, p. 249) declared that “(defining) is a mathematical activity of no less importance than other processes such as solving problems, making conjectures, generalising, specialising, proving, etc.”. Definitions allocate properties to mathematical objects, thus, providing a precise meaning for concepts and helping classify them (Alcock & Simpson, 2017; Fujita & Jones, 2007). Furthermore, processes of teaching and learning definitions represent a significant research theme, as described by Sinclair et al. (2016), wherein learners' understanding of defining and classifying shapes determines a meaningful research question to answer. Particularly for mathematics teachers, those who rely on their knowledge of definitions while selecting the pedagogical approaches to teaching these definitions to students (Avcu, 2022; Susanto, 2020). Notably, the importance of emphasising teachers' knowledge stems from what is demonstrated in most literature regarding the strong association between this knowledge, teachers' instructional practices, and students' learning outcomes (Kelcey et al., 2019).

More specifically, the topic of quadrilaterals considers a substantial area of research on reasoning skills that could be developed through recognising geometric figures and exploring and linking their characteristics to form deductive inferences (Okazaki & Fujita, 2007; Van de Walle et al., 2012, as cited in Erdogan & Dur, 2014). Yet, it stays among geometry topics wherein learners experience various difficulties, including defining quadrilaterals and determining relationships among them (Fujita, 2012; Özerem, 2012; Şahin & Başgöl, 2020). These difficulties continue even in today's mathematics classrooms because it has multiple origins that, side by side, need to be improved to guarantee the quality of the intended outcomes. They are classified under three categories (a) epistemological (related to students' understanding), (b) ontogenic (students' readiness and maturity), and (c) didactic obstacles (teachers' practices) that are underlined in this study (Brousseau, 2006, as cited in Lutfi et al., 2021).

Defining quadrilaterals requires perceiving necessary and sufficient conditions, which cannot be accomplished before the 2nd level of geometric thinking, according to Van Hiele's theory (Duartepe-Paksu et al., 2012). This could be interpreted within the scope of geometry standards by the National Council of Teachers of Mathematics (NCTM), wherein students should be able to "analyse characteristics

and properties of two- and three- dimensional geometric shapes and develop mathematical arguments about geometric relationships" (NCTM, 2000, p. 41). Seriously, if this is expected from pre-k-12 school students, what about prospective teachers who should sustain students in attaining these expectations? Do they possess such knowledge? Do current educational courses help them develop adequate knowledge of basic geometric figures?

That is highlighted in Şahin and Başgöl's (2020) study in which, besides the limited representation of concepts in textbooks and the complicated structure of quadrilaterals, the inadequate teachers' knowledge regarding concepts and their focus on the prototypical models remains one reason why students maintain several misconceptions (e.g., failure to expressing the notion of parallelism in cases of rectangles and squares, portray a rectangle as a combination of two squares [Ozkan & Bal, 2017]). As concluded, previous research revealed that most prospective teachers stay unable to (1) precisely define, classify, and determine the minimal characteristics of quadrilaterals; (2) recognise relationships among quadrilaterals; also (3) their level of geometric thinking related to this topic is low (Çontay & Paksu, 2012; Duatepe-Paksu et al., 2012; Erdogan & Dur, 2014; Fujita & Jones, 2007; Fujita, 2012; Kuzniak & Rauscher, 2007; Miller, 2018; Pagiling & Nur'aini, 2022; Pickreign, 2007). For example, in Fujita and Jones's (2007) study regarding how trainee elementary school teachers (aged 18) define special parallelograms and how they perceive relationships among them, it was found that merely 12%, 58.9%, 21.5%, and 38% of participants were able to accurately define trapezoids, parallelograms, rectangles, and squares, respectively. Furthermore, in 2012, Fujita reported that trainee teachers and lower secondary school students are likely to identify quadrilaterals by prototypical examples, which causes difficulties in comprehending the inclusion relationships.

A similar investigation was conducted by Erdogan and Dur (2014), wherein the results revealed that the participants (pre-service primary mathematics teachers) were affected by the prototypical images of quadrilaterals learned during their schooling years and, consequently, they were neither able to use the hierarchical definitions of quadrilaterals nor recognize relationships among them. In detail, although some teachers correctly defined trapezoids, parallelograms, rectangles, rhombuses, and squares, only 40% of those teachers were able to demonstrate hierarchical relationships. On the contrary, the results of Ndlovu (2014) were much better, in which the pre-service teachers expressed a higher Van Hiele level of comprehending geometrical definitions than class inclusion.

Also, Ulger and Broutin (2017) examined third-grade pre-service secondary school mathematics teachers' understanding of quadrilaterals in terms of personal and formal figural concepts. The results indicated that the participants based their definitions on prototype figures and partially expressed the internal relationships between quadrilaterals through these definitions; that is, they had difficulty when understanding the inclusion relations of quadrilaterals. Similar to that were Bharaj and Francis's (2020) investigation; it attempted to determine prospective elementary mathematics teachers' (aged 17-24) conceptions of the characteristics of the quadrilaterals. Accordingly, their findings indicated that the participants seemed to have specific prototypical images of quadrilaterals (e.g., the rectangle defines a figure with two long and two short parallel sides and four 90° angles). Such findings were interpreted by Kabaca (2017), wherein he asserted that the individual's first visual definition of a geometric figure (i.e., personal concept image) considers a principal obstacle to perceiving relationships among quadrilaterals.

Recently, Avcu (2022) explained pre-service middle school mathematics teachers' concept definitions of special quadrilaterals considering the linguistic structure of the Turkish names given to these quadrilaterals, wherein the syntactic, semantic, and lexical structures of names given to quadrilaterals were regarded as possible reasons affecting the defining process. This matches Susanto's (2020) argument on the effect of the language on the definition understanding; as stated, "The

terminology in the Indonesian language for rectangle (literally “long square”) has a strong effect on teachers’ concept image” (p. 3); accordingly, it is difficult for learners to pretend that the squares are rectangles. Again, in the Turkish context, Özdemir and Çekirdekci (2022) conveyed teacher candidates’ lack of recognising quadrilaterals by the relationships among them, which resulted from strengthening the edge properties while ignoring the diagonal properties of quadrilaterals; besides, they argued that, generally, contents of undergraduate geometry are not sufficient.

These studies expose that the research on prospective teachers’ understanding of quadrilaterals is yet debatable and requires further investigation; hence, the current study endeavours to contribute to this arena. Briefly stated, rather than presenting characteristics of the lack of understanding of quadrilaterals and their reasons, like what is already detailed in the literature, this study embraces

another perspective of exploring the progression of this understanding. Therefore, on one side, the previously defined deficiencies could be assigned to suitable levels of understanding, and on the other side, future activities could be proposed to overcome them.

Research Problem

Although previous research clarified what difficulties prospective teachers encounter when defining quadrilaterals and some possible causes for these difficulties (e.g., personal concept image, lexical ambiguity, strengthening the edge properties), a few of them have regarded levelling teachers’ understanding of definitions depending upon their accuracy. Besides, the connection between teachers’ definitions and their awareness of relationships among special quadrilaterals is not well expressed throughout the previous studies. Some of these gaps are handled in the current investigation; it aims at uncovering Van Hiele’s level 3 of geometric thinking within the context of quadrilaterals. In other words, the progress of thinking from Van Hiele’s level 2 to level 3 will be described based on teachers’ definitions of special quadrilaterals and their representation of the relationships among them.

According to Van Hiele’s model, the most notable theoretical framework for learning geometric figures and their properties (Wang & Kinzel, 2014), learners at level 1 (Visualization/ Recognition) stay influenced by prototype images or visual properties acquired in their early learning (e.g., parallelograms should be inclined, rectangles have two long and two short sides). Then, at level 2 (Descriptive/ Analytical), they are expected to recognise such figures by their properties. At level 3 (Informal deduction/ Rational), which constitutes the beginning of deductive reasoning and definition formation, learners could define figures hierarchically since they could identify interrelationships among them. As reported by Fujita and Jones (2007, p. 5), “learners at van Hiele level 3 are, for example, expected to be able to deduce that a rectangle is a special type of parallelogram by considering definitions and properties of these quadrilaterals”. Later at level 4 (Formal deduction), they can construct mathematical proofs employing propositions, axioms, and theorems. Finally, at level 5 (Rigor/ Mathematical), learners could transfer their understanding to other non-Euclidean geometries (Çontay & Paksu, 2012; De Villiers, 1994; Fujita et al., 2019; Ndlovu, 2014; Van Hiele, 1986; Wang & Kinzel, 2014).

In general, prospective mathematics teachers are expected to reach these levels to instruct quadrilaterals effectively and not to be among the reason why students face difficulties while learning quadrilaterals (Harper & Driskell, 2021; Ndlovu, 2014; Özdemir & Çekirdekci, 2022; Şahin & Başgöl, 2020). As discussed by Avcu (2022), when teaching definitions of quadrilaterals, teachers should know that (1) the definition must include only necessary and sufficient conditions (common content knowledge) and (2) multiple equivalent and non-equivalent definitions could be generated for a quadrilateral (specialised content knowledge). This corresponds to the context of geometry education in Egypt wherein, even though middle-grade students are formally required to (1) define trapezoids, parallelograms, rhombuses, rectangles, and squares; and (2) describe relationships among them (The

Egyptian Ministry of Education and Technical Education, 2020), several local studies have reported students' inadequacy achieving these objectives (Alhannan, 2019; Almaraghy, 2020; Ekramay, 2020). Besides, a lack of research that regards teachers' side as a possible ground for such difficulties was observed.

Furthermore, and from a theoretical perspective, although several investigations explored how different groups of students define quadrilaterals (see the Introduction), a scarcity of research that utilised the results of such studies to reflect on minor levels of geometric thinking included in Van Hiele's level 3 (i.e., levels of thinking within this main level) was noticed. That is expressed by Wang and Kinzel (2014, p. 289) as follows: "According to the van Hiele model, students begin to form definitions of geometric figures and to reason deductively at Level 3. However, the model does not explicitly describe thinking at this level". Therefore, to fill this gap, the present study aims at exploring sub-levels included in Van Hiele's level 3 of geometric thinking by analysing a case of Egyptian prospective mathematics teachers' understanding of special quadrilaterals and their awareness of relationships among them.

In that sense, the current study matches Wang and Kinzel's (2014) standpoint. That is, Wang and Kinzel (2014) utilized Sfard's (2008) framework (a discursive lens) to analyse prospective teachers' geometric discourse for the case of quadrilaterals, and accordingly, they came up with particulars within Van Hiele's level 3. On the contrary, it differs from others like Çontay and Paksu (2012). In Çontay and Paksu's (2012) research, the participants were asked to classify quadrilaterals wherein their understanding of class inclusion could be clarified and ordered in terms of Van Hiele levels; as a result, each response was assigned to a specific Van Hiele level (e.g., one preservice teacher was at Van Hiele Level 3). Nonetheless, the current study (see the Methodology) hypothesized that all participants already achieved Van Hiele's levels 1 and 2, and the focus is on how they progressed towards the entire accomplishment of level 3.

Research Focus

Considering what is articulated before, the present study, on one hand, extends similar examinations (Avçu, 2022; Wang & Kinzel, 2014) and, on the other hand, clarifies the status of prospective teachers' understanding of special quadrilaterals that constitute the essential issue within the geometry content of middle grades, which is crucial to guide teacher education programs. As emphasised, further studies are needed to explore prospective middle school mathematics teachers' understanding and knowledge of quadrilaterals (Avçu, 2022; Miller, 2018). This is addressed in the current study by placing the focus on a case of prospective mathematics teachers in the Egyptian context so that some deficiencies of local research in this domain could be handled.

Research Aim and Research Questions

This study attempts to explore the progress of thinking from Van Hiele's level 2 to level 3 within the context of quadrilaterals through a case of Egyptian prospective mathematics teachers; accordingly, the following questions are addressed:

- How do prospective mathematics teachers (PMTs) define special quadrilaterals (trapezoids, parallelograms, rhombuses, rectangles, squares)?
- To what extent are PMTs aware of relationships among special quadrilaterals?
- What theoretical model would be appropriate to capture minor levels of Van Hiele's level 3 of geometric thinking within the context of quadrilaterals?

Theoretical Perspective and Prototype 1 of the Framework

In mathematics, processes of defining a concept vary between descriptive (a posteriori) and constructive (a priori) (De Villiers, 1994; De Villiers, 1998). The describing definition, the focus of this study, outlines a known object by distinguishing a few characteristic properties (Freudenthal, 1973, p. 458, as cited in De Villiers, 1998). It is executed by specifying a proper subset (the definition) of the total set of the concept properties from which all other properties could be logically deduced (De Villiers, 1998). In this study, the descriptive definition of special quadrilaterals that dominates most geometry textbooks (Usiskin et al., 2008) is sharpened, wherein the mathematics definition refers to a “collection of words which specifies all the objects to be described, and only them” (Bell & Woo, 1998, p. 56).

As argued by De Villiers (1994) on the relationship between defining and classifying, which are related to each other, the mathematical concept could be defined within either a hierarchical classification or a partitional one. While hierarchical classification represents the concept within a subset of more general concepts, partitional classification identifies each concept as disjoint from another (Fujita & Jones, 2007; Ulger & Broutin, 2017). For instance, the trapezoid could be defined as a quadrilateral with (1) at least one pair of opposite sides parallel or (2) only one pair of opposite sides parallel; that is, the former is hierarchical since it recognized parallelograms as trapezoids, and the latter is partitional wherein parallelograms were excluded from trapezoids. Both definitions are mathematically correct; however, in most cases, the hierarchical definition stays more economical (specify only necessary and sufficient conditions) than the partitional one that requires adding more properties (more than necessary characteristics) to exclude other related concepts (De Villiers, 1994; Fujita et al., 2019). Hence, the hierarchical definition is favoured in mathematics school curricula (Fujita & Jones, 2007) since it reflects a further understanding of the relationships among quadrilaterals (inclusion relationships) and helps in advancing deductive reasoning and proof (Erez & Yerushalmy, 2006, as cited in Ulger & Broutin, 2017; Fujita, 2012).

The above-documented classification of De Villiers (1994) was prescribed by Usiskin et al. (2008) using terms exclusive and inclusive that match the partitional and hierarchical definitions, respectively. While the exclusive definition is correct for a specific quadrilateral, the inclusive one would be valid for a family of quadrilaterals. Recently, Bütüner and Filiz (2017) classified Turkish teachers' definitions of quadrilaterals as erroneous, prototype, and hierarchical. Although both determine proper definitions, the former is correct for a specific concept only, while the latter stands valid for this concept and its special cases (group). Again, prototype and hierarchical definitions correspond to De Villiers's (1994) classification of partitional and hierarchical, respectively.

Based on this argument, it was hypothesized that PMTs' special quadrilaterals understanding could be ordered as follows: (L0) faulty, (L1) partitional-uneconomical, (L2) partitional-economical, (L3) hierarchical-uneconomical, and (L4) hierarchical-economical that reflect the entire attainment of Van Hiele's level 3 in the context of quadrilaterals (see Table 1). Noting that economical and uneconomical correspond to Zazkis and Leikin's (2008) notions of minimal and non-minimal definitions, respectively; while the former includes parts that cannot be implied from other properties of the definition, the latter contains additional properties more than the necessary ones. Besides, the concept definition, according to this study, refers to the *personal concept definition* that is defined by Tall and Vinner (1981, p. 152) as “the form of words that the student uses for his own explanation of his (evoked) concept image”, which might or might not, equal to the formal concept definition.

Table 1*Levels of Special Quadrilaterals Understanding “Prototype 1”*

<i>Levels of a quadrilateral understanding</i>		<i>Characteristics of the level</i>	
		<i>Attributes of a quadrilateral</i>	<i>Consideration of Inclusion relationships</i>
<i>L2. Faulty ($\leq$ Van Hiele's level 2)</i>		X (Not relevant; not sufficient; not necessary)	X (Not considered)
<i>Level 2 < Partial understanding < level 3</i>	<i>L2.1 Partitional uneconomical</i>	√ (More than the sufficient attributes)	X (Not considered)
	<i>L2.2 Partitional economical</i>	√ (Only the sufficient attributes)	X (Not considered)
	<i>L2.3 Hierarchical uneconomical</i>	√ (More than the sufficient attributes)	√ (Considered)
<i>Full understanding = level 3</i>	<i>L3. Hierarchical economical</i>	√ (Only the sufficient attributes)	√ (Considered)

Table 1 describes the predetermined analytical framework inspired by similar previous studies (Avcu, 2022; Ndlovu, 2014). In detail, Ndlovu (2014) classified understanding of definitions into non-standard, economical, uneconomical, very uneconomical, incorrect, and uninterpretable. Furthermore, Ndlovu's (2014, p. 6650) study results concluded that “allowances should be made for differences in geometrical understandings within individual students and that the Van Hiele theory be interpreted in broader terms to allow for partial attainment of a level”, which confirms the viewpoint of this study. Alike, based on the sufficiency and necessity of articulated properties of definitions, Avcu's (2022) framework (adapted from Zazkis and Leikin (2008)) scored degrees of correctness of definitions into 0, 1, and 2 points to indicate neither necessary nor sufficient conditions (0), necessary but not sufficient conditions or sufficient but not necessary conditions (1), and necessary and sufficient conditions (2), respectively. Moreover, the correct definitions with necessary and sufficient conditions were further classified as minimal, barely not minimal, or significantly not minimal (or improper terms).

Research Methodology

General Background

The present study represents a case study that is viewed by Creswell (2007, p. 73) as “a methodology, a type of design in qualitative research, or an object of study, as well as a product of the inquiry”. Specifically, it defines a single instrumental case study that fits the study perspective; that is, the concern of Van Hiele's level 3 of geometric thinking was focused; accordingly, a bounded case of PMTs was selected to illustrate this concern (Creswell, 2007). This bounded case – the study participants – already accomplished Van Hiele's level 2, as detailed in the next section.

Participants

The data were collected from a purposeful sample of PMTs (24 participants) who accomplished Van Hiele's level 2. This intentional selection of participants happened in light of the standard of mastering level 2 of geometric thinking; thus, the intended progression of thinking toward level 3 could be sharpened. All the study participants were regular graduate students enrolled in a diploma program that aims to prepare non-educational graduates to be mathematics teachers during the two consecutive academic years 2021/2022 and 2022/2023.

Generally, those participants, ranging between 25-40-year-old, shared similar common knowledge of mathematics since they all graduated from technical faculties (science and engineering)

and joined this diploma to be able to work in the education field. In addition, they gained some experience on the topic of special quadrilaterals during the Teaching Methods course that was mandatory to register.

Procedures of Data Collection and Analysis

At first and before collecting the primary data, it was essential to ensure that the participants had already reached Van Hiele's level 2 where they could list the properties of special quadrilaterals (Ndlovu, 2014). To do so, during the microteaching course, a group of PMTs was invited to draw instances of a trapezoid, parallelogram, rhombus, rectangle, and square; and to determine each quadrilateral property. Accordingly, the study sample was selected; it specified 24 participants who could distinguish quadrilaterals by related properties (i.e., meet the study criteria).

Next, considering multiple relevant studies that investigated learners' knowledge of quadrilaterals and their understanding of the inclusion relationships (Avcu, 2022; Bütüner & Filiz, 2017; Erdogan & Dur, 2014; Fujita & Jones, 2007; Ndlovu, 2014; Syamsuddin, 2019), a survey was used to collect the principal data required for this study. This was done after obtaining the demanded permissions from the faculty and cordial consensus from the participants to share their responses anonymously merely for research concerns; alternatively, their answers would not be considered for the formal assessment of the course.

This survey consisted of two main questions: (Q1) *Define the following special quadrilaterals (in one or more different ways):* trapezoid, parallelogram, rhombus, rectangle, and square; (Q2) *Represent the relationship among the quadrilaterals defined in Q1.* The participants were asked to respond to these questions in their language (The Arabic language) with no time rules; however, it took them around 45 minutes to complete it. Although the given questions were consistently found in the literature, they were further judged by local mathematics educators regarding their language clarity and suitability to explore PMTs' understanding of special quadrilaterals.

The participants' answers were collected and analysed within two cycles. The first was accomplished in November 2021, wherein 16 PMTs' responses to both questions were scrutinized considering Prototype 1. In other words, the researchers evaluated the possibility of each response being designated to each level of understanding described in Prototype 1. One year later, in November 2022, 8 PMTs partook in this study by answering the same questions, in which their responses helped validate Prototype 1. That is, the researchers replicated the same analytical process performed in the first cycle to confirm whether all responses could be included in the suggested levels. As shown in Tables 3-7 (see the Results), definitions written in black, blue, and red colours denote PMTs' responses that emerged in the first cycle, second cycle, and both cycles, respectively.

Besides the researchers' agreement on the classification of responses, and to ensure the validity of the content analysis in this study, it was compared to categorizations of data in other related studies like Duatepe-Paksu et al. (2012) and Bütüner and Filiz (2017). For example, in Bütüner and Filiz's (2017) analysis, mathematics teachers' definitions of special quadrilaterals were categorized as hierarchical, prototype, and erroneous or partially hierarchical. Bütüner and Filiz (2017) first determined the validity of a definition; if it was not valid, it was classified as erroneous/ partially hierarchical/ partially accurate, which matches the level of faulty in the current study. On the other side, if it was correct, they classified it as either hierarchical or prototype; hierarchical if it was proper for all special cases of the given quadrilateral, while if not, it should be a prototype definition. This seems as if the prototype definition in Bütüner and Filiz's (2017) study combines the partitional levels (economical/ uneconomical) proposed in the current study. Concretely, in Bütüner and Filiz's (2017) analysis, they noted that a trapezoid could be defined (a) hierarchically as a quadrilateral having two at

least a pair of parallel sides or (b) prototypically as a quadrilateral having only one pair of parallel sides; that corresponds to the hierarchical economical and partitional economical definitions of a trapezoid, respectively (see Table 3).

In addition to the PMTs' written responses to Q1 in the survey (the data required to answer the first research question), 24 representations of the relationship among special quadrilaterals were portrayed as answers to Q2. Since the main objective of this question was to explore the participants' awareness of the relationships among quadrilaterals, clinical interviews were conducted with the participants to confirm the links that appeared in their represented models. Using both sources of data (written responses and interviews) helped ensure the consistency and validity of the results. For example, the 3 participants who drew Model A (see Figure 6 and the Appendix) declared that there is no relationship between trapezoids and parallelograms. Yet, rhombuses, rectangles, and squares are all special cases of parallelograms. Also, squares maintain the properties of both rhombuses and rectangles. Accordingly, the researchers judged that those participants were aware of all links expressed in Figure 9, except the four associations that include trapezoids. Similarly, after interviewing the participants who displayed relationships as Model B (see Figure 7), their understanding of parallelogram-rhombus, parallelogram-rectangle, and parallelogram-square linkages was verified.

Research Results and Discussion

To answer the first research question (How do PMTs define special quadrilaterals?), the participants were encouraged to document one (or two) definitions of a trapezoid, parallelogram, rhombus, rectangle, and square; still, some participants offered a single definition for each (see Tables 3-7).

Not only participants' written responses were analysed, but also the figures drawn by some supported interpret these responses more confidently. As a result (see Figure 2), around 70% of the delivered definitions were correct, while the incorrect ones had common themes of including (a) necessary but not sufficient conditions and (b) inappropriate terms. The description of these incorrect definitions categories is out of the current study focus; besides, it has already been detailed in Avcu's (2022) investigation.

This high percentage of correct responses was expected since the selected sample already attained level 2 of geometric thinking (see the Methodology). More expressly, the participants demonstrated remarkable performance in generating correct definitions of rhombuses and squares compared to the case of trapezoids and rectangles, which match studies like Miller (2018) and Türnüklü et al. (2013). Furthermore, this result remains close to the results of Ndlovu (2014), who declared that more than 68% of the pre-service teachers (16 participants) were able to define trapezoids (75%), parallelograms (75%), rhombuses (68.6%), rectangles (87.5%), and squares (93.8%) correctly. Also, Erdogan and Dur (2014) reported that the percentages of pre-service teachers' correct definitions of trapezoids, parallelograms, rhombuses, rectangles, and squares were 46%, 96%, 33%, 96%, and 95%, respectively. On the contrary, percentages of correct definitions of special quadrilaterals provided by pre-service teachers were low in other studies such as Duatepe-Paksu et al. (2012), Güner and Gülten (2016), and Özdemir and Çekirdekci (2022). Yet, the correct definitions altered in terms of being economical and inclusive, as determined in prototype 1.

Figure 2

Percentages of Faulty vs. Correct Definitions of Special Quadrilaterals

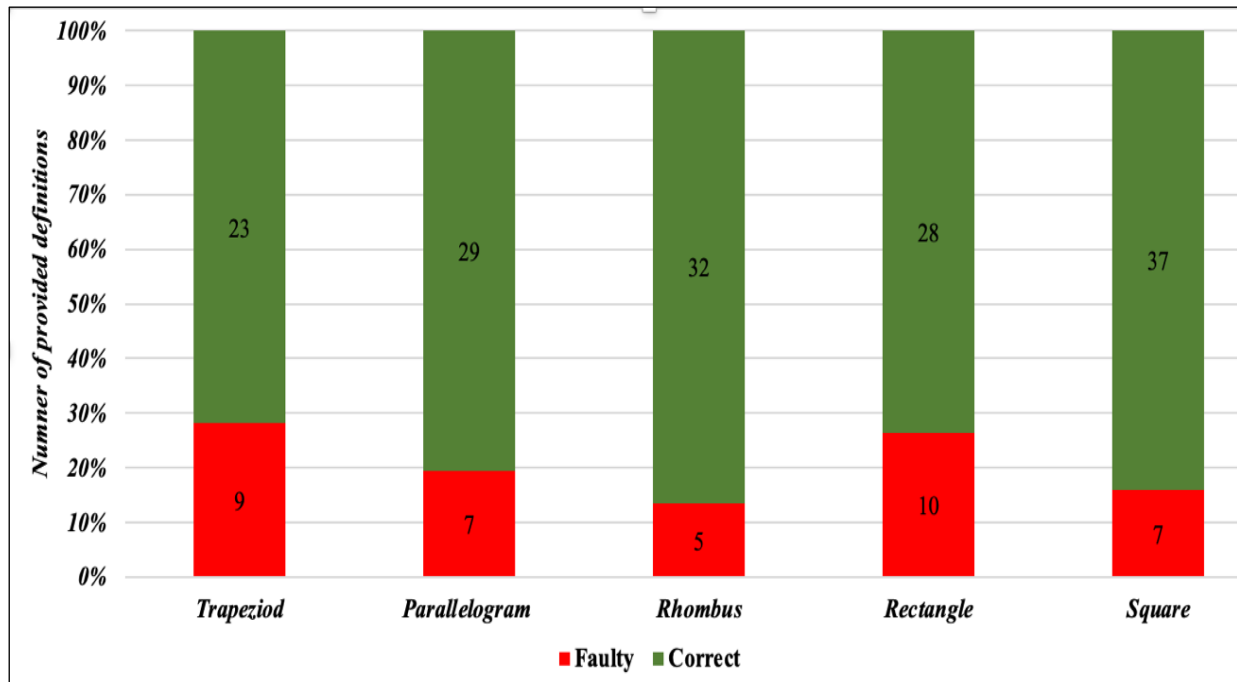


Table 3

PMTs' Levels of Trapezoid Definition Understanding

Levels	PMTs' personal definitions of trapezoid	No.
L2. Faulty	- A quadrilateral with four unequal and non-parallel sides. - A parallelogram with only two opposite parallel/ non-parallel sides. (4) - A parallelogram whose opposite sides are not equal. Necessary but not sufficient conditions: - A quadrilateral with four unequal sides. - A quadrilateral in which each acute angle is opposite to an obtuse angle. Inappropriate terms: - A closed geometric figure with only two sides parallel.	9
L2.1 Partitional uneconomical	A polygon whose sum of interior angles equals 360 degrees with only a pair of opposite sides parallel.	1
L2.2 Partitional economical	- A quadrilateral with only one pair of opposite sides parallel. (13) - A quadrilateral with only one pair of parallel unequal sides. (4)	17
L2.3 Hierarchical uneconomical		0
L3 Hierarchical economical	A quadrilateral with a pair of opposite sides parallel. (5)	5
	Total number of provided definitions of trapezoids	32

Table 4

PMTs' levels of parallelogram definition understanding

Levels	PMTs' personal definitions of parallelogram	No.
L2. Faulty	- A quadrilateral whose diagonals are equal and perpendicular bisectors of each other. - A regular quadrilateral in which each two opposite sides parallel. - A rectangle with two acute angles. <i>Necessary but not sufficient</i> - A quadrilateral with a pair of parallel side. - A quadrilateral with a pair of parallel sides and two adjacent complementary angles. <i>Inappropriate terms</i> - A polygon in which each two opposite sides are parallel and equal in length. - A close geometric figure with two opposite sides parallel and equal in length.	7
L2.1 Partitional uneconomical		0
L2.2 Partitional economical	- A quadrilateral with two unequal adjacent sides and two pairs of opposite sides equal. - A quadrilateral whose unequal non-perpendicular diagonals, but they bisect each other.	2
L2.3 Hierarchical uneconomical	- A polygon whose sum of the interior angles is 360 degrees, and two pairs of opposite sides parallel. - A quadrilateral with two pairs of opposite sides parallel and equal in length. (9) - A quadrilateral with two pairs of opposite sides parallel and equal in length, and whose diagonals bisect each other.	11
L3 Hierarchical economical	- A quadrilateral with two pairs of opposite sides parallel. (13) - A quadrilateral with two pairs of opposite sides equal. (2) - A quadrilateral whose diagonals bisect each other.	16
	Total number of provided definitions of parallelograms	36

Table 5

PMTs' Levels of Rhombus Definition Understanding

Levels	PMTs' personal definitions of rhombus	No
L2. Faulty	- A quadrilateral whose sides are equal in length and whose angles are right angles. - A square with two acute angles. <i>Necessary but not sufficient</i> - A quadrilateral with two pairs of opposite sides parallel and any two adjacent angles are supplementary. - A quadrilateral with two adjacent sides equal and perpendicular diagonals. - A quadrilateral whose diagonals are perpendicular but not equal.	5
L2.1 Partitional uneconomical	A quadrilateral with equal sides and unequal perpendicular diagonals. (2)	2
L2.2 Partitional economical	A quadrilateral with equal sides and no right angles.	1
L2.3 Hierarchical uneconomical	- A quadrilateral with four sides equal and perpendicular diagonals. - A quadrilateral with four sides and four angles, two pairs of opposite sides parallel, and its diagonals bisect each other at 90 degrees. - A quadrilateral with four sides equal and two pairs of opposite sides parallel. - A parallelogram in which each two adjacent sides are equal in length (3).	8

	• A parallelogram whose diagonals are perpendicular and bisect each other. • A parallelogram whose sides are equal, and diagonals are perpendicular to each other.	
L3 Hierarchical economical	• A quadrilateral whose sides are equal. (5) • A parallelogram with two adjacent sides equal. (11) • A parallelogram with perpendicular diagonals. (5)	21
	Total number of provided definitions of rhombuses	37

Table 6

PMTs' Levels of Rectangle Definition Understanding

Levels	PMTs' personal definitions of rectangle	No.
L2. Faulty	• A quadrilateral which could be divided into two squares. • A square whose sides are equal in length and whose diagonals are perpendicular. <i>Necessary but not sufficient</i> • A quadrilateral with two pairs of opposite equal sides. (3) • A quadrilateral with two adjacent perpendicular unequal sides. • A parallelogram with two pairs of opposite parallel and equal sides. (2) <i>Inappropriate terms</i> • A geometric figure in which each two opposite sides are parallel and equal in length. • A geometric figure with only one right angle.	10
L2.1 Partitional uneconomical		0
L2.2 Partitional economical		0
L2.3 Hierarchical uneconomical	• A quadrilateral with two pairs of opposite sides parallel and one right angle (2). • A quadrilateral with two pairs of opposite sides parallel and equal in length; and whose all angles are right. (2) • A quadrilateral with two pairs of opposite sides equal and one right angle. • A quadrilateral with two pairs of opposite sides equal and at least one right angle. • A quadrilateral with two pairs of opposite sides parallel and four right angles. • A parallelogram with four right angles and equal diagonals. (3)	10
L3 Hierarchical economical	• A parallelogram with one right angle. (15) • A parallelogram whose diagonals are equal in length. (3)	18
	Total number of provided definitions of rectangles	38

Table 7

PMTs' Levels of Square Definition Understanding

Levels	PMTs' personal definitions of square	No.
L2. Faulty	<i>Necessary but not sufficient</i> • A quadrilateral with two adjacent equal perpendicular sides. (3) • A quadrilateral whose all sides are equal in length.	7

	• A parallelogram with two adjacent sides equal and whose diagonals bisect each other. • A parallelogram whose diagonals are equal in length. • A four-sided geometric figure with two pairs of opposite sides parallel and all sides are equal in length.	
L2.1 Partitional uneconomical	• A quadrilateral with two pairs of opposite sides parallel, all sides are equal, and all angles are right. • A quadrilateral with equal sides, equal angles, and perpendicular diagonals. • A quadrilateral whose sides are equal, and all angles are right angles. (3) • A regular quadrilateral with one right angle and two adjacent sides equal. • A quadrilateral whose diagonals are equal, bisect each other, perpendicular, and angles bisectors.	7
L2.2 Partitional economical	• A quadrilateral with all sides equal and one right angle. (3)	3
L2.3 Hierarchical uneconomical	• A rhombus whose diagonals are equal, perpendicular, and bisect each other. • A parallelogram whose sides are equal, and all angles are right angles. (3) • A parallelogram whose sides are equal, angles are right angles, and diagonals are equal and perpendicular to each other. • A parallelogram with equal sides, angles are right angles, and two pairs of opposite sides are parallel.	6
L3 Hierarchical economical	• A parallelogram with two adjacent sides equal and one right angle. (11) • A parallelogram whose diagonals are equal and perpendicular to each other. • A rhombus with one right angle. (4) • A rectangle with two adjacent sides equal. (4) • A rectangle whose diagonals are perpendicular.	21
	Total number of provided definitions of squares	44

Based on prototype 1, the data in the above tables are represented in Figure 3. It shows that the two levels of hierarchical economical and hierarchical uneconomical were evident (around 54% and 24%, respectively) compared to both partitional economical and partitional uneconomical (around 15% and 7%, respectively); more precisely, the partitional uneconomical level seemed absent in the participants' definitions, except for some cases of squares, rhombuses, and trapezoids.

In that sense, the researchers anticipated that the determinants of Prototype 1 might be overlapped. Admitting the description of hierarchical and partitional definitions in Erdogan and Dur's (2014, p. 111) study, "The definitions that contain sufficient information to exclude non-examples are called partitional definitions. The definitions that contain all objects including all of the properties and that are more economical and shorter than partitional definitions are called hierarchical definitions", indicates a relationship between hierarchies and the economics of the definition. This was initially noted by De Villiers (1994, p. 15) as one function of the hierarchical classification; it "leads to more economical definitions of concepts"; thus, the "hierarchical definition is shorter than a partitional one which has to include additional properties". Alternatively stated, defining quadrilaterals hierarchically promotes constructing the definition more economically. This is noticeable in Figure 3 when comparing the (a) hierarchical economical (54%) to the partitional economical (15%); and (b) the hierarchical-economical to the hierarchical uneconomical (24%). Therefore, and considering this argument, the researchers decided to separate these levels and rearrange the data considering one property either by focusing on the economy or inclusion, as displayed in Figures 4 and 5.

Figure 3

Prototype 1 Levels of PMTs' Definition Understanding

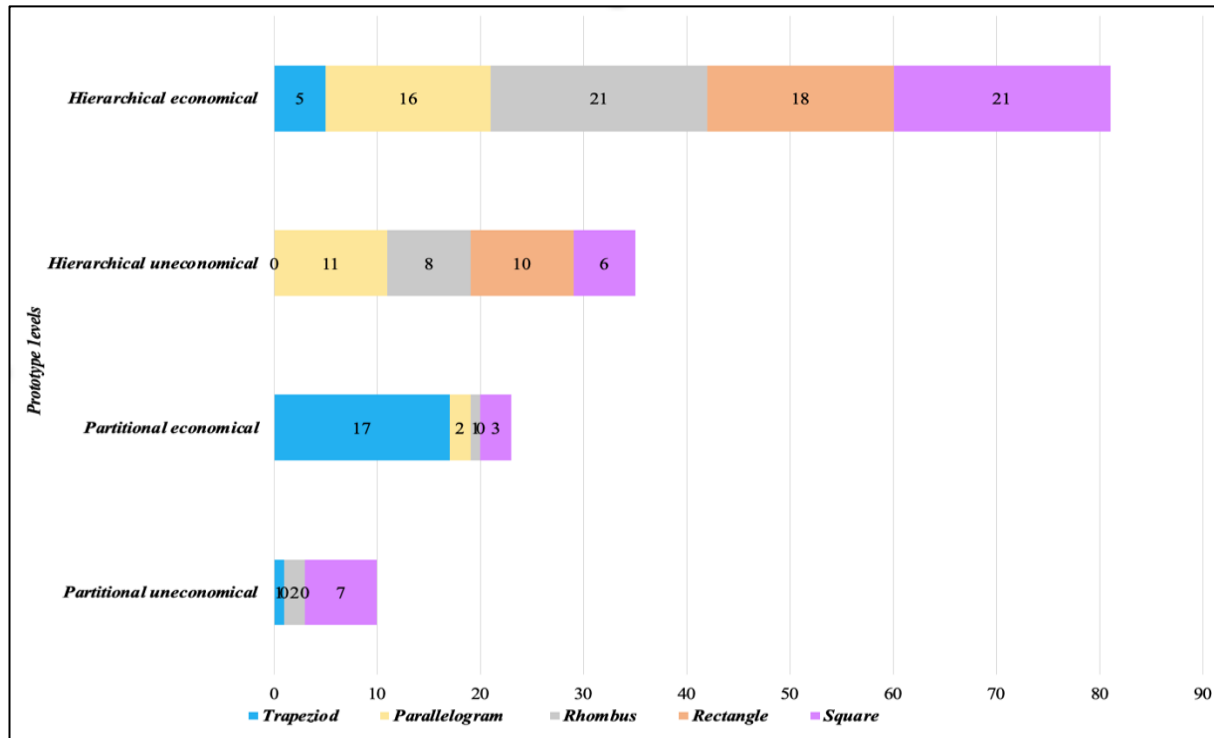


Figure 4

Levels of Definition Understanding by

Inclusion

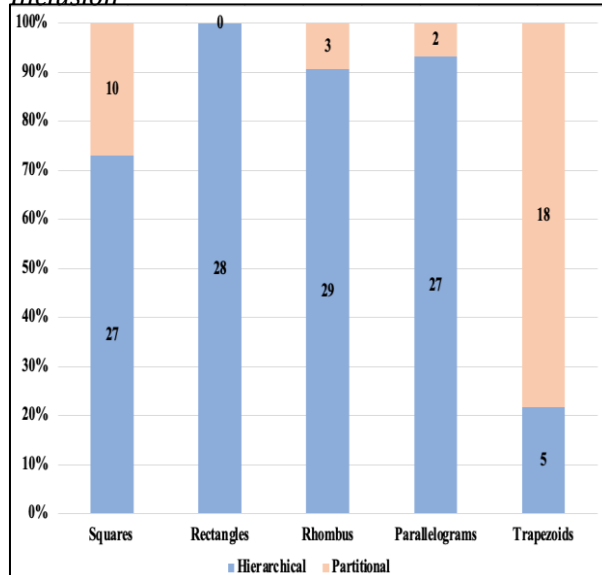
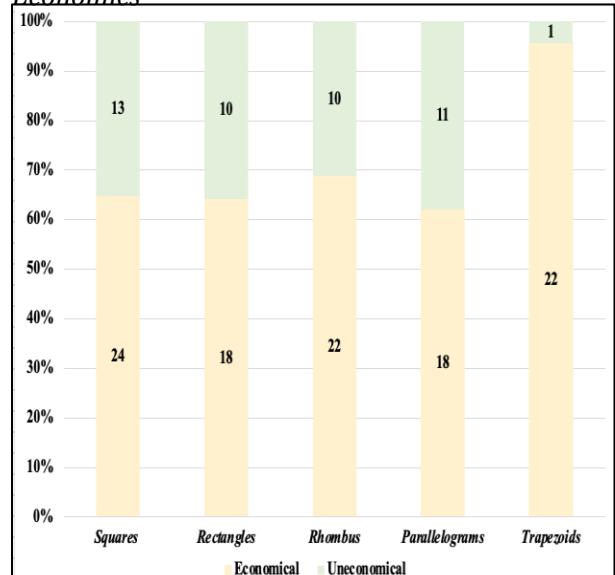


Figure 5

Levels of Definition Understanding by

Economics



First, looking to Figure 4 conveys a result that disagrees with multiple previous studies. According to these studies, most learners in various grades face difficulty in defining special quadrilaterals because of their lack of understanding of the hierarchical classification and inclusion relations (Fujita & Jones, 2007; Fujita, 2012; Jones et al., 2002; Pickreign, 2007; Ulger & Broutin, 2017), while, except for the case of trapezoids, more than 70% of participants of this study already defined the special quadrilaterals

hierarchically. Most probable, this occurred because of the characteristics of the study sample, who already accomplished Van Hiele's level 2, besides their awareness of the relationships among these quadrilaterals since the Egyptian school textbook of grade 7 provides a clear representation of these relationships and recommends teachers to highlight it. That is underlined in Žilková's (2015) study, wherein country context, level of education, cognitive level of learners, and textbooks' views are possible determinants when explaining the students' definition of quadrilaterals.

Considering the above-documented finding, the researchers anticipated the reason why the participants could, hierarchically, define the special quadrilaterals is the participants' awareness of relationships among these quadrilaterals. In other words, the researchers believed that the participants reflected on their internal representations (mental models) of relationships among special quadrilaterals to help them while defining. To ensure that, the participants were requested to portray such relationships (Q2). Accordingly, their representations were classified into three models (see Figures 6, 7, and 8; also, authentic instances are provided in the appendix); 3, 3, and 18 representations for models A, B, and C, respectively.

Moreover, the 24 participants' drawings were analysed by the reciprocal links between every two quadrilaterals to answer the second research question. After verifying the participants' understanding of relationships through brief interviews (see the Methodology), it was found that most PMTs were conscious of relationships among quadrilaterals, except for trapezoids, as shown in Figure 9. They precisely comprehended that (a) rhombuses, rectangles, and squares are special parallelograms, also

(b) rhombuses and rectangles could be transformed into squares when adding a property. Still, the present study participants' awareness of the relationships among quadrilaterals is high compared to other studies like Okazaki and Fujita (2007) and Žilková (2015).

In detail, although 93%, 72%, 41%, and 25% of Erdogan and Dur's (2014), Žilková's (2015), Okazaki and Fujita's (2007), and Ndlovu's (2014) study participants, respectively could identify the Parallelogram- Rhombus relationship, all the current study participants did so. Similarly, percentages of recognising the Parallelogram- Rectangle relationship were 93% (Erdogan & Dur, 2014), 44% (Žilková, 2015), 40% (Okazaki & Fujita, 2007), and 31% (Ndlovu, 2014) compared to 100% in the present study. Again, for the Rhombus-Square relationship, it was acknowledged by 87.5% (21 cases) of this study participants compared to 63% (Ndlovu, 2014), 25% (Okazaki & Fujita, 2007), and 15% (Žilková, 2015).

Figure 6

Model A Representation of Relationships Among Special Quadrilaterals

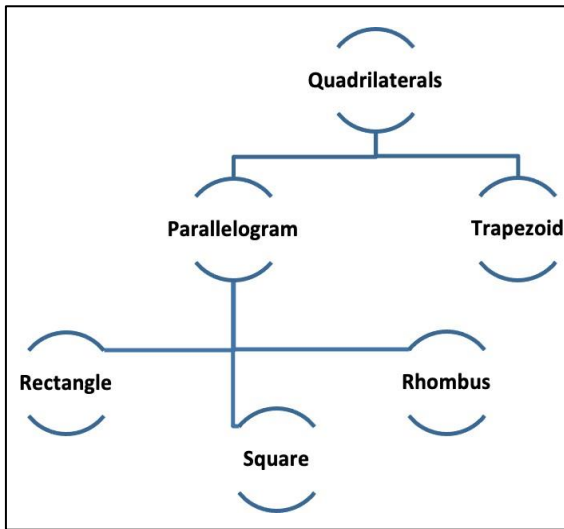


Figure 7

Model B Representation of Relationships Among Special Quadrilaterals

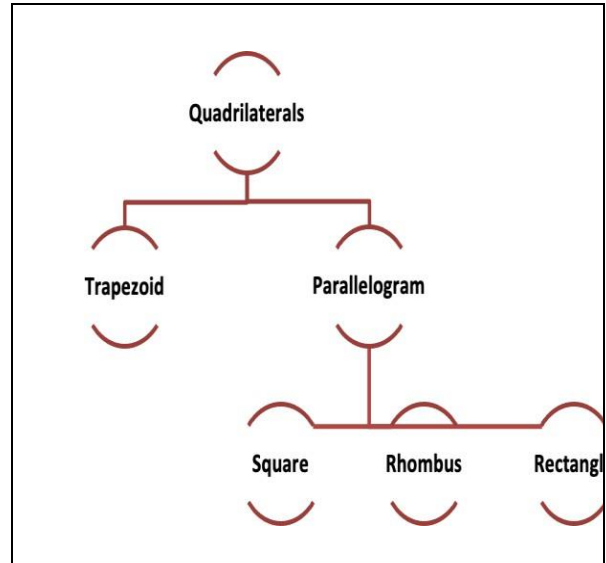


Figure 8

Model C Representation of Relationships Among Special Quadrilaterals

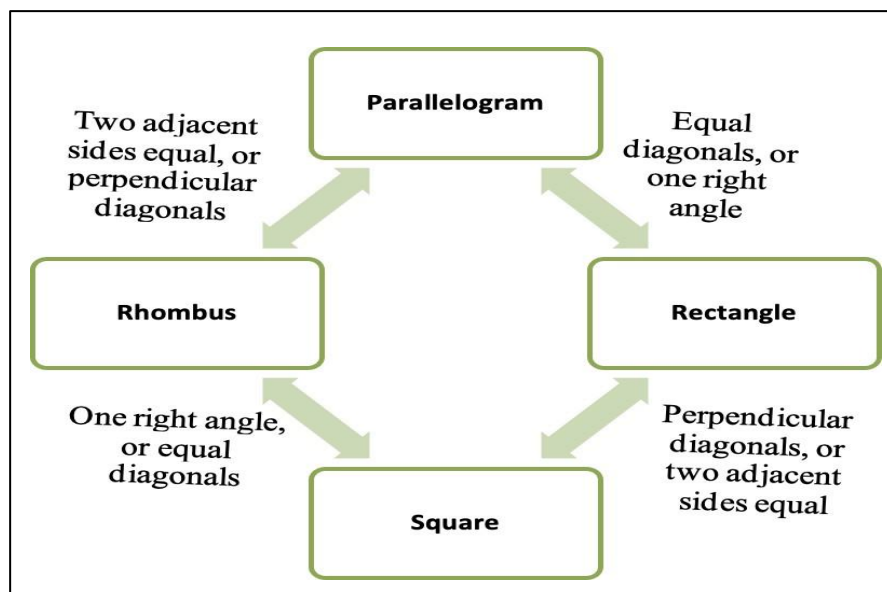
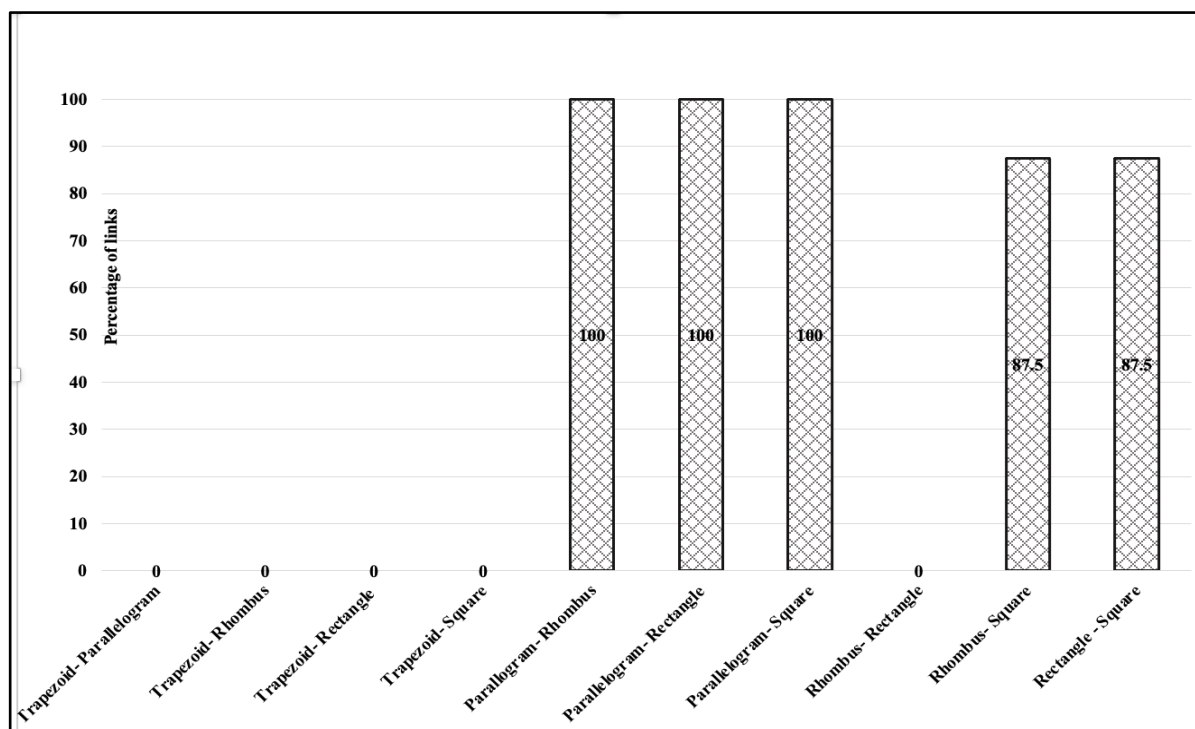


Figure 9

PMTs' Awareness of Relationships Among Special Quadrilaterals



Second, exploring Figure 5 shows that more than 60% of the provided correct definitions are economical, which stays high compared to other studies like Ndlovu (2014) and Avcu (2022). In detail, the percentages of correct economical were about 44%, 6%, 6%, 13%, and 19% in Ndlovu's (2014) study corresponded to 87%, 45%, 36%, 1%, and 3% in Avcu's (2022) research for trapezoids, parallelograms, rhombuses, rectangles, and squares, respectively.

Third, comparing the depicted data in Figures 4 and 5 reveals that grading the definition understanding in terms of the economy appears more suitable than focusing on the inclusion relationships; if and only if the learners did accomplish Van Hiele's level 2 of geometric thinking and they are progressing towards level 3. As exhibited in both figures, percentages of PMTs' identification of definitions hierarchically constituted 93%, 91%, 100%, and 73% compared to 62%, 69%, 64%, and 65% for parallelograms, rhombuses, rectangles, and squares, respectively, if these definitions were classified based on the economy property. That is, the range of the first distribution (27%) is higher than the second (7%), which indicates that categorising definitions economically minimizes the variability that might appear among individuals' understanding of special quadrilaterals.

Accordingly, it can be argued that if concentrating on the economics of a definition, it is possible, consequently, to reach the inclusion relationships. For example, instead of defining a square as *a quadrilateral with equal sides, equal angles, and perpendicular diagonals- partitional uneconomical* (see Table 7), we would change it to *a rhombus with equal angles and perpendicular diagonals- hierarchical uneconomical*; hence, to be more economical, it would be *a rhombus with equal angles- hierarchical economical* because the concept "rhombus" does possess the perpendicular diagonals. In that sense, the definition of the square has been advanced from the level of *partitional uneconomical* to the *hierarchical economical*.

Such an argument matches De Villiers (1986), who demonstrated that the "additional unnecessary and untrue attributes [in learners' definitions] are the main causes of difficulties in the understanding

of inclusion relations for quadrilaterals” (Ndlovu, 2014, p. 6649). Thus, excluding these unnecessary attributes to construct the definition economically would influence the comprehension of the inclusion relationships. Recently, for the importance of definition economics, Kabaca (2017) has recommended operating the three properties of diagonals (i.e., congruent, perpendicular, dividing each other in ratio) or any possible combinations of these properties to define quadrilateral, which would be more economically than utilizing properties of angles and sides.

This probably explains why Zazkis and Leikin’s (2008) and Avcu (2022), who followed them, concentrated on the extent of minimality (minimal, barely not minimal, or -not minimal) while categorizing prospective secondary school teachers’ correct appropriate definitions of a square. Also, Ndlovu (2014) classified pre-service teachers’ understanding of geometrical definitions and class inclusion as non-standard (correct economical not usually provided in textbooks), correct economical, correct uneconomical, correct very uneconomical, and uninterpretable. It also strengthened the economics of the correct definitions, regardless of being partitional or hierarchical.

Additionally, it is crucial to note that the answer to Q2 that expresses PMTs’ awareness of the inclusion relationships (see Figure 9) is consistent with the answer to Q1. Concretely, looking to Figure 4 displays that about 22%, 93%, 91%, 100%, and 73% PMTs could define trapezoids, parallelograms, rhombuses, rectangles, and squares, respectively hierarchically, which also admits PMTs’ recognition of the inclusion relationships (except for trapezoids). This finding suggests that prioritizing the economics of definitions should be complemented by admitting learners’ awareness of the direction/extent of inclusion. That is, leveling learners’ understanding of special quadrilaterals has to regard the amalgam of economics and learners’ awareness -represented by their intentions- (Prototype 2) instead of economics and hierarchies (Prototype 1). Acknowledging this would solve Ndlovu’s (2014, p. 6650) dilemma of which “students can be at different levels of van Hiele understanding for different aspects/concepts of a geometrical topic”.

Based on this argument, Prototype 1 could be further revised to focus essentially on the economics of the definitions; yet, learners’ awareness of relationships among these definitions should be considered (i.e., whether the learner tries, consciously, to exclude/include the defined concept from the set of general concepts). Therefore, the resultant theoretical model (see Figure 8) represents the answer to the third research question; it describes the minor levels of Van Hiele’s level 3 of geometric thinking within the context of quadrilaterals.

Table 8

Levels of Special Quadrilaterals Understanding “Prototype 2”

	<i>Characteristics the concept definition in this level</i>	<i>Examples from PMTs’ responses</i>
<i>Faulty</i> <i>≤ Van Hiele’s level 2</i>	- contains necessary but insufficient conditions. - includes inappropriate terms, wherein there is a possibility for maintaining some non-examples of the concept. - begins with a special concept to define a more general one.	The parallelogram is a quadrilateral with a pair of parallel sides. The trapezoid is a closed geometric figure with only two sides parallel. [This could be a hexagon] The parallelogram is a rectangle with two acute angles.
<i>Slightly economical</i> <i>(Moves towards the direction of inclusion)</i>	- maintains a whole statement (definition) that could be replaced by a specific concept (term). - holds more than sufficient conditions (additional properties more than necessary ones).	The rhombus is a quadrilateral with four sides equal and perpendicular diagonals. <i>[The definition (a) excludes rhombuses from parallelograms; however, it recognizes squares as a</i>

<i>Van Hiele's level 2 < Partial understanding < level 3</i>	- contains some properties that could be deduced from another. - intends to verify the concept definition by adding supplementary properties (i.e., a list of redundant properties). - indicates either the general set of concepts where the defined concept belongs or the special cases from the defined concept, or both (recognises subsets and supersets of the defined concept).	<i>subset of rhombuses. (b) contains a property of perpendicular diagonals that could be deduced from having equal sides]</i>
Fairly economical <i>(Moves towards the direction of partitional)</i> <i>Van Hiele's level 2 < Partial understanding < level 3</i>	- holds more than sufficient conditions. - contains extra properties that aim to specify the concept from other related concepts. - excludes the defined concept from the more general one; also excludes some/all special cases from this defined concept.	The rhombus is a quadrilateral with equal sides and no right angles. <i>[The definition (a) excludes (specifies) rhombuses from both parallelograms and squares. (b) The property of "no right angles" is not necessary, yet, it is added to confine the concept.]</i>
Economical <i>Full understanding = Van Hiele's level 3</i>	- contains the sufficient conditions only (no words could be removed). - no property could be deduced from another (no superfluous information). - admit the defined concept within a set of more generalised concepts; also, recognizes the set of special concepts from this defined concept.	A rhombus is a parallelogram with two adjacent sides equal. <i>[The definition admits rhombuses to be special parallelograms; also, squares as included within the set of rhombuses.]</i>

Table 8 (Prototype 2) answers the third research question; it concretises the minor levels of Van Hiele's level 3 of geometric thinking within the context of quadrilaterals. These levels that are proposed in Prototype 2 appear consistent with the framework employed in the recent study of Pagiling and Nur'aini (2022) where the levels of prototypical, partial prototypical, and hierarchical were used to analyse secondary mathematics teachers' special content knowledge of defining and classifying quadrilaterals. Furthermore, it responds to Ndlovu's (2014, p. 6650) proposal on adapting Van Hiele's levels where "Van Hiele theory be interpreted in broader terms to allow for partial attainment of a level". Alternatively stated, the difficulty of categorising definition understanding considering the concept definition and the inclusion relationships together, since it is probable for a learner to be at a level (or in transition) when defining a concept and at another level when determining class inclusion, could be overcome through the proposed framework (Prototype 2). It essentially strengthens the extent of the economics of the concept definition, which includes the specified words (precision in terminologies) and the intention of utilising these words (towards partitional or inclusion). Hence, the individual's level of geometric thinking could be determined based on the consistency between his personal concept definition and awareness of the inclusion/exclusion of other related concepts.

Conclusions and Implications

In terms of the importance of processes of defining and classifying in learning and teaching geometric thinking, this study aimed to track the progress of thinking from Van Hiele's level 2 to level 3 based on teachers' definitions of special quadrilaterals and their awareness of the relationships among them. To do so, a bounded purposeful case of prospective mathematics teachers was selected and requested to (a) define these special quadrilaterals: trapezoids, parallelograms, rhombuses, rectangles, and squares; and (b) represent the relationships among these quadrilaterals. Hence, their responses

were analysed and assigned to Prototype1 levels. These levels were developed theoretically as Faulty, Partitional uneconomical, Partitional economical, Hierarchical uneconomical, and Hierarchical economical.

Analysing the participants' answers allowed developing Prototype 1 to Prototype 2, which reconceptualised these levels into faulty, slightly economical, fairly economical, and economical. Prototype 2 ranks learners' understanding of special quadrilaterals according to (a) the economics of the concept definition and (b) their awareness of relationships among other related definitions to this concept, expressed by their intention to exclude or include the concept within another set of concepts.

One critical point concerning the developed framework is its acknowledgment of De Villiers's (1994) remark about emphasising the partitioned definition as equivalent to the hierarchical; "a partition classification is equally acceptable and a frequently employed method in mathematics" (De Villiers, 1994, p. 17). That is, this framework highlights the economics of the definition relatively than strengthening being hierarchical or partitional. Yet, learner's awareness/ intention towards excluding/including the defined concept from its general set have to be regarded.

The study also revealed the effectiveness of the textbook as a vital determinant of learners' definition of quadrilaterals, as previously remarked in investigations like Duatepe-Paksu et al. (2012) and Žilková (2015). Concretely, it has been interpreted that participants' adequate level of awareness of the inclusion relationship among special quadrilaterals, which was consistent with their personal concept definitions, might be caused by their experience with the school textbooks of middle grades, specifically the grade 7 textbook that gives a visual representation of these relationships. Nonetheless, simply appointing hierarchical definitions and classification was criticized by De Villiers (1994) if it didn't enable promoting learners' conceptual understanding.

Considering the value of growing mathematics teachers professionally to secure the students' success (Morris et al., 2009), some recommendations to help those teachers handle their future classrooms could be presented. Practically, teacher education of geometry should sharpen the principle of economics/ minimality of a definition to allow prospective teachers to attain Van Hiele's level 3 since this minimality considers a universal principle that helps students developing more sophisticated reasoning when working deductively in mathematics (Avcu, 2022). The dynamic geometry software (e.g., Sketchpad, GeoGebra, Cabri) would help to advance learners' levels of geometric thinking while the discussion should be oriented towards (a) making the definition more economical through distinguishing between critical and non-critical aspects; and, at the same time, (b) explore each definition in terms of being excluded from or included in other related concepts.

Also, mathematics educators should train prospective teachers on how to track each student's progress evaluation; and adapt the pedagogical approaches while teaching quadrilaterals depending on the students' levels of study, wherein the uneconomical definitions might appear easier and more intuitive to young students than adults (Susanto, 2020; Van Dormolen & Zaslavsky, 2003). In that sense, a profound argument on mathematical definitions embedded in school textbooks at different grades could be an essential issue during teacher education programs.

Suggestions for Future Research

Some limitations might be considered while interpreting the results of this study, specifically the developed framework. First and importantly, the characteristics of the study sample used to grow this framework; it was selected intentionally on the criteria of attaining Van Hiele's level 2 of geometric thinking, besides their knowledge of the school curriculum (including the topic of quadrilaterals). The second limitation is the small number of participants and the specified questions they responded to;

consequently, further refinements could be made to examine the framework validity with a large sample and variety of tasks. That is, when interpreting the results, we have to think deeply about Žilková's (2015, p. 31) notation of which, "the comparison of students' knowledge from different countries is extremely sensitive and it needs to be very carefully interpreted".

The present study, theoretically, is a perspective for further investigations to explore all sub-levels of Van Hiele's fixed levels; on the other hand, practically, it benefits reflections on proper pedagogical approaches and corresponding interventions in order to train prospective mathematics teachers to teach geometric thinking effectively.

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Declarations of Conflicting Interests

The authors declare no competing interests.

References

- Alhannan, O. M. M. (2019). A proposed strategy based on successful intelligence theory for teaching geometry in enhancing spatial ability and evaluative thinking skills of prep stage first graders [استراتيجية مقترحة قائمة على نظرية الذكاء الناجح لتدريس الهندسة في تنمية القدرة المكانية ومهارات التفكير التقويمي لدى تلاميذ [الصف الأول الإعدادي]. *Mathematics Education Journal*, 22(10), 6–63. <https://doi.org/10.21608/armin.2019.81260>
- Alcock, L., & Simpson, A. (2017). Interactions between defining, explaining and classifying: The case of increasing and decreasing sequences. *Educational Studies in Mathematics*, 94(1), 5–19. <https://doi.org/10.1007/s10649-016-9709-4>
- Almaraghy, E. E. S. (2020). Using the Mantle of Expert strategy in teaching engineering in an integrated manner to enhance achievement and reduce the degree and causes of mental wandering among primary school students [استخدام استراتيجية عباءة الخبير في تدريس الهندسة بأسلوب تكاملي على التحصيل وخفض [درجة التجول العقلي والحد من أسبابه لدى تلاميذ المرحلة الابتدائية]. *Mathematics Education Journal*, 23(1), 31–79. <https://doi.org/10.21608/armin.2020.80893>
- Avcu, R. (2022). Pre-service middle school mathematics teachers' personal concept definitions of special quadrilaterals. *Mathematics Education Research Journal*. <https://doi.org/10.1007/s13394-022-00412-2>
- Bell, G., & Woo, J. H. (1998). Probing the links between language and mathematical conceptualization. *Mathematics Education Research Journal*, 10(1), 51–74. <https://doi.org/10.1007/BF03217122>
- Bharaj, P. K., & Francis, D. C. (2020). "A square is not long enough to be a rectangle": Exploring prospective elementary teachers' conceptions of quadrilaterals. In A.I. Sacristán, J. C. Cortés-Zavala, & P. M. Ruiz-Arias (Eds.), *Mathematics Education Across Cultures: Proceedings of the 42nd Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 727–728). PME-NA <https://doi.org/10.51272/pmena.42.2020-106>
- Brousseau, G. (2006). *Theory of didactical situations in mathematics: Didactique des mathématiques, 1970–1990* (Vol. 19). Springer Dordrecht. <https://doi.org/10.1007/0-306-47211-2>

- Bütüner, S. Ö., & Filiz, M. (2017). Exploring Turkish mathematics teachers' content knowledge of quadrilaterals. *International Journal of Research in Education and Science*, 3(2), 395–408. <https://ijres.net/index.php/ijres/article/view/186>
- Creswell, J. W. (2007). Five qualitative approaches to inquiry. In J. W. Creswell (Ed.), *Qualitative inquiry and research design: Choosing among five approaches* (pp. 53–84). Thousands Oaks: SAGE Publications.
- Çontay, E. G., & Paksu, A. D. (2012). Preservice mathematics teachers' understandings of the class inclusion between kite and square. *Procedia – Social and Behavioral Sciences*, 55, 782–788. <https://doi.org/10.1016/j.sbspro.2012.09.564>
- De Villiers, M. (1986). *The role of the axiomatization in mathematics and mathematics teaching*. Stellenbosch, RSA: Research Unit for Mathematics Education, University of Stellenbosch.
- De Villiers, M. (1994). The role and function of a hierarchical classification of quadrilaterals. *For the Learning of Mathematics*, 14(1), 11–18. <http://www.jstor.org/stable/40248098>
- De Villiers, M. (1998). To teach definitions in geometry or teach to define? In A. Olivier & K. Newstead (Eds.), *Proceedings of the 22nd conference of the international group for the psychology of mathematics education* (Vol. 2, pp. 248–255). Stellenbosch, RSA: University of Stellenbosch.
- Duatepe-Paksu, A., Pakmaka, G. S., & Iymen, E. (2012). Preservice elementary teachers' identification of necessary and sufficient conditions for a rhombus. *Procedia – Social and Behavioral Sciences*, 46, 3294–3253. <https://doi.org/10.1016/j.sbspro.2012.06.045>
- Erdogan, E. O., & Dur, Z. (2014). Preservice mathematics teachers' personal figural concepts and classifications about quadrilaterals. *Australian Journal of Teacher Education*, 39(6), Article 8. <http://dx.doi.org/10.14221/ajte.2014v39n6.1>
- Ekramay, M. M. (2020). Using co-operative inquiry based on technology in teaching geometrical content to develop spatial sense, and geometrical understanding [استخدام الاستقصاء التعاوني المتمركز حول استخدام التكنولوجيا في تدريس محتوى الهندسة لتنمية المقدرة على الحس المكاني والفهم الهندسي]. *Mathematics Education Journal*, 23(6), 223–277. <https://doi.org/10.21608/armin.2020.115309>
- Erez, M. M., & Yerushalmy, M. (2006). "If you can turn a rectangle into a square, you can turn a square into a rectangle..." young students experience the dragging tool. *International Journal of Computers for Mathematical Learning*, 11(3), 271–299. <https://doi.org/10.1007/s10758-006-9106-7>
- Freudenthal, H. (1973). *Mathematics as an educational task*. Dordrecht: Reidel.
- Fujita, T. (2012). Learners' level of understanding of the inclusion relations of quadrilaterals and prototype phenomenon. *Journal of Mathematical Behavior*, 31(1), 60–72. <http://dx.doi.org/10.1016/j.jmathb.2011.08.003>
- Fujita, T., & Jones, K. (2007). Learners' understanding of the definitions and hierarchical classification of quadrilaterals: Towards a theoretical framing. *Research in Mathematics Education*, 9(1), 3–20. <http://dx.doi.org/10.1080/14794800008520167>
- Fujita, T., Doney, J., & Wegerif, R. (2019). Students' collaborative decision-making processes in defining and classifying quadrilaterals: A semiotic dialogic approach. *Educational Studies in Mathematics*, 101(3), 341–356. <https://doi.org/10.1007/s10649-019-09892-9>

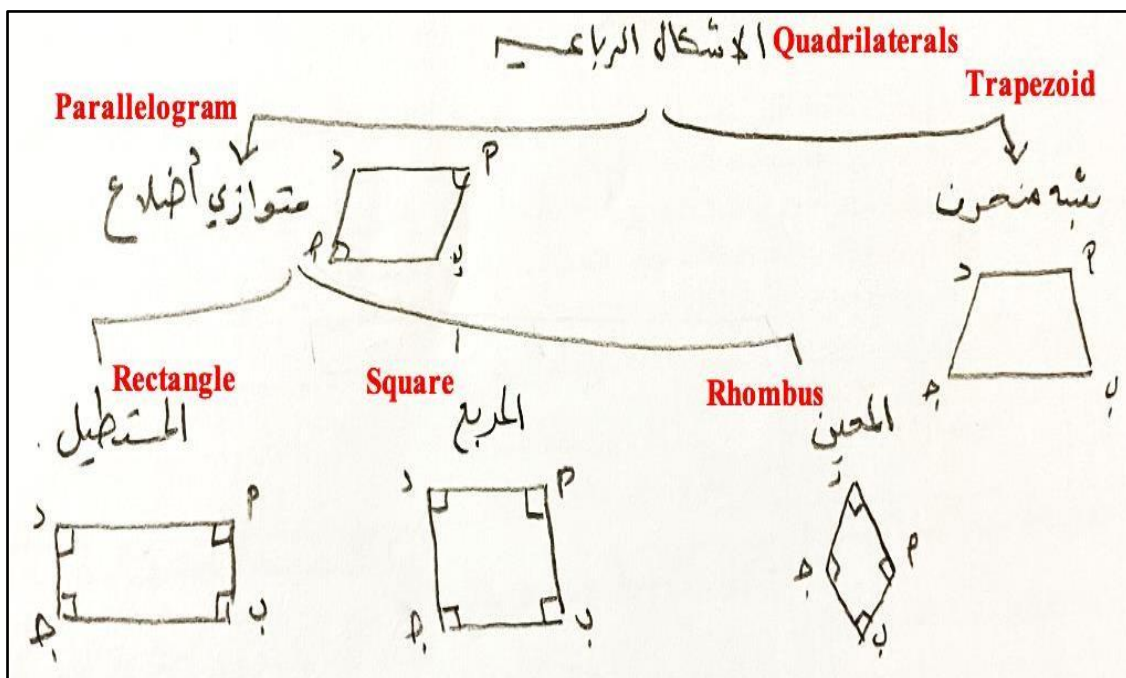
- Güner, P., & Gülten, D. Ç. (2016). Pre-service primary mathematics teachers' skills of using the language of mathematics in the context of quadrilaterals. *International Journal on New Trends in Education and Their Implications*, 7(1), 13-27. <https://files.eric.ed.gov/fulltext/ED607571.pdf>
- Harper, S. R., & Driskell, S. O. S. (2021). Prospective mathematics teachers' geometric definitions and conceptions about properties of two-dimensional shapes. In D. Olanoff, K. Johnson, & S. M. Spitzer (Eds.), *Productive struggle: Persevering through challenges: Proceedings of the forty-third annual meeting of the North American chapter of the International Group for the Psychology of mathematics education*. Philadelphia, PA. <http://www.pmena.org/pmenaproceedings/PMENA%2043%202021%20Proceedings.pdf>
- Jones, K., Mooney, C., & Harries, T. (2002). Trainee primary teachers' knowledge of geometry for teaching. In *Proceedings of the British Society for Research into Learning Mathematics*, 22(2), 95–100. <https://core.ac.uk/download/pdf/33327.pdf>
- Kabaca, T. (2017). Understanding the hierarchical classification of quadrilaterals through the ordered relation according to diagonal properties. *International Journal of Mathematical Education in Science and Technology*, 48(8), 1240–1248. <https://doi.org/10.1080/0020739X.2017.1334969>
- Kelcey, B., Hill, C. H., & Chin, J. M. (2019). Teacher mathematical knowledge, instructional quality, and student outcomes: a multilevel quantile mediation analysis. *School Effectiveness and School Improvement*, 30(4), 398–431. <https://doi.org/10.1080/09243453.2019.1570944>
- Kuzniak, A., & Rauscher, J. C. (2007). On the geometrical thinking of pre-service school teacher. In *Proceeding Cerme4, Sant Feliu de Guixols Spain*.
- Lutfi, M. K., Juandi, D., & Jupri, A. (2021). Students' ontogenic obstacle on the topic of triangle and quadrilateral. *Journal of Physics: Conference Series*, 1806, Article 012108. <https://doi.org/10.1088/1742-6596/1806/1/012108>
- Miller, S. M. (2018). An analysis of the form and content of quadrilateral definitions composed by novice pre-service teachers. *Journal of Mathematical Behavior*, 50, 142–154. <https://doi.org/10.1016/j.jmathb.2018.02.006>
- Morris, A. K., Hiebert, J., & Spitzer, S.M. (2009). Mathematical knowledge for teaching in planning and evaluating instruction: what can preservice teachers learn?. *Journal for Research in Mathematics Education*, 40(5), 491–529. <https://doi.org/10.5951/jresmetheduc.40.5.0491>
- NCTM (2000). *Principles and standards for school mathematics*. Reston, VA: NCTM.
- Ndlovu, M. (2014). Pre-service teachers' understanding of geometrical definitions and class inclusion: an analysis using the Van Hiele model. In L. G. Chova, A. L. Martínez, & I. C. Torres (Eds.), *INTED2014 Proceedings* (pp. 6642–6652). Valencia, Spain: International Academy of Technology, Education and Development.
- Okazaki, M., & Fujita, T. (2007). Prototype phenomena and common cognitive paths in the understanding of the inclusion relations between quadrilaterals in Japan and Scotland. In J. H. Woo, H. C. Lew, K. S. Park, & D. Y. Seo (Eds.), *Proceedings of the 31st Conference of the International Group for the Psychology of Mathematics Education* (Vol. 4, pp. 41–48). Seoul: PME.
- Özdemir, A., & Çekirdekci, S. (2022). Geometric habits of mind: The meaning of quadrilaterals for elementary school student teachers. *International Journal of Educational Studies in Mathematics*, 9(1), 49–66. <https://doi.org/10.17278/ijesim.1033078>

- Özerem, A. (2012). Misconceptions in geometry and suggested solutions for seventh grade students. *Procedia-Social and Behavioral Sciences*, 55, 720–729. <https://doi.org/10.1016/j.sbspro.2012.09.557>
- Ozkan, M., & Bal, A. P. (2017). Analysis of the misconceptions of 7th grade students on polygons and specific quadrilaterals. *Eurasian Journal of Educational Research*, 16(67), 161–182. <https://doi.org/10.14689/ejer.2017.67.10>
- Pagiling, S. L., & Nur'aini, K. D. (2022). Specialized content knowledge lower secondary school teachers on quadrilaterals. *PYTHAGORAS Jurnal Pendidikan Matematika*, 17(1), 333–345. <https://doi.org/10.21831/pythagoras.v17i1.42446>
- Pickreign, J. (2007). Rectangle and rhombi: How well do pre-service teachers know them?. *Issues in the Undergraduate Mathematics Preparation of School Teachers*, 1. <https://files.eric.ed.gov/fulltext/EJ835492.pdf>
- Şahin, O., & Başgöl, M. (2020). Pre-service primary school teachers' pedagogical content knowledge on quadrilaterals. *Acta Didactica Napocensia*, 13(2), 284–305. <https://eric.ed.gov/?id=EJ1280407>
- Sfard, A. (2008). *Thinking as communicating: Human development, development of discourses, and mathematizing*. Cambridge University Press. <https://doi.org/10.1017/CBO9780511499944>
- Sinclair, N., Bartolini Bussi, M. G., de Villiers, M., Jones, K., Kortenkamp, U., Leung, A., & Owens, K. (2016). Recent research on geometry education: an ICME-13 survey team report. *ZDM Mathematics Education*, 48, 691–719. <https://doi.org/10.1007/s11858-016-0796-6>
- Susanto, D. (2020). Problematic of definition and terminology affecting primary teachers' mathematical knowledge for teaching geometry. *Journal of Physics: Conference Series*, 1567, Article 022096. <https://doi.org/10.1088/1742-6596/1567/2/022096>
- Syamsuddin, A. (2019). Investigating student's geometric thinking in looking for the linkages of quadrilaterals (A case study on students in the formal operation stage). *International Journal of Environmental & Science Education*, 14(7), 435–444. <http://www.ijese.net/makale/2134.html>
- Tall, D., & Vinner, S. (1981). Concept image and concept definition in mathematics with particular reference to limits and continuity. *Educational Studies in Mathematics*, 12(2), 151–169. <https://doi.org/10.1007/BF00305619>
- The Egyptian Ministry of Education and Technical Education. (2020). *Mathematics for first preparatory grade, first term*. Book Sector.
- Türnüklü, E., Gündoğdu Alaylı, F., & Akkaş, E. N. (2013). Investigation of prospective primary mathematics teachers' perceptions and images for quadrilaterals. *Educational Sciences: Theory and Practice*, 13(2), 1225–1232. <https://files.eric.ed.gov/fulltext/EJ1017328.pdf>
- Ulger, T. K., & Broutin, M. S. (2017). Pre-service mathematics teachers' understanding of quadrilaterals and the interval relationships between quadrilaterals: The case of parallelograms. *European Journal of Educational Research*, 6(3), 331–345. <https://doi.org/10.12973/eu-jer.6.3.331>
- Usiskin, Z., Griffin, J., Witonsky, D. B., & Willmore, E. (2008). *The classification of quadrilaterals: A study of definition*. Information Age Publishing, Inc.

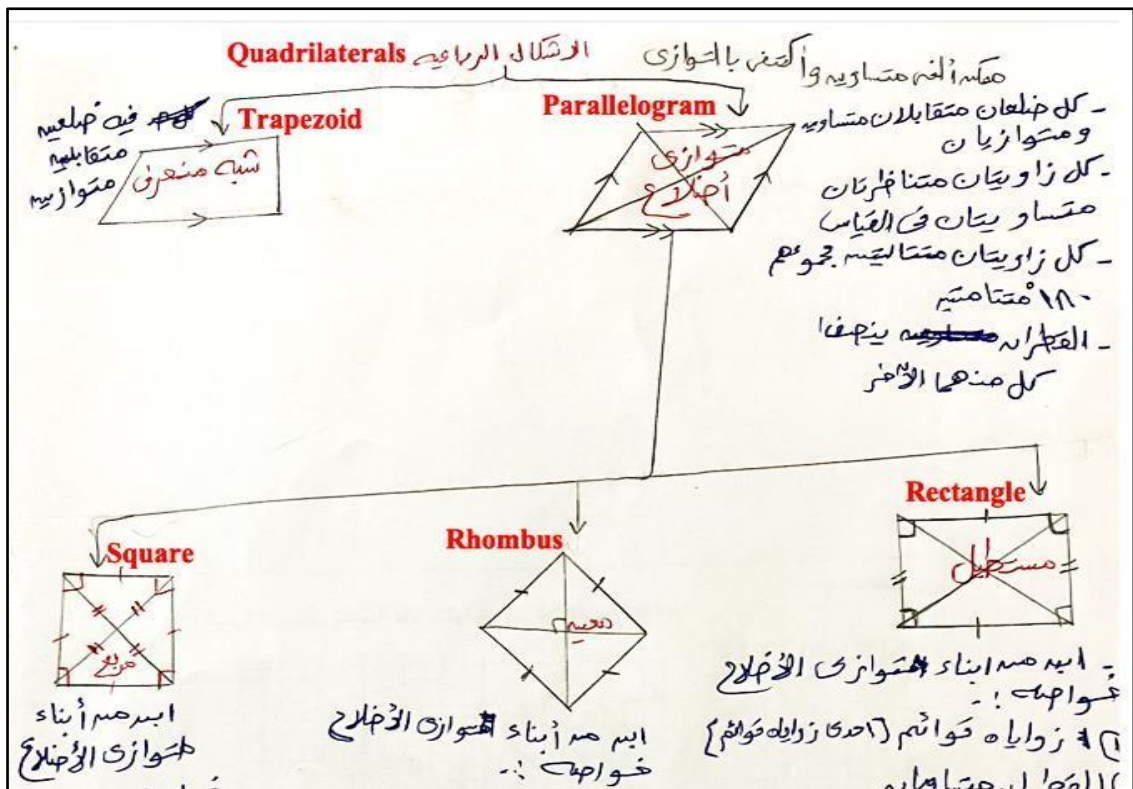
- Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2012). *Elementary and middle school mathematics: Teaching developmentally* (7th ed.). Nobel Akademik Yayoncolok.
- Van Dormolen, J., & Zaslavsky, O. (2003). The many facets of a definition: The case of periodicity. *Journal of Mathematical Behavior*, 22(1), 91–106. [https://doi.org/10.1016/S0732-3123\(03\)00006-3](https://doi.org/10.1016/S0732-3123(03)00006-3)
- Van Hiele, P. M. (1986). *Structure and Insight: A theory of mathematics education*. Academic Press.
- Wang, S., & Kinzel, M. (2014). How do they know it is a parallelogram? Analysing geometric discourse at van Hiele Level 3. *Research in Mathematics Education*, 16(3), 288–305. <https://doi.org/10.1080/14794802.2014.933711>
- Zazkis, R., & Leikin, R. (2008). Exemplifying definitions: A case of a square. *Educational Studies in Mathematics*, 69(2), 131–148. <https://doi.org/10.1007/s10649-008-9131-7>
- Žilková, K. (2015). Misconceptions in pre-service primary education teachers about quadrilaterals misconceptions in pre-service primary education teachers about quadrilaterals. *Journal of Education, Psychology and Social Sciences*, 3(1), 30–37.

Appendix

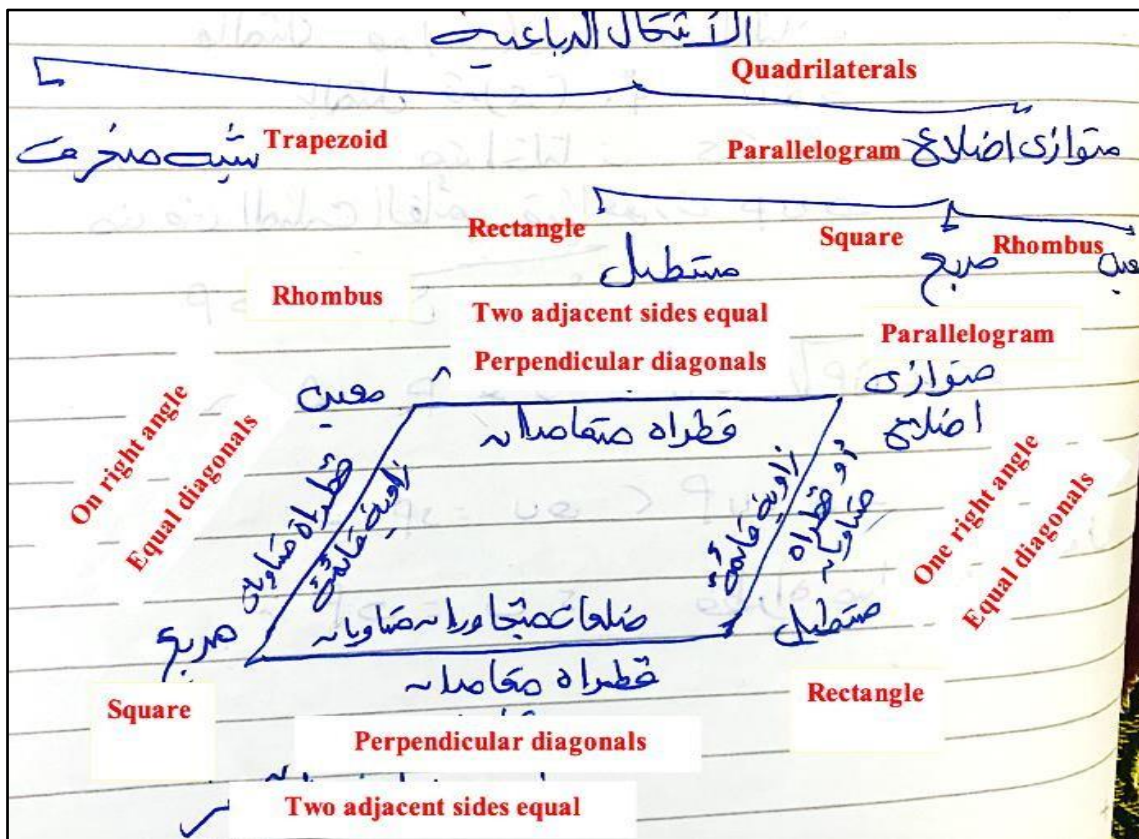
An Example of Model A Representation of Relationships Among Special Quadrilaterals



An Example of Model B Representation of Relationships Among Special Quadrilaterals



Examples of Model C Representation of Relationships Among Special Quadrilaterals



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The Future of Higher Education: Implementation of Virtual and Augmented Reality in the Educational Process

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Abstract: The introduction of VR and AR into the higher education is a particularly interesting phenomenon for the education of the future. Thus, the aim of the study was to determine the impact of using VR and AR as a possible strategy to enhance teaching in higher education institutions and as a replacement for outdated teaching methods. Virtual and augmented realities are tools that enable dynamic training in a virtual environment by facilitating the management of its components. Virtual immersion in the process of the information comprehension allows students exploring complex environments and situations by manipulating the elements that make up the environment. The purpose of this study is to analyse the introduction of VR and AR in the learning process as a favourable area of the development of higher education. The analysis of the relevance and effectiveness of virtual artefacts in higher education was obtained using the following methods: a literature review was used in the research to systematically gather, analyse, and synthesize existing published literature on the topic. The next stage was the observation, data analysis and interpretation. The results of the work were obtained through a double analysis. First, the state of the art of the related literature was investigated, and second, the impact on students was assessed, offering an innovative alternative to traditional teaching methods at the pedagogical faculties where the observation was conducted. Search engines revealed 2300 articles on the use of VR and AR in higher education. As a result of the selection and verification process, only 50 state-of-the-art sources from 2018–2023 were selected (taking into account the scientific novelty of the topic). An observation of students obtained data to evaluate the implementation of resources in higher education by key elements: motivation, design, and collaboration. The question of whether the use of educational artefacts in VR and AR is applicable in the perspective of higher education and the values that should guide their strategy is revealed. Conclusions present the scientific and students' opinion in terms of the implementation of VR and AR in higher education. This research questions are revealed, the advantages and disadvantages, concepts and paradigms in this area are identified. The position on the significance of VR and AR as a pedagogical instrument is presented.

Keywords: artificial intelligence, virtual artefact, virtual immersion, motivation, collaboration, design.

Introduction

An ever-growing number of higher education institutions are introducing virtual reality into the educational process. The latest technologies give new openings for students as well as their teachers. Education is becoming “exciting”. Virtual and augmented reality transforms education and gives students the opportunity to learn with the help of specific equipment. On the other hand, although virtual and augmented realities are becoming more and more fashionable, their use in education is controversial. Therefore, a two-stage analysis based on theoretical works and practice of use seems to be important.

The three-dimensional space and virtual artefacts in educational achievements

Today, the creation of a three-dimensional space with the help of virtual artifacts makes it possible to achieve educational goals. Manipulating elements and events of the virtual environment is considered useful for achieving educational goals (Chen et al., 2022). A qualitative change in immersive technologies allows full immersion in a simulation of reality, where the student can interrelate with the virtually word in reality (Tezer et. al., 2019). Virtual immersion is a popularized term to define the features of immersive environments artificially created with the help of digital means. Since the first attempts to develop immersive sensory environments, the perception or acceptance of virtual artefacts by society has also changed (Alam, 2022a). Virtual reality methods are well suited for teaching all disciplines and professions that require specialized equipment, laboratories, and time-space actions, as they facilitate

practice in any specialty (Gustiani, 2020). Virtual technologies are not new. In this context, it should be noted that virtual and augmented reality is not new to education. For example, a headset has been used as a peripheral device for quite some time. The headset permitted the user entering the universe created by the computer (Irwanto et al., 2022). The fast expansion of ICT is constantly transforming the ways of searching, selecting, organizing, processing, and transferring knowledge. Among others, higher education, with its traditional methods, has felt the need to adapt to the increasing changes. In this aspect, teaching strategies can be understood as procedures that teachers flexibly use in their teaching methods. Materials and resources in a broad sense, including teaching materials and resources, are important, but they do not have a special value. Their use is only justified when they are integrated appropriately into the educational process, which must be compatible with the learning process, and in turn, must be compatible with the wider environment (Cabero-Almenara & Roig-Vila, 2019).

Comparison with traditional learning environments

Compared to traditional learning environments, virtual artefacts can offer an additional interactive experience as learners realize and experience the benefits of participating VR and AR education; they advance a more constructive, motivated attitude to learning through equipment and numerical inclusion.

Research Problem

Learning resources provide favourable material conditions for meeting the demands of the modern world and the dynamic development of technology. The problem of introducing VR and AR into higher instruction is to empirically prove their effectiveness in the process of learning the curriculum. Thus, in order to achieve greater efficiency, develop skills, habits, abilities, and form beliefs, education must rethink its goals, objectives, pedagogy, and didactics.

The problem of this study is the lack of scientific justification for the feasibility and safety of using virtual and augmented reality technologies in higher education (Marks & Thomas, 2022). The widespread pandemic has hastened the assimilation of tools into learning (Fauzi, 2022). Today, the integration of virtual artefacts is the norm rather than the exception (Guppy et al., 2022). Information is instantaneous and education needs additional technical capabilities to succeed in the future of education (Gustiani, 2020). In light of the flexibility in the practice of VR and AR, the education of the future should accentuate lifelong learning and various types of technological professional development for educators (Pelletier et al., 2022). As a result of the progress, the educational requirements of students have changed dramatically, and they seek a more engaging learning environment that motivates, develops, and teaches teamwork (Zhang et al., 2022). In addition, the new generation of students does not perceive virtual artefacts as a novelty but readily adapts to progress (Alam, 2022b).

Research Focus

The presented scientific research focuses on the study of virtual artefacts in higher education, both in terms of theoretical work and their practical use to achieve educational goals. An observation of students allowed us to find out their opinion on the introduction of VR and AR in the educational process, and a review of scientific literature made it possible to reveal the general picture of the adaptation of target skills of students in this context.

Research Aim and Research Questions

The resolution of the given revision is to analyse in-depth the implementation of VR and AR in the education of the future by analysing the related literature and working with a students' group. The use of VR and AR in higher training in a collaborative manner is considered. Thus, the purpose of the paper

was to conduct a methodical review of scientific literature to explore this topic in more depth. With this in mind, the following research questions were developed in this systematic literature review and description of the empirical experiences of learners:

- 1: What are the profits of VR and AR compared to traditional methods?
- 2: What are the key targets of virtual artefacts in higher education?
- 3: What were the main conclusions of students about the use of VR and AR in higher education?
- 4: What is the virtual immersion impact on the mental and socio-emotional student's state?

Research Methodology

The methodology of this study included two stages. A literature review was used in the research to systematically gather, analyse, and synthesize existing published literature on the topic. It involved the review and critical evaluation of previous studies, articles, books, and other relevant sources to identify gaps, inconsistencies, and trends in the existing knowledge. The next stage was the observation, data analysis and interpretation of results. The first stage of the research included an explanation of the content of information by topic and keywords: artificial intelligence, virtual artefact, virtual immersion, motivation, collaboration, design. We selected 50 scientific articles and classified them according to the following topics: motivation, design, and collaboration.

The second stage of the research was to assess the impact of the introduction of VR and AR during classes at pedagogical faculties as a resource for strengthening strategies for teaching main subjects at the Master's degree programs in higher education institutions of Ukraine. The aim was to conduct a two-stage study. A detailed evaluation of related literature and observation of student's attitude while working with AR and VR. This two stage analysis was accomplished in order to determine the level of impact of the introduction of VR and AR on the educational process of pedagogical faculties students compared to the use of traditional tools. The variable under study was the impact of VR and AR on students' learning in both dimensions (teaching and learning strategies). The study was conducted during the second semester of the educational year 2023. The group consisted of 40 students from all over Ukraine. The observation was conducted after completing the first semester, using an email sent to the university mailboxes of students and consisted of only 4 questions (which overlap with the questions in the article but are slightly adjusted to the needs of students). The emphasis was placed on the applicants' impressions of working with virtual artefacts (Table 1).

Table 1

Questions for the Group

An open survey
1: What do you think are the benefits of VR and AR in comparison to outdated methods?
2: What motivates you more to use virtual artefacts in the classroom ?
3: What do you think about the use of VR and AR in higher medical learning?
4: Do you experience any cognitive and socio-emotional impact during virtual immersion in simulation centres?

Source: author 's own development.

General Background

At the first stage, a detailed literature review using the EPPIC investigation method allowed identifying relevant articles as accurately as possible, summarise the collected information by topic, and divide the research into smaller topics: motivation, collaboration, and design.

At the second stage, the group variable distinguished between students who had experience in using virtual reality as a learning resource and those who used traditional technologies as a resource to enhance teaching and learning strategies (books, models, video presentations). It is important to clarify that not all participants who experimented with VR and AR had the opportunity to manipulate the equipment in the software environment offered for the study of the subjects. The time allocated for studying the virtual course was approximately thirty minutes, which is a limitation given the time available for technology integration. The impact was measured using a survey (see Table 1).

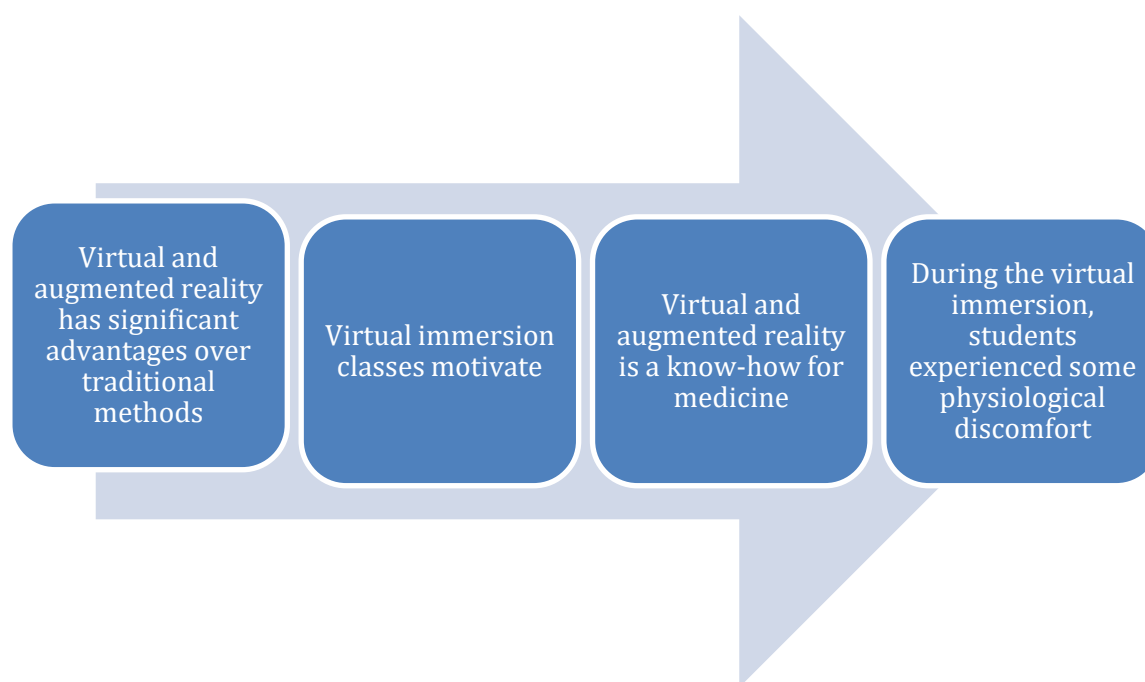
Sample / Participants / Group

At the first stage, databases were selected (Google scholar, Research Gate, Scopus, ERIC), and searched in English or Ukrainian using descriptive operators selected for each database. 2300 non-repeating articles were found.

The variable of the next phase of the investigation was the focus group work (40 representatives) and the formulation of a hypothesis after processing the answers of the applicants. The hypothesis can thus be formulated as follows (Fig. 1):

Figure 1

Hypotheses Based on Applicants' Answers



Source: author's own development.

The study was explanatory in nature, as it aimed to determine the level of influence of the introduction of VR and AR on students, as well as the impact of the introduction of VR as a technological resource that enhances teaching and learning strategies.

Instrument and Procedures

In order to answer the research question, a systematic review was conducted using the content analysis. The logical evaluation of the scientific literature expansively identified, evaluated and synthesized all applicable studies concerning the subject. The sum of papers found in the identified files and the descriptors used (Table 2):

Table 2*Determination by Descriptors*

Database and key terms	Number of sources
Google scholar - higher education, VR and AR in higher education, students' motivation	575
Research Gate - education, virtual artefacts, VR and AR, and higher training	292
Scopus - virtual reality in higher education. Designing classes with elements of virtual immersion	1027
ERIC - the latest technologies in education, virtual or augmented reality, higher education and training, virtual reality in medicine	406
Total	2300

*Source: author 's own development.***Data Analysis**

The corpus of 2300 articles was reduced by the following selection criteria:

Table 3*Selection Criteria*

Criteria	Quantity
Years of publication 2018-2023	1000
Achievements in the field of immersive technologies	178
Peer-reviewed research in an academic context	50

Source: author 's own development.

The total number of articles restricted to 50 made it possible to prove the theoretical part of the work.

The feasibility of introducing VR and AR into higher education of the future was determined by means of an open survey. However, the variable that made it possible to build the scale was one key closed question: "Are virtual artefacts more effective than traditional teaching methods?"

The gauge used oscillated from 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree.

Thus, the group consisting of 40 students from all over Ukraine was conducted via email questioning. Classes were held in parallel with the traditional approach/inclusion of virtual reality in turn. The alternation made it possible for students to understand the advantages and disadvantages of both approaches. An observation was conducted after the course. Students were asked to submit all their ideas and answers to the above-mentioned questions After collecting the data, the authors had the opportunity to compare the overall picture of the group's impressions. It should be noted that the issues or preferences identified in the responses are virtually identical to those raised by scholars in the field and the paper hypothesis.

The hypothesis based on the literature analysis was as follows: virtual and augmented reality should be introduced into higher education, especially in the study of medicine, maths, automobile and highway engineering. Virtual artefacts that would replace traditional teaching methods would primarily motivate students to learn and achieve better results. In this aspect, the goal was to establish the opinion

of students and to find similarities or differences with the hypothesis.

Research Results

All carefully chosen articles on VR and AR in higher education mainly concentrated on 3 significant aspects connected with the knowledge assignment: motivation, involvement, and collaboration. Also articles that dealt with the design of educational VR and AR artefacts were retained. Additionally, the article marks mentions to preceding investigation to sustain the presented models and concepts. First, it was advisable regroup the papers by topic and then briefly summarise the main aspects of educational artefacts in VR and AR (Table 4).

Table 4

Generalization of the Main Profits of Educational Artefacts in VR and AR

Aspects related to knowledge transfer	Authors
Motivation The main profits of VR and AR in education are linked to educating students and motivating them. Motivation increases attention that is an important mental purpose for learning. Educational artefacts, particularly educational games, have a constructive influence on motivation and learning awareness. For example, immersive games in the education. Virtual reality helps to improve observation skills, develops scientific competence, and motivates students, pointing to the prospective of VR and AR adoption during learning, which not only motivates but also pushes students to develop their own technological developments in this area. VR and AR have a constructive outcome on motivation, but it does not have a positive effect on student engagement. According to scientists, virtual reality does not have a noticeable advantage in skill development.	Chen (2019); Khan et al. (2019); Wenk et al. (2023). Acosta et al. 2019; Cabero-Almenara and Roig-Vila (2019); Tezer et al. (2019). Chen et al. (2019); Chen et al. (2022); Lin and Yu (2023); Matovu et al. (2023); Obeid and Demirkan (2023). Javornik et al. (2022); Lin and Hou (2022); Low et al. (2022); Wang et al. (2022)

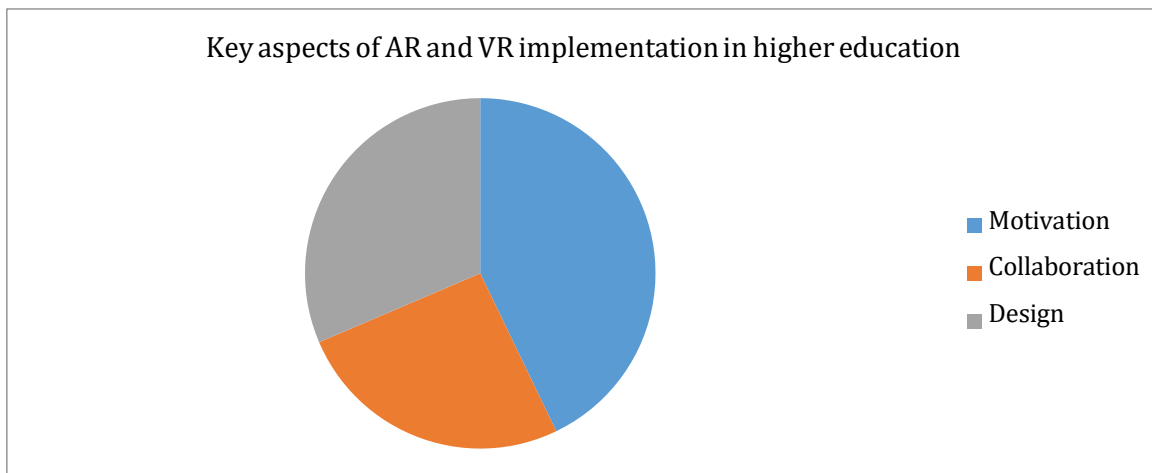
Design VR and AR propose a beneficial immersive experience in higher education. The augmented reality offered by new technologies, is appropriate to constructivist educational methods and simulation-based learning Cyberkineses is a shared problem in VR and AR. It manifests itself in the form of sensory conflict and neural shifts. The main symptoms of cyberkineses are seasickness, migraine, faintness, spatial perplexity, as well as vertigo.	Ateş and Garzón (2023); Guaya et al. (2023); Guerra-Tamez (2023); Khodabandeh (2023); Rojas-Sánchez et al. (2023); Yang et al. (2023). Agbafe et al. (2023); Alkhabra et al. (2023); Babakr et al. (2019); Fillipova (2021); Frewen et al. (2022); George et al. (2023); Huang (2022); Iwanaga et al. (2023); Lympouridis (2023); Mystakidis and Sonntag et al. (2019); Najmi et al. (2023); Uriarte-Portillo et al. (2023); Williams (2022).
Collaboration Virtual artifacts enable interaction and collaboration, providing space for the development of kinesthetic, visual, and spatial skills. Dialogue allows higher education students to expand their understanding through interaction with others. VR and AR learning environments are able to allow students solving difficulties as a team anyplace in the world. VR and AR are more communicating and engaging for learners than using conservative resources, as they allow deepening the understanding by problem solving in team. VR and AR permit the consumer communicating in real-time with a distant tutor. VR and AR improve students' mental procedures and their practical actions, particularly, by engaging with invisible, abstract, and complex concepts.	Cabero-Almenara and Roig-Vila, (2019); Chen et al. (2022b); Guerra-Tamez, 2023); Iwanaga et al. (2023); Khodabandeh (2023). Tezer et. al. (2019). Huang (2022); Lin and Yu (2023); Mystakidis and Lympouridis (2023); Seufert et al. (2022); Uriarte-Portillo et al. (2023). Babakr et al. (2019); Bogusevschi et al. 2020; Matovu et al. (2023); Najmi et al. (2023); Rojas-Sánchez et al. (2023).

Source: author's own development.

The literature analysis indicates that the introduction of VR and AR in the future of higher education is more motivating for students, followed by the importance of designing virtual artefacts, and thirdly, the increased collaboration due to the above advantages (Fig. 1).

Figure 1

The Impact of the VR and AR Introduction in Learning



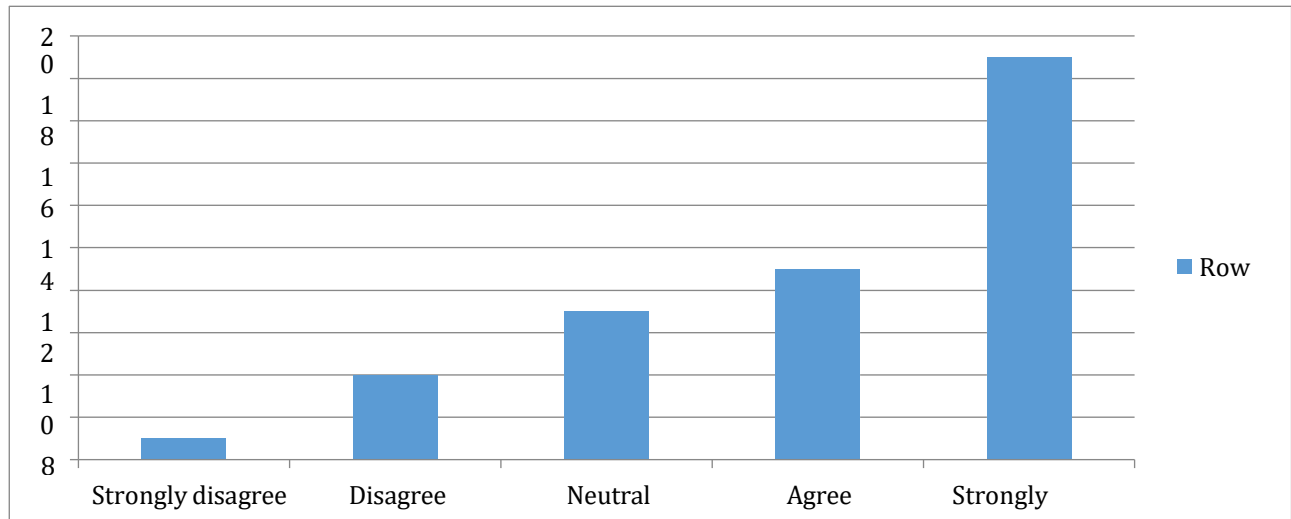
Source: authors' own development.

The results of the paper can be summarized by summarizing the applicants' opinions. That is, to briefly describe their impressions and responses.

According to the variable that made it possible to build the scale: "Are virtual artifacts more effective than traditional teaching methods?" the results were as follows (Fig. 2):

Figure 2

The Expediency of Replacing Traditional Methods with Virtual Artifacts According to the Students' Answers



Source: authors' own development.

Students' awareness in the virtual content

Students who had the opportunity to manipulate the equipment exhibited awareness in the virtual content exploring, which indicates that the content seen during the classes interested and motivated them. According to the responses, the latest technologies contribute to the in-depth study of the subjects and facilitate the learning.

It was found that students compare the VR and AR use with the use of models or drawings (traditional methods). According to the students' opinion, it is necessary to get rid of outdated teaching methods, and virtual immersion classes create a positive impact when considering the material (33).

Eight participants complained about the impact of VR and AR (from a psycho-emotional and physiological point of view). These students (8 responses) believe that new virtual reality submissions could be advanced in teaching, but there are risks, including for short-term and long-term health. After all, being in the virtual world should not fuel certain unhealthy social impulses. The majority of students (36) believe that VR and AR are perceived by experts as the technologies of the future of higher education.

The answers' analysis

According to the answers, we can group the main advantages and disadvantages mentioned by the applicants.

The main advantages of VR and AR. VR and AR allow for the safe handling of objects in dangerous environments, VR and AR offer the ability to track complex areas in science, VR and AR increase the ability of students to control their learning and provide sensory engagement, VR and AR improve three-dimensional perception, inspiration and mental processes of scholars, VR and AR allow for real-time remote communication with a teacher, VR, and AR promote motivation, engagement and knowledge transfer, VR and AR facilitate interaction and improve cooperation between students and teachers.

Discussion

Giving the literature examination, scholastic artefacts developed in VR and AR could increase attention and perception. Nevertheless, their effectiveness should not only comprise education methods reformed to the target audience but also use the suitable environs for the extent of acquaintance that is being taught. A connected opinion is taken by Mulders et al. (2020), who accentuate that the technique used and the select of VR and AR artefacts should be constant, as these two elements balance each other. Indeed, the presented research approves that more emphasis needs to be positioned on the design of educational artefacts to strike an equilibrium between the desire of operating the tool and its aptitude to diffuse knowledge. VR and AR permits collaboration and teamwork, offers innovative space, and increases kinaesthetic, optical, and three-dimensional skills. As the limitation of the study show regrettably, existing technologies limit the use of VR and AR, not to mention the prices related to hardware assimilation and the restricted number of solicitations in the context of higher education. Additionally, there is still the problem of their social tolerability.

This paper also raises the issue of the risks related to the VR and AR use. Giving to Smutny (2022), virtual reality can lead to alterations in human behaviour caused by psychological or neurological changes. Indeed, the lack of research on the risks posed by immersive technologies, especially for young children, makes us thoughtful. One can find similar opinions in this field. To diminish the risks connected with VR and AR, their use in higher education should be gradual and periodically reviewed in accord with the results of investigation and analytical tests that were laid down when they were created (Sholihin et al., 2020).

In this paper the significance of hastening researches on phenomena that disturb users of VR and AR and thus permit inventors to generate educational artefacts that are harmless and better modified to users is also highlighted. So, this literature deepened the research findings in knowledge about the organization of important components that affect the efficiency of instructive artefacts, namely VR and AR, particularly, the development of an environment that does not carry a cognitive load on learners, the drawbacks related to the use of immersive artefacts and their significance in the perception of material, especially in the exact sciences (Fillipova, 2021).

The examination of the obtained data presented the fact that the introduction of VR and AR in

higher education is a powerful tool for influencing both teaching and learning strategies for the education of the future. As the literature shows, although the data obtained from the observation revealed some negative responses about the impact of VR and AR on students, with the right tools, it is possible to create effective virtual learning scenarios. In this context, Checa and Bustillo (2020) highlight the enthusiasm with which students explore virtual environments for learning purposes.

The most common response in pedagogical research observations was a surprise when navigating and exploring the functionality of the virtual environment, with learners emphasizing the quality of the presentation of anatomical images (Pelletier et al., 2022). Such manifestations are perceived as an encouragement to further improve learning environments and strategies, with the main goal of providing the best learning opportunities (Alam, 2022a). Without denying the obvious benefits of using virtual immersion in learning, Wenk et al. (2023) consider that both the needs and challenges of virtual communication are too often ignored. The needs of learners, who are ultimately the ones who should benefit from these tools, are often ignored (Williams, 2022). In this aspect, the results of the study suggest that new technologies such as VR and AR are “more than desirable in the design of environments that facilitate learning” (Ateş & Garzón, 2023).

Based on the fact that motivation was at the top of the list in this study, it should be noted that as learners' motivation increased, their engagement, participation, and cooperation increases. Additionally, the great motivation is an important forecaster of deep involvement, which can have a progressive influence on students' educational enactment, time spent on educational accomplishments, higher-level groundwork, and evocative education, as well as on behaviour and arrogances toward education.

The limitations of the presented work are time and human resources. Since the paper analyses the works of 2018-2023 (in light of their relevance), it would be advisable to devote future research to the historical paradigm of the development of the introduction of VR and AR in higher education with the involvement of a survey of students of different graduation years. Like in a similar study it is demonstrated, the dynamics of the efficacy of the usage of the modern technologies in the education of the future (Sholihin et al. 2020). The scientific thought is that the purpose of virtual learning in the education of the future is to achieve educational goals by transferring new knowledge and skills. In order to formulate learner-friendly goals and to adapt their target skills, media and methods should be coordinated. In this aspect, scripts and well-designed artefacts are very important and should be adapted to the critical expertise that the teacher is trying to convey. An in-depth analysis of the related literature has shown that instructive technologies are tools that serve human beings and that their development should be based primarily on motivational models as well as learning schemes to achieve the pedagogical goals of learning. Educational theories should be taken into account when using VR and AR in higher education. This will make it possible to achieve the pedagogical goals of learning. Most studies on this topic authorise that if instructive artefacts are well-designed, they are beneficial for learning. However, they need to be shaped taking into account learners benefits and aptitudes. The paper notes that the goal in higher education is to increase the knowledge assignment, not promoting tools.

Conclusions and Implications

The obtained results in the study lead to the conclusion that VR and AR are recommended resources to teaching enhancing and learning strategies in maths, pedagogical sciences, engineering and in higher education in general. The impact caused by VR and AR indicates the need to replace traditional teaching methods. The results of the paper were in line with scientific opinion that postulated that the introduction of VR and AR in the higher schooling of the future makes it easier for teachers to teach by

demonstrating more interactive content of subjects.

Although the results showed the benefits of implementing virtual and augmented reality, like virtual artifacts enable interaction and collaboration, providing space for the development of kinesthetic, visual, and spatial skills; the virtual dialogue allows higher education students expanding their understanding through interaction with others; VR and AR learning environments are able to allow students solving difficulties as a team anyplace in the world; VR and AR are more communicating and engaging for learners than using conservative resources, as they allow deepening the understanding by problem solving in team; VR and AR permit the consumer communicating in real-time with a distant tutor; VR and AR improve students' mental procedures and their practical actions, particularly, by engaging with invisible, abstract, and complex concepts, it is recognised that there is a need to allocate time and resources to integrate this technology, given that it requires a certain period of training that is well worth the investment. Looking ahead, the medical simulation centres in Ukraine where the work was conducted are currently designing more modern space and equipment that will allow them to become virtual reality laboratories for Ukrainian higher medical education institutions. Thus, the education of the future has to offer the preeminent implements in order to attain the educational objective. The paper also emphasises the importance of taking into account the risks associated with virtual and augmented reality. After all, according to the analysis of scientific papers and students' opinion, their use can lead to changes in human behaviour by causing psychological or neurological changes. The risks of side effects in virtual reality, such as cybernetic malaise, have been identified. This work allowed us to identify the possible pedagogical benefits of VR and AR and their limitations. It turned out that virtual technologies have certain advantages and limitations, but they need to be used with caution. There are always particular risks of abuse or wrong manipulation, or even risks of inappropriate design for students. It is important for further research to assess the risks associated with the misuse of these technologies. Researches in the field of VR and AR in higher education need to be significantly increased.

Suggestions for Future Research

It would be interesting to take into consideration the strategies for implementing VR in education and its impact on the cognitive and psycho-emotional students'. Moreover, the analysis their investment worth and the highlighting of the benefits of these technologies for education is worth mentioning in the future researches.

Limitation of the study

The limitations of the work were, first of all, the lack of skills of the students in working with virtual artefacts. Despite the fact that their generation is technologically advanced, in practice, it was in the educational process that the relevant skills were lacking. The next limitation was the small focus group in the study. This is due to the fact that at the moment, Universities in Ukraine are not fully equipped with virtual artefacts, so access to them during classes is provided to small groups. The final limitation is the financial aspect. The introduction of virtual and augmented reality into the educational process is expensive, and due to a lack of funding, its progress in education is slow. Therefore, focusing on investing and financing virtual artefacts in education is a promising area for future research.

References

Acosta, J. L. B., Navarro, S. M. B., Gesa, R. F., & Kinshuk, K. (2019). Framework for designing motivational augmented reality applications in vocational education and training. *Australasian Journal of Educational Technology*, 35(3). <https://doi.org/10.14742/ajet.4182>

- Agbafé, V., Jazayeri, H. E., Baker, N., & Cederna, P. S. (2023). Augmenting medical and surgical education with Virtual Reality (VR). *Plastic and Reconstructive Surgery*, 152(3), 556e–558e. <https://doi.org/10.1097/PRS.00000000000010546>
- Alam, A. (2022a). Mapping a sustainable future through the conceptualization of transformative learning framework, education for sustainable development, critical reflection, and responsible citizenship: an exploration of pedagogies for twenty-first century learning. *ECS Transactions*, 107(1), Article 9827. <https://doi.org/10.1149/10701.9827ecst>
- Alam, A. (2022b). Social robots in education for long-term human-robot interaction: socially supportive behaviour of robotic tutor for creating robo-tangible learning environment in a guided discovery learning interaction. *ECS Transactions*, 107(1), Article 12389. <https://doi.org/10.1149/10701.12389ecst>
- Alkhabra, Y. A., Ibrahim, U. M., & Alkhabra, S. A. (2023). Augmented reality technology in enhancing learning retention and critical thinking according to STEAM program. *Humanities and Social Sciences Communications*, 10(1), 1–10. <https://www.nature.com/articles/s41599-023-01650-w>
- Ateş, H., & Garzón, J. (2023). An integrated model for examining teachers' intentions to use augmented reality in science courses. *Education and Information Technologies*, 28(2), 1299–1321. <https://link.springer.com/article/10.1007/s10639-022-11239-6>
- Babakr, Z., Mohamedamin, P., & Kakamad, K. (2019). Piaget's cognitive developmental theory: Critical review. *Education Quarterly Reviews*, 2(3). https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3437574
- Bogusevschi, D., Muntean, C., & Muntean, G. M. (2020). Teaching and learning physics using 3D virtual learning environment: A case study of combined virtual reality and virtual laboratory in secondary school. *Journal of Computers in Mathematics and Science Teaching*, 39(1), 5–18. <https://www.learntechlib.org/p/210965/>
- Cabero-Almenara, J., & Roig-Vila, R. (2019). The motivation of technological scenarios in augmented reality (AR): Results of different experiments. *Applied Sciences*, 9(14), Article 2907. <https://doi.org/10.3390/app9142907>
- Checa, D., & Bustillo, A. (2020). Advantages and limits of virtual reality in learning processes: Briviesca in the fifteenth century. *Virtual Reality*, 24(1), 151–161. <https://link.springer.com/article/10.1007/s10055-019-00389-7>
- Chen, C. H., Huang, C. Y., & Chou, Y. Y. (2019). Effects of augmented reality-based multidimensional concept maps on students' learning achievement, motivation and acceptance. *Universal Access in the Information Society*, 18, 257–268. <https://link.springer.com/article/10.1007/s10209-017-0595-z>
- Chen, M. P., Wang, L. C., Zou, D., Lin, S. Y., Xie, H., & Tsai, C. C. (2022). Effects of captions and English proficiency on learning effectiveness, motivation and attitude in augmented-reality-enhanced theme-based contextualized EFL learning. *Computer Assisted Language Learning*, 35(3), 381–411. <https://doi.org/10.1080/09588221.2019.1704787>
- Chen, Y. C. (2019). Effect of mobile augmented reality on learning performance, motivation, and math anxiety in a math course. *Journal of Educational Computing Research*, 57(7), 1695–1722. <https://doi.org/10.1177/073563311985403>

- Fauzi, M. A. (2022). E-learning in higher education institutions during COVID-19 pandemic: Current and future trends through bibliometric analysis. *Heliyon*, 8, Article 09433. <https://doi.org/10.1016/j.heliyon.2022.e09433>
- Filipova, L. V. (2021). Computer technologies during the study of biochemistry. *Topical Issues of the Humanities*, 2(46), 179–184. <https://doi.org/10.24919/2308-4863/46-2-29>
- Frewen, P., Oldrieve, P., & Law, K. (2022). Teaching psychology in virtual reality [Advance online publication]. *Scholarship of Teaching and Learning in Psychology*. <https://doi.org/10.1037/stl0000341>
- George, O., Foster, J., Xia, Z., & Jacobs, C. (2023). Augmented reality in medical education: A mixed methods feasibility study. *Cureus*, 15(3). <https://doi.org/10.7759/cureus.36927>
- Guaya, D., Meneses, M. Á., Jaramillo-Fierro, X., & Valarezo, E. (2023). Augmented reality: An emergent technology for students' learning motivation for chemical engineering laboratories during the COVID-19 pandemic. *Sustainability*, 15(6), Article 5175. <https://doi.org/10.3390/su15065175>
- Guerra-Tamez, C. R. (2023). The impact of immersion through virtual reality in the learning experiences of art and design students: The mediating effect of the flow experience. *Education Sciences*, 13(2), Article 185. <https://doi.org/10.3390/educsci13020185>
- Guppy, N., Verpoorten, D., Boud, D., Lin, L., Tai, J., & Bartolic, S. (2022). The post-COVID-19 future of digital learning in higher education: Views from educators, students, and other professionals in six countries. *British Journal of Educational Technology*, 53(6), 1750–1765. <https://doi.org/10.1111/bjet.13212>
- Gustiani, S. (2020). Students' motivation in online learning during Covid-19 pandemic era: A case study. *Holistics (Hospitality and Linguistics): Jurnal Ilmiah Bahasa Inggris*, 12(2). <https://doi.org/10.2991/assehr.k.220202.029>
- Huang, W. (2022). Examining the impact of head-mounted display virtual reality on the science self-efficacy of high schoolers. *Interactive Learning Environments*, 30(1), 100–112. <https://doi.org/10.1080/10494820.2019.1641525>
- Irwanto, I., Dianawati, R., & Lukman, I. R. (2022). Trends of augmented reality applications in science education: A systematic review from 2007 to 2022. *International Journal of Emerging Technologies in Learning (Online)*, 17(13), 157–175. <https://doi.org/10.3991/ijet.v17i13.30587>
- Iwanaga, J., Muo, E. C., Tabira, Y., Watanabe, K., Tubbs, S. J., D'Antoni, A. V., ... & Tubbs, R. S. (2023). Who really needs a Metaverse in anatomy education? A review with preliminary survey results. *Clinical Anatomy*, 36(1), 77–82. <https://doi.org/10.1002/ca.23949>
- Javornik, A., Marder, B., Barhorst, J. B., McLean, G., Rogers, Y., Marshall, P., & Warlop, L. (2022). 'What lies behind the filter?' Uncovering the motivations for using augmented reality (AR) face filters on social media and their effect on well-being. *Computers in Human Behavior*, 128, Article 107126. <https://doi.org/10.1016/j.chb.2021.107126>
- Khan, T., Johnston, K., & Ophoff, J. (2019). The impact of an augmented reality application on learning motivation of students. *Advances in human-computer interaction*, 2019, Article 7208494. <https://doi.org/10.1155/2019/7208494>
- Khodabandeh, F. (2023). Exploring the viability of augmented reality game-enhanced education in

- WhatsApp flipped and blended classes versus the face-to-face classes. *Education and Information Technologies*, 28(1), 617–646. <https://link.springer.com/article/10.1007/s10639-022-11190-6>
- Lin, Y. C., & Hou, H. T. (2022). The evaluation of a scaffolding-based augmented reality educational board game with competition-oriented and collaboration-oriented mechanisms: Differences analysis of learning effectiveness, motivation, flow, and anxiety. *Interactive Learning Environments*. <https://doi.org/10.1080/10494820.2022.2091606>
- Lin, Y., & Yu, Z. (2023). A meta-analysis of the effects of augmented reality technologies in interactive learning environments (2012–2022). *Computer Applications in Engineering Education*, 31(4), 1111–1131. <https://doi.org/10.1002/cae.22628>
- Low, D. Y. S., Poh, P. E., & Tang, S. Y. (2022). Assessing the impact of augmented reality application on students' learning motivation in chemical engineering. *Education for Chemical Engineers*, 39, 31–43. <https://doi.org/10.1016/j.ece.2022.02.004>
- Marks, B., & Thomas, J. (2022). Adoption of virtual reality technology in higher education: An evaluation of five teaching semesters in a purpose-designed laboratory. *Education and information technologies*, 27(1), 1287–1305. <https://link.springer.com/article/10.1007/s10639-021-10653-6>
- Matovu, H., Ungu, D. A. K., Won, M., Tsai, C. C., Treagust, D. F., Mocerino, M., & Tasker, R. (2023). Immersive virtual reality for science learning: Design, implementation, and evaluation. *Studies in Science Education*, 59(2), 205–244. <https://doi.org/10.1080/03057267.2022.2082680>
- Mulders, M., Buchner, J., & Kerres, M. (2020). A framework for the use of immersive virtual reality in learning environments. *International Journal of Emerging Technologies in Learning (ijET)*, 15(24), 208–224. <https://www.learntechlib.org/p/218562/>.
- Mystakidis, S., & Lympouridis, V. (2023). Immersive Learning. *Encyclopedia*, 3(2), 396–405. <https://doi.org/10.3390/encyclopedia3020026>
- Najmi, A. H., Alhalafawy, W. S., & Zaki, M. Z. T. (2023). Developing a sustainable environment based on augmented reality to educate adolescents about the dangers of electronic gaming addiction. *Sustainability*, 15(4), Article 3185. <https://doi.org/10.3390/su15043185>
- Obeid, S., & Demirkan, H. (2023). The influence of virtual reality on design process creativity in basic design studios. *Interactive Learning Environments*, 31(4), 1841–1859. <https://doi.org/10.1080/10494820.2020.1858116>
- Pelletier, K., McCormack, M., Reeves, J., Robert, J., Arbino, N., Dickson-Deane, C., ... Stine, J. (2022). 2022 *EDUCAUSE Horizon report teaching and learning edition*. EDUC22. <https://www.learntechlib.org/p/221033/>
- Rojas-Sánchez, M. A., Palos-Sánchez, P. R., & Folgado-Fernández, J. A. (2023). Systematic literature review and bibliometric analysis on virtual reality and education. *Education and Information Technologies*, 28(1), 155–192. <https://link.springer.com/article/10.1007/s10639-022-11167-5>
- Seufert, C., Oberdörfer, S., Roth, A., Grafe, S., Lugin, J. L., & Latoschik, M. E. (2022). Classroom management competency enhancement for student teachers using a fully immersive virtual classroom. *Computers & Education*, 179, Article 104410. <https://doi.org/10.1016/j.compedu.2021.104410>

- Sholihin, M., Sari, R. C., Yuniarti, N., & Ilyana, S. (2020). A new way of teaching business ethics: The evaluation of virtual reality-based learning media. *The International Journal of Management Education*, 18(3), Article 100428. <https://doi.org/10.1016/j.ijme.2020.100428>
- Smutny, P. (2022). Learning with virtual reality: A market analysis of educational and training applications. *Interactive Learning Environments*. <https://doi.org/10.1080/10494820.2022.2028856>
- Sonntag, D., Albuquerque, G., Magnor, M., & Bodensiek, O. (2019). Hybrid learning environments by data-driven augmented reality. *Procedia Manufacturing*, 31, 32–37. <https://doi.org/10.1016/j.promfg.2019.03.006>
- Tezer, M., Yıldız, E., Masalimova, A., Fatkhutdinova, A., Zheltukhina, M., & Khairullina, E. (2019). Trends of augmented reality applications and research throughout the world: Meta-analysis of theses, articles and papers between 2001-2019 years. *International Journal of Emerging Technologies in Learning (ijET)*, 14(22), 154–174. <https://www.learntechlib.org/p/217151/>
- Uriarte-Portillo, A., Ibáñez, M. B., Zatarain-Cabada, R., & Barrón-Estrada, M. L. (2023). Comparison of using an augmented reality learning tool at home and in a classroom regarding motivation and learning outcomes. *Multimodal Technologies and Interaction*, 7(3), Article 23. <https://doi.org/10.3390/mti7030023>
- Wang, X.-M., Hu, Q.-N., Hwang, G.-J., & Yu, X.-H. (2022). Learning with digital technology-facilitated empathy: An augmented reality approach to enhancing students' flow experience, motivation, and achievement in a biology program. *Interactive Learning Environments*. <https://doi.org/10.1080/10494820.2022.2057549>
- Wenk, N., Penalver-Andres, J., Buetler, K. A., Nef, T., Muri, R. M., & Marchal-Crespo, L. (2023). Effect of immersive visualization technologies on cognitive load, motivation, usability, and embodiment. *Virtual Reality*, 27(1), 307-331. <https://link.springer.com/article/10.1007/s10055-021-00565-8>
- Williams, R. (2022). An academic review of virtual learning environments. *ICRRD Quality Index Research Journal*, 3(2), 143–145. <https://doi.org/10.53272/Icrrd>
- Yang, F. C. O., Lai, H. M., & Wang, Y. W. (2023). Effect of augmented reality-based virtual educational robotics on programming students' enjoyment of learning, computational thinking skills, and academic achievement. *Computers & Education*, 195, Article 104721. <https://doi.org/10.1016/j.compedu.2022.104721>
- Zhang, X., Chen, Y., Hu, L., & Wang, Y. (2022). The metaverse in education: Definition, framework, features, potential applications, challenges, and future research topics. *Frontiers in Psychology*, 13, 6063. <https://doi.org/10.3389/fpsyg.2022.1016300>

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Fostering Language Learning Strategies Through Comparative Linguistics: Future Directions for Azerbaijani Higher Education

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Abstract: The **purpose of the study is to** examine the motivation for using comparative linguistics methods, namely the methodology of the comparative language approach in English classes at Baku State University (BSU), and to show the levels of typological errors among students. In the paper an analysis of related literature **was used**. Among the sources that contained the key terms of the presented work, 30 were selected in order to describe the issue in the broadest possible way. In addition, for the practical part of the work, elements of comparative linguistics in the study of English among first-year students of the Faculty of Germanic Philology at the BSU were used. Students were divided into 2 groups. One of them studied English based on the tenets of comparative linguistics. The novelty lies in the fact that usually in the linguistic environment such subjects as comparative linguistics are introduced at the senior courses. The **results of the study** showed that based on the comparative linguistic method in the didactics of teaching a foreign language, bilingual students perceive the acquisition of English

based on the comparison of sounds, morphemes, and lexemes at the associative level with their native language (despite the fact that Azerbaijani belongs to another group of languages) and has a systemic flexibility. Initially, one relied on the developed didactic methods of comparative linguistics. The final module showed better results for Group 2. The **conclusions** indicate that typological errors among BSU students are language “noise”. However, phonological, morphological, lexical, and syntactic errors can be eliminated through comparative didactics in foreign language teaching. It improves the general cognitive and metacognitive applicants’ abilities, strengthens their understanding of their native language, strengthens reading and writing, and develops general communication skills. So, the methodology of the comparative language approach is active, participatory, and motivating.

Keywords: foreign language, language group, speech noise, plurilingualism, typological error.

Introduction

In its early days, comparative linguistics was perceived by linguists as “comparative analysis” (Martin & Quiroz, 2019). Comparative linguistics, whose original ambition was to compare two languages “urgently, rigorously and systematically” and especially their structural differences. According to Thompson et al. (2019), such an analysis makes it possible to achieve methods for better adaptation to the specific difficulties encountered in foreign language learning. The comparative approach is to establish a procedure for combining different forms of languages that perform equivalent functions in communication (Sztahó & Fejes, 2023). It should be mentioned, that even comparative approaches consist in the systematic study of a linguistic phenomenon in two (or more) languages in parallel (vice versa) to highlight their differences and similarities Körner and Rummer (2023) the scientific thoughts never addressed to a such experience in comparative didactic of two languages that are far each of other from the point of view of its language family. However, often, for practical purposes, comparative analysis also sheds new light on a particular phenomenon in one of the two languages.

Irkinovich (2022) proposes a method of grammatical problems, along with an analysis of the relationship between language and culture. Indeed, it is important for two distant languages to accomplish cultural evidences in didactic. According to Allovidinovna and Kizi (2022), comparative linguistics is a comparative methodology applied to the analysis of two languages that differ in phonological systems, grammar, vocabulary, writing, or culture. For these purpose didactic exercises, based on the comparison of L1 and L2, exercises based on description heteronymic exercises, interlingual paraphrasing, correction of errors and interlanguage should be applied during the class. In the same aspect, Kholmatova and Olamnazarova (2022) insists that the comparison between the mother tongue and the foreign language holds the key to the abilities or difficulties of foreign language learning.

Comparative linguistics is of great importance in learning and teaching a foreign language. In learning a foreign language, the influence of the mother tongue is one of the main obstacles. In order to better understand the points that are likely to be influenced by the mother tongue, it is effective to make comparisons between the mother tongue and the target language, analysing their similarities and differences and typological errors (Talabovna, 2023). More specifically, the comparative analysis can be applied in many segments of foreign language teaching, with the goal of predicting, describing, and explaining errors and difficulties caused by the influence of the mother tongue (Coopmans et al., 2023).

In the proposed paper, one agrees that the influence of the mother tongue is one of the main obstacles in learning a foreign language.

Comparative linguistics is a synchronic analysis, i.e., the purpose of the analysis is the state of its development in a certain period, not the evolution of that language (Lipkin et al., 2023).

Kong et al. (2023) note that comparative linguistics attempts to research the contrast of two or more languages synchronously, to describe their similarities and differences in order to identify theoretical patterns and serve other relative fields. However, the diachronic element is essential in foreign language learning. It should be introduced beginning with the third year of studies. The historical aspect in a comparative language history will improve the learning process.

As it can be mentioned, comparative studies cover a broad field, bounded by typology, language teaching, translation, and language acquisition. None of these disciplines belongs to it alone, but it is through the transmission of comparative studies that these disciplines come into interaction (Cheng et al., 2020). Over the years, researches in the field of foreign language acquisition have been characterised by the diversification of theoretical approaches, which has led to a variety of methods used in linguistics (Khani & Mirdehghan, 2020). The achievements of linguists in the field of foreign language learning focus on the problem of diversity of learning contexts for different categories of language learners. Since a multitude of cultures coexist in Azerbaijan, the method of comparative linguistics is often chosen by higher education institutions in foreign languages teaching (Abdulhasanli et al., 2023).

It is important for the given research in terms of its multiculturalism. In linguistic science, the comparative method is a homogeneous way of comparing diverse idioms for determining the comparability (Saud, 2019). The mentioned technique focuses on the value of unvarying sound alteration. Consequently, any alteration in a language sounds that can occur over time regularly arises without exclusion (Schweikhard & List, 2020). Languages are examined with the help of the comparative method in order to determine if they are part of a common proto-language, the nostratic language that developed several other languages (Haas, 2021). The comparative method is able to propose the branch of a language family that developed the first.

Using genetics and similarities historical linguistics looks for an analogy to debate the relations between idioms so that two languages from the same language-say, English and German-are called related by virtue of belonging to the Germanic group (Ellis, 1966).

Languages with a common origin are grouped into families. In this sense, the comparison of native and foreign languages, even taking into account the complexity of this process (different and distant groups of L1 and L2 languages), is revolutionary. It is important to note that this is just an analogy and does not mean anything about the genetic makeup of native speakers - an English-speaking person in the modern world is not necessarily a descendant of representatives of Germanic communities (Salehi & Neysani, 2017).

The comparative method usually uses consonant words in the languages that are being compared. Words, terms present in each language, borrowed terms, everything is compared, and correspondences between sounds are noted (Saud, 2019). For example, the *f* sound in German corresponds to the *p* sound in Latin at the beginning of a word: the Latin *pater* has the same meaning as the German *Vater* (pronounced Fah-tuh). In the comparative method, the linguist records all the correspondences between the languages in question and then begins to write sound rules to explain the changes. The sound rule for the example above would explain how one sound in the native language became *p* in Latin and *f* in German. You should always consider the location in the word of the sound match. As for example the Latin language “*p*”, parallels only with the German “*f*” at the commencement of a lexeme.

By equating two or more interrelated languages and leaving no suggestion of the native language, a scientist can use the comparative method to rebuild a supposed native language (Gambarova, 2023). One of the well-known and most comprehensive recreated languages is Proto-Indo-European, from which hundreds of European, Middle Eastern, Central, and South Asian languages have developed, counting the above-mentioned examples of Latin and German. Consequently, taking into account

mistakes, the so-called language "noise" in understanding and translation of a foreign language is straightforward in comparative didactic.

Giving to Allahverdiyeva (2023), meanwhile the systematic sound change rules state that there are no exclusions to the sound change rules, everything that appears like an exception should be scrutinised and clarified in a way that contents linguistic values. A seeming irregularity may be due to

the properties of a dissimilar sound change rules or to the consecutive order where numerous sound changes happened, or it may occur as the word in query entered the language after the sound changes. Afterward defining the sound change rules for the set of languages under study, the following stage in the comparative method is to control the order of sound change (Rezvani, 2023). This is why things that seemed to be exclusions to the assumed rules can become in accessible.

Consequently, comparative linguistics methods can be a long and complicated process, and sometimes hypotheses are based on conjecture. However, the comparative method is crucial for historical linguists and is in charge for almost all presently acknowledged linguistic genealogies.

Research Problem

The methods of comparative linguistics are in line with the approach of multilingual education, which is actively pursued in higher education institutions in Azerbaijan. The multilingual education is expressed by the openness to others in terms of finding commonalities and differences in them. According to Johanson (2023), bilinguals learn the "otherness" organically, as another modality of their identity. The problem of the presented study is the theorisation of comparative linguistics as such. It has always been considered separately from the didactics of foreign language learning itself. This study focuses on the combination of theory and practice in higher education institutions of philology. This combination is based on the identification of similarities and differences between languages in order to facilitate students' learning of a foreign language. The comparison of languages is part of the intercultural approach. The very idea of comparison stems from the intercultural approach, which compares similarities and differences between cultural practices while trying to avoid stereotypes (Dannemann, 2019). The intercultural approach, adopted in the context of language comparison, is worked out from the perspective of foreign language learning.

The commonalities between languages are based on singular universals. Similarly, at the level of language learning, there are singular universals: there are similarities and differences between languages at the phonetic, lexical, and syntactic levels, and languages and communication are imbued with culture (Rezaee et al., 2020). Language comparison is based on observations, on research that shows that a new language is always learned based on the mother tongue or the languages that are already known. Learning another language always means modelling the system to be achieved on the system of origin, regardless of what language level (sound, syntax, lexical) it is learned.

Research Focus

In this study, one focuses on the theoretical tenets of comparative linguistics in terms of foreign language learning and perception. Given the multiculturalism and multilingualism of Azerbaijan, this focus is particularly interesting. Since it is with the help of their own words that bilinguals construct the perception of a foreign language. In short, the applicant will use what they already know to learn a new language, will resort to simplifications or interference between the native and foreign languages.

According to Xu et al. (2023), this behaviour is completely normal and is a step on the way to building a language system. The native language acts as a filter through which a foreign language is learned. This filter opens up possibilities for any communication, whether it is the perception of sounds,

the use of words, or the use of non-verbal codes (Kuriyozov et al., 2020). As a result, learners open themselves up to the automatic perception of both languages.

Research Aim and Research Questions

The present study' aim was analysing the development of language learning strategies through comparative linguistics in Azerbaijani higher education. The aim was also to examine the effectiveness of the comparative linguistics methods use, namely comparative didactics in English classes at Baku State University, and to show the levels of typological errors and ways of their solving among students. The experiment aimed to answer the following questions:

- 1) Is the comparative language approach effective for developing communication skills?
- 2) How does comparative didactics participate in the adaptation to different regions of communication and in the use of language for communication in both oral and written forms for students of higher philological education in Azerbaijan?
- 3) What are the typological mistakes of Azerbaijani applicants who are mostly bilingual?

Research Methodology

In this work, one relied on the methodology of the comparative linguistic approach, which is based on identifying similarities and differences between the native and foreign languages of applicants. Within the framework of the presented work, the comparison was carried out "without prioritising" languages (Tang et al., 2020). On the contrary, it was part of an intercultural approach that focused on multilingualism. The methodology of the comparative language approach was active, participatory, and motivating. It focused to encourage learners to express themselves and encouraged the exchange of ideas at the level of learner-learner, learner-teacher. In the process of learning a foreign language, for a philologist, motivation is the driving force of learning (Tursunovich, 2022). Motivation can be increased by using authentic didactic materials in the native language of the learners. The comparative approach is carried out jointly, in a classroom setting, between learners and the teacher (Molway et al., 2022).

It should be noted that the comparative language approach does not require the teacher to know the languages of the learners. In fact, this is impossible given the wide range of languages spoken by students of higher philological education in Azerbaijan.

The applicants are put in the position of an "expert" in their native language. The approach was implemented through reflective sessions of exchange of ideas and discoveries, which educate both teachers and learners. The role of the teacher was to help learners by advising them to organize their knowledge in accordance with the foreign language they were learning.

Comparing languages is not a method that should be used on a regular basis. Rather, it is a position to be taken when a mistake is made, when a new point (grammatical, spelling, etc.) seems difficult to resolve, or when learners do not feel comfortable in a new language (Bunyadova, 2020). Comparison of languages can and should be done in different ways according to the level of language proficiency and abilities of the learners.

General Background

The benefits of language comparison in foreign language learning is an effective tool. Language comparison is a way to increase the value of learners' native languages, restore their value and logic, and put them on the same level as the Azerbaijani language. The comparison allows learners to re-establish or maintain a connection with their mother tongue. This is very important. It is important to

try to maintain this connection for the following reasons (Table 1):

Table 1

Advantages of the Comparative Linguistic Approach in a Foreign Language Learning

Advantage.	Characteristics
Didactics based on comparison	can help answer the initial question in learning a foreign language: "What is the difference between the native language and the language being learned?"
Description-based didactics	seeks to describe the systematic differences between the two languages.
Heteronymy or equivalence of meaning	Identification of the meaning, function, variety of expression, the word, its place, even intonation, as an integral part of any comparison. Their interrelation shows that what a word gives in one language is expressed in another by the place of words or the choice of another word.
Interlanguage paraphrasing	The comparative element in didactics is focused on solving problems related to learning and mastering a foreign language and should therefore transform equivalences established by the learner into one-to-one equivalences so that one L1 unit always corresponds to one L2 unit.
Error and interlanguage management	Interlanguage errors are defined as "noise" that completely or partially interferes with the correct acquisition of the L2. However, the term noise can be linked to the law of intentionality: errors made by a native speaker are in most cases slips of the tongue and much less often errors, so-called comparable beginner's errors. The noise can also be a violation of the message due to ignorance of the rules governing the functioning of a foreign language. It is about phonetic, morphological, lexical, and syntactic contrast.

Source: author's own development.

Sample / Participants / Group

The research methods included a review of the reference sources that formed the theoretical and methodological basis of the study. The works of scientists who have devoted their works to such categories as "comparative phonology", "comparative linguistics", "didactics" are considered. The work included modelling, analysis, and generalization of pedagogical experience, survey methods (conversation, questionnaire, interviewing), observation, experiment, and processing of experimental data. The present study analysed the **pragmatics of using the** methodology of the comparative language approach in English classes at Baku State University (BSU). The experiment was conducted on 26 first-year students majoring in English Language and Literature from September to December 2022. The age range was 17-18 years old. Thirteen of the twenty-six students started learning English this year (they had previously studied French or German) and were selected for testing. Three of them were true beginners in English, while the rest had studied English during their schooling. That is, 16 students can be considered beginners in learning English. Six students who were able to complete the task (the other four students write very slowly and could not complete the tests during the special session) were selected to be tested in this study. Ten participants were bilingual. Sixteen were newcomers and they had unsatisfactory skills in learning and memorising the material and formed a group of participants in the traditional foreign language acquisition. The first group, consisting of 10 students, was taught using

the academic approach. The second group (16 students) used the methodology of the comparative linguistic approach to learning English.

Instrument and Procedures

During one semester of the first year of study, the first group No. 1 was taught using the traditional methodology. Group 2 studied English based on the tenets of comparative linguistics. Since traditional methods are described in detail in the related literature, the work of Group 2 is described in details. As mentioned above, the students worked for a semester based on exercises developed in the key of comparative linguistics. During the semester, 12 hours a week were devoted to various comparative exercises (according to the syllabus):

- Didactic exercises based on the comparison of L1 and L2. These exercises were based on didactic games (listening to find differences and similarities between L1 and L2);
- Didactic exercises based on description (writing - with a focus on enriching vocabulary, i.e. getting to know different ways of word formation);
- Heteronymic exercises (search for equivalent meanings, expressions, words in comparison with the native language);
- Interlingual paraphrasing (oral speech - exercises to expand vocabulary, selection of synonyms and antonyms);
- Correction of errors and interlanguage (grammatical writing exercises, relying on translation from L2 to L1, analysis of interlanguage errors).

At the end of the semester the students were given final module tests, which included a task to work on the translation of the test. Explanations of the use of each method were given in detail for each test version. Two consecutive tests were conducted using the classical approach of memorising grammatical and lexical material to determine the effectiveness of individual methods and the possible combination of the two methods. Students were informed that they were participating in two comparative tests. The texts tested were unknown to the participants, otherwise, it would have distorted the results, as these were tests of memorization. On the day of the test, they were given the English vocabulary materials and its phonetic reproduction, and each participant tried to reproduce the word in writing, i.e., they were already familiarized with the vocabulary. This study describes in detail only the actions of students who use the comparative linguistics method in learning English since academic methods have already been described in many scientific works. In the so-called analysis phase, group 2 had to read the text in the target language (L2), analyse each part of it (words, structures, etc.) in detail, and then translate it into their native language (L1). The key point, especially in the case of English, is to always supply the student with a text that includes not only vocabulary with alley transcriptions and contrasting material. The texts to be translated as a final test should reveal errors, the so-called language “noise” at the phonetic, morphological, lexical, and syntactic levels.

Data Analysis

The main goal was to find the best conditions for students to understand the material. In this sense, the comparison of native and foreign language, even taking into account the complexity of this process (different and distant groups of L1 and L2 languages) is revolutionary. Students in both groups had to read the text in English (L2) and understand and analyse the global and its unique parts, comparing the two languages. It is important to emphasise that the ability to translate texts accompanied by word explanations and grammatical rules is revolutionary in the sense that it avoids the use of dictionaries.

Looking up a word in a dictionary can be a rather time-consuming and costly task. Therefore, the homogeneous use of associations with the mother tongue in teaching is productive and facilitates learning.

The limitation of this study was the number of students, so the results reflect reality only in terms of this sample. Such a small number of participants is due to the small enrolment of students in the English Translation program in 2022. Therefore, in the future, it would be interesting to conduct a study on a larger number of students to obtain more relevant results.

Research Results

At the stage of phase synthesis, it was necessary to read an unfamiliar text in L2 English and translate it into the native language (L1). The applicants' work was checked for errors, the so-called language "noise" in the perception and translation of the proposed test. During the test, attention was paid to phonological and lexical errors in reading, and to morphological and syntactic errors in translation. For group 2, comparative didactics was of high linguistic interest. The need to justify the new approach showed certain difficulties faced by the students (more information, a large number of ordered language operations, checking the compliance of achievements with the standards of the target language, and, finally, streamlining and adapting the didactic and methodological program in the light of errors recorded in the testing. Didactic contrastivity allows learning a foreign language by systematically comparing two contact languages and analysing interference errors. Therefore, the object of comparative didactics will be able to join in the identification of problems that arise when learning a foreign language, both despite the existing knowledge and thanks to the existing knowledge. Consequently, it was necessary to identify the problems in contrast to the various areas of extension of this approach (phonetics, grammar, vocabulary, syntax, and even culture). The learner may know the rules specific to these areas (phonetics, grammar, vocabulary, syntax, and even culture), but sometimes he does not use them, and sometimes he does not apply them correctly. Therefore, it was necessary to lead students to construct the specific problem they were facing, to look for an algorithmic application from their original language. Consciously the use the contrast between the source and target languages helped identifying, constructing and, therefore, solving problems that foreign language learning in all its aspects can pose.

Thus, the test results showed the following results (Table 2):

Table 2

Student Results and Grades by Assignments in Percentage Terms

<i>Groups</i>	<i>Reading.</i>	<i>Translation.</i>	<i>Phonological lexical errors</i> and	<i>Morpho-syntax errors</i>
<i>Group 1 (comparative didactics)</i>	29%	32%	17%	38%
<i>Group 2 (traditional method)</i>	5%	12%	6%	12%

Source: author's own development.

In addition, examples of typical contrasts in the phonological, morphological, syntactic, lexical, and cultural spheres are given (Table 3):

Table 3*Examples of Contrasts*

A problematising contrast	Description.
Problematising phonological contrast	English phonemes do not reveal any specific problems in pragmatic use among learners. However, the fact of insufficient mastery of the conditions of use or non- use of this phoneme complicates its mechanical expression in contrast to the Azerbaijani language. The lack of a clear identification of the problem hinders any realistic approach to English prosody.
An example of morphological contrast	Difficulties arise at the level of perception of genders. Of course, there are philological justifications for this due to the peculiarities of the Azerbaijani language. Students instinctively tried to semantically classify gender nouns, and this category is significantly different in English.
An example of syntactic contrast	Lack of tense variety and imperfect morphology of the compound past tense. The forms of the latter cause difficulties. Students strive to build sentences in the past tense like L1.
An example of lexical contrast	As for the approach to the lexicon, the contrastive analysis of semantic equivalences of words raises the problem of the possibility of transferring meaning from one language to another. This is, in fact, the most common mistake.

Source: author's own development.

The identification of problems in professional translation went through successive phases: first, the problem was identified, and then contrasting parallels were drawn and solutions sought. The teacher is responsible for each of these three phases. Identifying the problem implies realising the problem. In this case, the feedback is essential for the use of comparative didactics. The teacher plays a crucial role, is aware of language problems, and therefore can encourage the learner to realize the problem, carefully avoiding its repetition. Thus, we can outline the main ways of solving language “noise” in the translations of future specialists (Table 4):

Table 4*Solving Language Noise in L1 to L2 Translations*

A problematising contrast	Problem-solving
Problematising phonological contrast	First, it is necessary to get rid of sonorous hesitation, as the speaker produces it in a manner similar to his native language. The syllabic division of the Azerbaijani language seems to oblige the learner to use the standard register of the mother tongue, and thus, it is necessary to emphasize avoiding it. This is especially true for bilinguals, who are even more tempted to follow their knowledge. Pronunciation should be shaped in a radically reversed L1 perspective, avoiding supranumeric consonants.
An example of morphological contrast	To get rid of the morphological problem of gender in the first place is to ask what regularities govern nouns in Azerbaijani. The solution is a solution directly resulting from contrastive didactics, because the contrastive aspect here is revealed by comparison with one's own language system: if there are regular correspondences between the form of words and their gender in L1, then we can conclude that even in L2 there are similar patterns. Secondly, it is necessary to raise the issue of gender.
An example of syntactic contrast	Explain the difference in tense forms in the form of a diagram. Perform contrasting exercises, making students come closer to the aspectual difference of tense forms.

An example of lexical contrast	It is necessary to observe in both languages the semantic distribution of various possible correspondences. This observational analysis of the data leads to a number of solution hypotheses, which are consistent with as many representations. Such analysis consists of re-observing the data and drawing conclusions by combining observations and ideas. In the case of semantic correspondences, it is the usage in the context of the data that specifically makes the difference between lexemes in L1 and L2.
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Source: author's own development.

Thus, the object of comparative didactics is primarily related to the identification of language “noise” problems that arise when learning a foreign language, both despite the existing knowledge and due to the existing knowledge. Therefore, the need to define the problem in contrast to the various areas of the approach's scope (phonetics, grammar, vocabulary, syntax, and even culture) is a crucial strategy. The learner may know the rules specific to these areas (phonetics, grammar, vocabulary, syntax, and even culture), but sometimes codifies them in the manner of his native language. Therefore, it is necessary to lead him to construct a specific problem the student is facing and look for an algorithmic application from his native language. The conscious use of the contrast between the source and target languages helps to identify, construct and, therefore, solve problems that can be posed by learning a foreign language in all its aspects.

Discussion

The overly widespread tendency to isolate learning and, consequently, mastery of a foreign language from the use of the mother tongue leads to learning difficulties that are problematic to overcome in the initial phases of learning. The comparison between data of didactic experience leads to the observation that learning a foreign language is fundamentally different from a child's mastery of their native language, due to the very existence of language mechanisms already formed in a novice bilingual: A method of teaching that denies the importance of the mother tongue is doomed to failure because it must be taken into account that “the traces left by the mother tongue are real, deep and lasting” (Pulido et al., 2022).

According to Talaván and Lertola (2022) and related work, it is necessary to look for new ways to learn foreign languages by looking into the depths of language theory. Comparativism is certainly not a new discovery. Teachers have always emphasised the differences between the mother tongue and the taught language to make it easier for beginners to learn. What is new, however, is the systematisation of the approach presented, described in numerous scientific studies (Phillips Galloway et al., 2020). In foreign language learning, the main difficulties in mastering a foreign language mostly stem from the differences between the two languages in contact (Isayeva, 2023).

The interaction and use of different didactic resources in learning is an integral part of today's world. From this perspective, Bensalem and Thompson (2022) see comparative pragmatics as an opportunity to observe how participants use different semiotic resources to build and shape

interactions. The authors are convinced that modern communication is increasingly viewed from a comparative perspective, and interlingual issues are becoming more relevant and attracting the attention of linguists. Despite the fact that in comparative studies (especially from the perspective of different language groups), some scholars differentiate language and images as separate communication systems, their interpretation often depends on linguistic structures (Rodríguez Barboza et. al., 2022).

The comparative perspective involves a comparison between two or more languages that are encountered in the learning process. In this respect, both differences and similarities between the languages being compared should be taken into account (Curran, 2019). Moreover, comparative analysis is actually a two-contrast analysis, since the number and position of the languages involved in this process are determined in advance. In this perspective, according to Pye (2017), in most cases there are only two languages, each of which occupies a certain position: one is the source language, L1, the other is the target language, L2, and the relationship between them is unidirectional from L1 to L2. The

genetic connections between the two languages are not taken into account at all, since only certain elements of the two languages will be systematically compared. Comparative research focuses much more on isolating errors (De Korne, 2022).

In a related work, Pulatova and Tolibova (2022) emphasise that comparative didactics deals with interference, errors that are attributed to the transposition of L1 structures in the production of L2 messages. The foreign language learner does indeed have elements that reflect what they want to express and the means at his or her disposal for this purpose. By highlighting the areas of the L2 that are most difficult to master at the L1 level, the teacher has the opportunity to organize the learning material according to common mistakes observed in learners' performance (Bergroth et al., 2022). According to Blow and Myers (2022), novice bilinguals start with a text composed in their language, which to transfer to the target language as faithfully as possible. This hypothesis is also supported by the interference errors evidenced in the discourse achievements of novice bilinguals. Indeed, usually, when learning a foreign language, a person transfers syllabic units from L1 to L2, but the freedom of the latter to interpret the source text is much more limited than that of the former. The text is imposed from the outside in one case, and in the other, it comes from within (Raxmonalievna, 2022).

In this regard, it should be noted that comparative didactics seeks to describe the systematic differences between the two languages involved in the learning process. It is in this aspect that translation seems to be important. Translation theory should establish procedures by which the conformity of the translated text to the protocol of the target language is measured or verified (Ouyang et al., 2022). Moreover, since language comparison proposes to formulate regular and binding correspondences between two languages that encounter each other in learning, it will basically preserve the constraints that apply in the target language.

According to Perkins and Zhang (2022), translation theory should take into account not only the inherent limitations of the L2 but also the transmission options that express different possible readings of the source text, as well as the preferred solutions that represent stylistic resources for the target language. In this aspect, Ye et al. (2022) note that, when equating linguistic units belonging to two different languages, difficulties arise such as the ambiguity of the L1 word, the lexical organization of the two languages in contact, the limitations of agreement or correspondence, and the syntactic structure where heteronyms are inscribed. Two units with a common meaning, different structure, but the same phonetic structure pose problems.

Thus, while preserving the differences between languages, comparative didactics is a means of helping to solve, at least partially, specific learning problems by developing pedagogical or bigrammatical grammar and organising teaching materials.

Conclusions and Implications

Teaching foreign languages is a complex process. Teachers continue to face difficulties due to the instability of language systems that belong to modern languages. Azerbaijani society is multicultural and multilingual. The study of foreign languages in higher education creates the basis for Azerbaijani society to open up and develop. The paper analyses the effectiveness of learning foreign languages in a comparative manner. The results showed that it improves students' general cognitive and metacognitive abilities, strengthens their understanding of the native language, strengthens reading and writing, and develops general communication skills. The motivation for using the methods of comparative linguistics, namely the methodology of comparative didactics in English classes at Baku State University (BSU), is considered. The levels of typological errors among students are determined. With the help of related literature, the theoretical basis of the work was created, which in turn made it possible to experimentally introduce elements of comparative linguistics as a didactic tool for first-year students. The results of the study showed that, based on the comparative linguistic method in the didactics of teaching a foreign language, bilingual students perceive the acquisition of English based on the comparison of sounds, morphemes, and lexemes at the associative level with their native language, and typological errors among BSU students are language "noise". However, phonological, morphological, lexical, and syntactic errors can be eliminated through comparative didactics in foreign language teaching. Conscious use of the contrast between the source and target languages helps to identify, construct and, consequently, solve problems that can be posed by learning a foreign language in all its aspects.

Suggestions for Future Research

Further consideration and development of the presented work is very promising in the context of Azerbaijan's multilingualism and multiculturalism. In terms of further research, comparative linguistics will allow focussing on comparing the structures of two or more languages spoken by bilingual learners, investigating their affinities, describing their interferences, and developing typology of errors in the context of 3-4 languages. In such a multilingual environment, this will provide foreign language teachers with a guide for developing more targeted, and therefore more effective, comparative teaching materials and methods.

Limitations

The limitations of the presented work are, firstly, the time frame. For a more detailed analysis, the first two years of future translators' training could be considered. The next limitation was the small focus group. This is due to the small number of applicants for the first year. The most problematic gap of this study consisted in the fact of multilingualism of Azerbaijani students. It is in order to work in a comparative way it is easier for teachers to work with two languages at first. With such a wide variety of languages spoken by students, it is quite difficult to direct their work in the right direction. The last limitation was the omission of the cultural element in language "noise" and in typological errors, since errors in cultural contrast are important for comparative studies.

References

- Abdulhasanli, T., Rzayeva, G., Amirova, A., & Huseynova, Z. (2023). Educational tourism as a source of linguistic and cultural competence of foreign students on the example of Azerbaijan. *Journal of Environmental Management and Tourism*, 14(4), 2077–2082. [https://doi.org/10.14505/jemt.v14.4\(68\).19](https://doi.org/10.14505/jemt.v14.4(68).19)
- Allahverdiyeva, V. (2023). Innovative productive method of teaching foreign languages to foreign students. *Multidisciplinary Science Journal*, 5, Article e2023029.

<https://malque.pub/ojs/index.php/msj/article/view/472>

- Allovidinovna, I. D., & Kizi, R. S. A. (2022). Methods of domestic and foreign representatives. *Eurasian Journal of Learning and Academic Teaching*, 9, 12–17. <https://www.geniusjournals.org/index.php/ejlat/article/view/1684>
- Bensalem, E., & Thompson, A. S. (2022). Multilingual effects on EFL learning: a comparison of foreign language anxiety and self-confidence experienced by bilingual and multilingual tertiary students. *International Journal of Bilingual Education and Bilingualism*, 25(7), 2653–2667. <https://doi.org/10.1080/13670050.2021.1943306>
- Bergroth, M., Llompart, J., Pepiot, N., van der Worp, K., Dražnik, T., & Sierens, S. (2022). Identifying space for mainstreaming multilingual pedagogies in European initial teacher education policies. *European Educational Research Journal*, 21(5), 801–821. <https://doi.org/10.1177/14749041211012500>
- Blow, D., & Myers, H. (2022). Comparative analysis of the 2022 DfE GCSE Subject Content for French, German, and Spanish and its implications for schools. *The Language Learning Journal*, 50(2), 238–248. <https://doi.org/10.1080/09571736.2022.2045678>
- Bunyadova, A. (2020). Comparative phraseological problems in modern linguistics. *İnsan ve Toplum Bilimleri Araştırmaları Dergisi*, 9(5), 3732–3740. <https://doi.org/10.15869/itobiad.786997>
- Cheng, X., Xu, W., Chen, K., Jiang, S., Wang, F., Wang, T., Chu, W., & Qi, Y. (2020). *SpellGCN: Incorporating phonological and visual similarities into language models for Chinese spelling check*. arXiv. <https://doi.org/10.48550/ARXIV.2004.14166>
- Coopmans, C. W., Kaushik, K., & Martin, A. E. (2023). Hierarchical structure in language and action: A formal comparison. *Psychological Review*, 130(4), 935–952. <https://doi.org/10.1037/rev0000429>
- Curran, V. G. (2019). Comparative law and language. In M. Reimann & R. Zimmermann (Eds.), *The oxford handbook of comparative law* (pp. 680–709). Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780198810230.013.21>
- Dannemann, G. (2019). Comparative law: Study of similarities or differences?. In M. Reimann & R. Zimmermann (Eds.), *The Oxford handbook of comparative law* (pp. 389–422). Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780198810230.013.12>
- Ellis, J. (1966). *Towards a general comparative linguistics*. Berlin, Boston: De Gruyter Mouton. <https://doi.org/10.1515/9783112414804>
- De Korne, H. (2022). Signs of difference: Language and ideology in social life [Book review]. *Journal of Sociolinguistics*, 26(5), 680–683. <https://doi.org/10.1111/josl.12595>
- Gambarova, G. (2023). Diachronic-dialectological research and study of habitual morphemes in linguistics (Based on the Azerbaijani language teaching materials). *Journal for Educators, Teachers and Trainers JETT*, 14(4), 128–137. <https://jett.labosfor.com/index.php/jett/article/view/1612/1015>
- Haas, P. (2021). Epistemic communities. In L. Rajamani & J. Peel (Eds.), *The Oxford handbook of international environmental law* (pp. 698–C40.S15). Oxford University Press. <https://doi.org/10.1093/law/9780198849155.003.0040>

- Irkinovich, N. R. (2022). Actual problems of teaching a foreign language in a technical university. *Texas Journal of Philology, Culture and History*, 5, 8–9. <https://zienjournals.com/index.php/tjpch/article/view/1302>
- Isayeva, A. (2023). Comparative analysis of word stress in English and Azerbaijani languages. *Grail of Science*, 24, 418–421. <https://doi.org/10.36074/grail-of-science.17.02.2023.077>
- Johanson, L. (2023). Global copies. In *Code copying* (pp. 18–20). BRILL. https://doi.org/10.1163/9789004548459_002
- Khani, M. H., & Mirdehghan, M. (2020). Typological comparison of relative structures in Azerbaijani Turkish, Korean, Hungarian and Persian. *Language Studies*, 10(2), 1–23. https://languagestudy.ihcs.ac.ir/article_5854_en.html
- Kholmatova, Z., & Olamnazarova, F. (2022). Problems of the communicational approach of language teaching in the primary class. *Asian Journal of Multidimensional Research*, 11(9), 140–144. <https://doi.org/10.5958/2278-4853.2022.00229.4>
- Kong, Q., Mulvihill, A., Slaughter, V., Fraser, H., Cavanagh-Welch, B., Elwina, F. C. ... Ruffman, T. (2023). Not just quantity but also quality of language: Cross-cultural comparisons of maternal mental state talk in New Zealand, Australia, and China. *PloS One*, 18(3), Article e0282480. <https://doi.org/10.1371/journal.pone.0282480>
- Körner, A., & Rummer, R. (2023). Valence sound symbolism across language families: a comparison between Japanese and German. *Language and Cognition*, 15(2), 337–354. <https://doi.org/10.1017/langcog.2022.39>
- Kuriyozov, E., Doval, Y., & Gómez-Rodríguez, C. (2020). *Cross-lingual word embeddings for Turkic languages*. arXiv. <https://doi.org/10.48550/ARXIV.2005.08340>
- Lipkin, B., Wong, L., Grand, G., & Tenenbaum, J. B. (2023). *Evaluating statistical language models as pragmatic reasoners*. arXiv. <https://doi.org/10.48550/ARXIV.2305.01020>
- Martin, J. R., & Quiroz, B. (2019). Functional language typology. In J. R. Martin, Y. J. Doran, & G. Figueredo (Eds.), *Systemic functional language description* (pp. 189–237). Routledge. <https://doi.org/10.4324/9781351184533-7>
- Molway, L., Arcos, M., & Macaro, E. (2022). Language teachers' reported first and second language use: A comparative contextualized study of England and Spain. *Language Teaching Research*, 26(4), 642–670. <https://doi.org/10.1177/1362168820913978>
- Ouyang, S., Ye, R., & Li, L. (2022). *WACO: Word-aligned contrastive learning for speech translation*. arXiv. <https://doi.org/10.48550/ARXIV.2212.09359>
- Perkins, K., & Zhang, L. J. (2022). The effect of first language transfer on second language acquisition and learning: From contrastive analysis to contemporary neuroimaging. *RELC Journal*. <https://doi.org/10.1177/00336882221081894>
- Phillips Galloway, E., Uccelli, P., Aguilar, G., & Barr, C. D. (2020). Exploring the cross-linguistic contribution of Spanish and English academic language skills to English text comprehension for middle-grade dual language learners. *AERA Open*, 6(1). <https://doi.org/10.1177/2332858419892575>

- Pulatova, S. H., & Tolibova, N. N. (2022). Some necessary options of learning English comparing with other foreign languages. *Eurasian Research Bulletin*, 4, 108–113.
https://uniwork.buxdu.uz/resurs/13299_1_67FAD2EA793C92A7F77A860231CC34C717ADA7CF.pdf
- Pulido, Y. F., Fuster-Guillen, D., Rojas-Rivera, W., Tamashiro, J. T., & Tataje, F. A. O. (2022). Didactic strategies to strengthen oral competence in English based on meta-analysis. *Journal of Positive School Psychology*, 6(3), 1794–1812.
<http://mail.journalppw.com/index.php/jpsp/article/view/1900>
- Pye, C. (2017). Chapter two. A history of crosslinguistic research on language acquisition. In *The comparative method of language acquisition research* (pp. 30-48). Chicago: University of Chicago Press. <https://www.degruyter.com/document/doi/10.7208/9780226481319/html#contents>
- Raxmonalievna, A. G. (2022). Lexical units related to the education system in a comparative study of different languages. *O'ZBEKISTONDA FANLARARO INNOVATSIYALAR VA ILMIY TADQIQOTLAR JURNALI*, 2(13), 259–266. <https://bestpublication.org/index.php/ozf/article/view/1751>
- Rezaee, H., Ahadi, H., & Aghamohammadi, A. (2020). The comparison of language development and lexical awareness indexes in bilingual (Azeri-Persian) hard of hearing and normal children. *Journal of Paramedical Sciences & Rehabilitation*, 9(1), 41–51.
<https://doi.org/10.22038/jpsr.2020.40712.1963>
- Rezvani, B. (2023). Republic of Azerbaijan: Ethnic identity and census categories. In I. Aminian Jazi & T. Kahl (Eds.), *Ethno-cultural diversity in the Balkans and the Caucasus* (pp. 81–104). Verlag der österreichischen Akademie der Wissenschaften. <https://www.austriaca.at/?arp=0x003e0c8a>
- Rodríguez Barboza, J. R., Ávila Sánchez, G. A., Pérez Saavedra, S. S., Rivera Rojas, C. N., & Acevedo Flores, J. (2022). Enfoque comunicativo como estrategia didáctica para mejorar la expresión oral del inglés en tiempos de pandemia. *Archivos Venezolanos de Farmacología y Terapéutica*, 41(1), 18–23.
<https://doi.org/10.5281/ZENODO.6370130>
- Salehi, M., & Neysani, A. (2017). Receptive intelligibility of Turkish to Iranian-Azerbaijani speakers. *Cogent Education*, 4(1), Article 1326653. <https://doi.org/10.1080/2331186x.2017.1326653>
- Saud, W. I. (2019). A contrastive analysis of ESL and EFL learning strategies. *Journal of Language Teaching and Research*, 10(2), 311–321. <https://doi.org/10.17507/jltr.1002.13>
- Schweikhard, N. E., & List, J.-M. (2020). Handling word formation in comparative linguistics. *SKASE Journal of Theoretical Linguistics*, 17(1), 2–26.
https://pure.mpg.de/pubman/faces/ViewItemOverviewPage.jsp?itemId=item_3237641
- Sztahó, D., & Fejes, A. (2023). Effects of language mismatch in automatic forensic voice comparison using deep learning embeddings. *Journal of Forensic Sciences*, 68(3), 871–883.
<https://doi.org/10.1111/1556-4029.15250>
- Talabovna, S. S. (2023). Comparison as a basis of cognition. *Galaxy International Interdisciplinary Research Journal*, 11(5), 507–509. <https://www.giirj.com/index.php/giirj/article/view/5250>
- Talaván, N., & Lertola, J. (2022). Audiovisual translation as a didactic resource in foreign language education. A methodological proposal. *Encuentro Journal*, 30, 23–39.
<https://doi.org/10.37536/ej.2022.30.1931>

- Tang, Y., Tran, C., Li, X., Chen, P.-J., Goyal, N., Chaudhary, V. ... Fan, A. (2020). *Multilingual translation with extensible multilingual pretraining and finetuning*. arXiv. <https://doi.org/10.48550/ARXIV.2008.00401>
- Thompson, G., Bowcher, W. L., Fontaine, L., & Schöenthal, D. (Eds.). (2019). *The Cambridge handbook of systemic functional linguistics*. Cambridge: Cambridge University Press.
- Tursunovich, R. I. (2022). Modern methods in the methodology of teaching a foreign language. *Central Asian Journal of Theoretical and Applied Science*, 3(12), 146–152. <https://doi.org/10.17605/OSF.IO/7WH3P>
- Xu, W., Zhao, P., Yao, Y., Pang, W., & Zhu, X. (2023). Effects of self-efficacy on integrated writing performance: A cross-linguistic perspective. *System*, 115, Article 103065. <https://doi.org/10.1016/j.system.2023.103065>
- Ye, R., Wang, M., & Li, L. (2022). *Cross-modal contrastive learning for speech translation*. arXiv. <http://arxiv.org/abs/2205.02444>

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Application of Artificial Intelligence in Ukrainian Education of the Future

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Abstract: **Aim:** The purpose of this study is to determine the most appropriate list of digital tools based on the use of artificial intelligence to improve the educational sector in Ukraine. **Methods:** The study included the following stages: compiling a list of expert organisations with assessments of the impact of AI technologies on education; evaluating AI solutions by experts and forming individual ratings; calculating relative ratings based on the frequency of mentions of AI solutions; identifying priority AI solutions by their leading positions; forming an optimal nomenclature of AI solutions; developing practical recommendations for the introduction of AI in education; analysing the future development of education using AI. **Results:** The study found that the use of AI to modernise the Ukrainian education system is best done using a comprehensive three-tier deployment system. The first level involves creating an infrastructure for AI, ensuring the interaction of systems. The second level involves optimising and enhancing learning. The third level is aimed at automating and improving educational and support processes. The proposed practical recommendations address the ethical, technical, and pedagogical aspects of AI implementation, allowing for the creation of a modern, efficient educational system that meets the requirements of the present and forms competent specialists of the future. **Discussion:** The research findings are crucial for modern education in Ukraine. The study identified opportunities and benefits of using AI in education, such as individualised learning, improved communication, and process automation. Recommendations for optimal artificial intelligence solutions will allow for a balanced approach to the implementation of these technologies, avoiding negative consequences and ensuring safety. These results provide a basis for the development of national standards for the use of AI in education and determine the vectors of further development of the industry, contributing to the creation of a modern, individualised and effective educational system that trains competent specialists of the future. Overall, the research findings define a strategic course for the integration of artificial intelligence into the educational space, which can significantly improve the quality and accessibility of education in Ukraine.

Keywords: Machine Learning, Natural Language Processing, AI-powered Virtual Assistants, AI-driven Education Ecosystem, E-learning, EdTech, Virtual & Augmented Reality, Cloud Technology, Intelligent Tutoring System, Smart Content

Introduction

Artificial Intelligence (AI) in the context of education represents a collection of computer technologies and programs designed to enhance learning and the learning environment. These technologies encompass systems for intelligent data analysis, virtual assistants, adaptive learning platforms, and other innovative tools. The use of AI in education is one of the most promising and relevant areas of research. Education is the basis of social development, and in the context of rapid technological progress, it is important to determine how artificial intelligence can affect the educational process and what benefits it can have for the future of Ukrainian education (Filgueiras, 2023; García-Peñalvo, 2023; Udvaros & Forman, 2023).

Individualised learning is one of the key advantages of using AI in education. Each student has their own personal characteristics, pace of perception, and assimilation of information. Artificial intelligence systems can analyse data on completed tasks, reactions to new material, and other parameters, which can help them customise the learning process for each individual student. This will help to achieve greater learning efficiency and increase the level of knowledge acquisition (Fuhrmann & Niemetz, 2023; Lamb et al., 2023; Malek et al., 2023).

However, along with the benefits of using AI in education, there are also ethical issues. It is important to consider the aspects of privacy and protection of students' personal data. The security and

transparency of algorithms used in AI-based educational systems need to be carefully studied and fully regulated (Masters, 2023; Nguyen et al., 2023; Uunona & Goosen, 2023).

In addition, it is important to keep in mind that the introduction of AI should not be limited to the automation of educational processes. Teachers have an integral role in the development and education of students, and their functions may be expanded by the use of new technologies. It is important to prepare the teaching staff to work with AI and develop methodological approaches that will help to effectively use these technologies in the educational process (Celik, 2023; Chiu et al., 2023; Park, 2023).

It should also be borne in mind that the introduction of AI in education should be based on research and evidence-based practice. It is important to design and implement AI systems based on mostly positive experiences, and to constantly evaluate their effectiveness and impact on the quality of learning (Dogan et al., 2023; Holmes et al., 2023; Nemorin et al., 2023).

Thus, the use of artificial intelligence in Ukrainian education of the future is a complex and multifaceted task that requires in-depth research, careful analysis of the impact, and careful consideration of ethical, pedagogical, and socio-cultural aspects.

Research Problem

The problem under study is to determine the optimal directions and opportunities for the use of AI in the future of Ukrainian education. Given the accelerated development of information technologies, there is a need to explore the possibilities of using AI to optimise educational processes, improve the quality of education and train competent specialists (Alqahtani et al., 2023; Chen et al., 2023; Karyy et al., 2023).

The central scientific problem is to develop strategies and methods for introducing AI into the educational space of Ukraine, taking into account the peculiarities of the national educational system and the requirements of modern society. The implementation of this task requires a deep analysis of AI capabilities, study of implementation experience in similar contexts, and development of conceptual frameworks that will achieve optimal results (Al-Worafi et al., 2023; Bilanych & Bokotey, 2013; Crompton & Burke, 2023; Teng et al., 2023).

However, along with the potential benefits of using AI in education, ethical issues arise. The problem of preserving the confidentiality and security of the personal data of participants in the educational process, as well as the exclusion of algorithmic bias in AI systems, requires careful consideration and development of appropriate regulatory mechanisms (Flores-Vivar & García-Peñalvo, 2023; Kassymova et al., 2023; Kooli, 2023).

However, it is important to note that the introduction of AI involves more than simple automation of educational processes. It involves developing new methodologies, adapting learning content to the needs of the modern labour market, and studying the impact of these changes on the role of the teacher and the student (Decuyper et al., 2023; Huang et al., 2023b; Järvelä et al., 2023).

Thus, the problem of applying artificial intelligence in Ukrainian education of the future requires in-depth research and a comprehensive approach to develop effective implementation models, taking into account ethical, technical, and pedagogical aspects.

Research Focus

The central focus of the study is to identify the best ways and opportunities to use AI in the future of Ukrainian education. Given the rapid development of technologies and their impact on modern

education, the study focuses on analysing and identifying specific methods, strategies and approaches to integrating AI into the educational process. An important aspect is the study of the possibilities of providing quality training for students based on the use of modern AI technologies.

The main focus of this study is to develop an optimal strategy for the implementation of AI technologies in the educational system of Ukraine. The key aspect of the study is the systematic analysis and identification of existing opportunities for the introduction of AI in the context of the educational process, as well as the development of specific recommendations that will help optimise teaching practices and improve the quality of education.

The study also focuses on an in-depth analysis of the peculiarities of the national educational system of Ukraine, namely the identification of key aspects that can be improved or optimised through the use of AI technologies. At the same time, great attention is paid to the adaptation of innovative methods to the specifics of the national educational paradigm.

Research Aim and Research Questions

The purpose of the study is to establish the optimal nomenclature of digital software tools based on the use of AI in order to modernise the educational sector of Ukraine.

Research question:

1. Establishing up-to-date facts about the benefits and risks of using AI in education, which will allow to identify key drivers and vectors of development of the system of digital adaptation of the education system.
2. Formation of a sample of the expert community, which will allow to establish the practical plane and subject area of AI in education.
3. Identification of the nomenclature of digital tools based on the use of AI, the potential of which allows to modernise the educational sector of Ukraine.
4. To determine the optimal composition of AI transformation tools for the education sector with the development of appropriate practical recommendations for the implementation of AI tools in the Ukrainian education system.
5. To formulate analytical conclusions about the promising points of development of education in Ukraine in the future, provided that the latest digital software and technologies are used, which will summarise the main results of the study and identify prospects for the future development of the education sector.

Research Methodology

General Background

The global AI in education market, which was valued at USD 1.82 billion in 2021, is projected to grow at a CAGR of 36.0% from 2022 to 2030. Factors contributing to this growth include increased investment in artificial intelligence and EdTech from both the private and public sectors, as well as the growing popularity of Edutainment. In 2020, according to a report by the Organisation for Economic Co-operation and Development (OECD), venture capitalists invested more than USD 75 billion in companies specialising in the development of AI startups (Grand View Research, 2021).

These indicators indicate that the level of AI's influence on the global education industry is

constantly increasing, which is ensured by the impact of certain transformation processes.

First, AI facilitates the personalisation of learning. By analysing data about the learner and their interaction with platforms, it is possible to create an individual learning path, taking into account the level of knowledge, learning pace, and personal characteristics. This allows each student to learn the material as efficiently as possible (Bhutoria, 2022; Huang et al., 2023a; Xu et al., 2023).

Another important aspect is the possibility of gamification of learning. The use of game elements, challenges, and rewards can increase the motivation of students to actively participate in the learning process. This contributes to deeper learning and active engagement with the content (Bezzina & Dingli, 2023; Lampropoulos, 2023a; Yang et al. 2023).

Additionally, AI allows collecting and analysing a huge amount of learning data. This gives teachers the opportunity to receive detailed reports on students' progress, identify gaps, and respond to them in a timely manner. This approach allows for an individualised approach to each student and provides more effective control over the learning process (Baidoo-Anu & Owusu Ansah, 2023; Liu & Wang, 2021; Martínez et al., 2023).

In turn, the use of virtual and augmented realities in AI-assisted learning allows for an immersive learning environment. Students can learn difficult and abstract concepts in an interactive format, which contributes to a deeper understanding of the material (Lampropoulos, 2023b; Ma, 2021; Saghiri et al., 2022).

Taking these aspects into account, we can conclude that AI opens up new opportunities for modern education to improve the learning and development of students, providing personalisation, motivation, and effective control over the learning process.

A summary of the key development drivers that contribute to the rapid implementation of AI in the global education sector is shown in Table 1.

Table 1

A Brief Description of the Drivers of AI Integration into the Global Educational Space

Development driver	Characteristics	Scientific description
Adaptability	AI systems can adapt the content and tasks according to the student's performance, ensuring a more efficient learning process.	Xie et al. (2022)
Analytics	AI allows collecting and analysing learning data, which helps teachers and administrators improve the learning process.	Ouyang et al. (2023)
Virtual and augmented reality	The use of AI can allow learners to explore virtual worlds in depth or use augmented reality for learning.	Rusillo-Magdaleno et al. (2023)
Gamification	The use of game elements and tasks helps to create interest and motivation for learning.	Modi and Gochhait (2023)
Global access	AI-powered online platforms allow you to get a quality education from anywhere, regardless of geographic location.	Rangel-de Lázaro and Duarte (2023)
Feedback	AI provides immediate feedback and hints to help students understand their mistakes and correct them.	Hooda et al. (2022)

Reducing routine tasks	AI can automate routine tasks, allowing teachers to use more time for individual work with students.	Rensfeldt and Rahm (2023)
Innovation	The introduction of AI promotes new approaches to learning and the creation of innovative teaching methods.	Tan (2023)
Personalised training	AI allows you to create individualised curricula, taking into account the needs, level of knowledge, and pace of learning of each student.	Xiao and Yi (2023)
Collaboration and communication	AI provides opportunities for teamwork and interaction among students, which helps to develop communication skills.	Esplugas (2023)

Source: author's own development.

Thus, the introduction of artificial intelligence into the educational process brings about positive changes, improves learning efficiency, and creates new opportunities for the development of students.

However, AI also has a number of limitations that have been identified through comparative analysis (Cheng et al., 2023; Cribben & Zeinali, 2023; Voskoglou & Salem, 2020) – Table 2.

Table 2

Risk-Based Analysis of AI Application in Education

Advantages.	Disadvantages.
Accessibility: AI-powered online platforms and applications make learning accessible to everyone, regardless of location or time.	Deep understanding learning: Some aspects of learning that require deep understanding and critical thinking may be difficult for AI to replicate.
Assessment efficiency: AI allows collecting and analysing learning data, which contributes to a more objective assessment and identification of students' difficulties.	Threat to data privacy: The use of AI may raise questions about the privacy and protection of personal data of students.
Engaging students: The use of game elements and interactive platforms engages learners in learning and makes it fun.	Dependence on technology: In the event of technical problems or lack of access to technology, learning can be hindered.
Resource optimisation: AI helps teachers to use time and resources efficiently by focusing on the individual needs of students.	Cost and support: Implementing and maintaining AI systems can be costly and time-consuming.
Personalised learning: AI allows you to create individual learning paths for each student, taking into account their needs, abilities, and pace of learning.	Lack of a humane element: AI cannot completely replace the interaction between a teacher and a student, especially in difficult issues and moral aspects.
Improving the learning experience: Interactivity and adaptation of content to learners' learning styles contribute to better learning.	Technical limitations: Effective use of AI requires the availability of appropriate infrastructure and technical resources.

Source: authors' own development.

The uncontrolled use of artificial intelligence (AI) in education has raised a number of accompanying moral and ethical dilemmas that require careful analysis and management to ensure ethical practice in the educational process. The main ones are outlined in Table 3.

Table 3

Moral and Ethical Aspects of AI Implementation in Education

Aspects	Characteristics	Scientific description
Competence matching and training	The use of AI by students to perform individual tasks may violate the principle of competence acquisition. Individual AI tasks can lead to insufficient work on educational material, deprive students of the opportunity for active training and self-development, which affects the quality of their education.	Shidiq (2023)
Dependence on technology	Over-reliance on AI can lead to a loss of independent thinking and problem-solving skills. Students may lose the ability to critically analyse and think creatively, which are important competencies in the modern world.	Fitria (2021)
Shifting the emphasis in education	The use of AI can lead to a focus on the outcome of tasks, rather than an emphasis on understanding and meaningful learning. This can lead to superficial knowledge acquisition without deep understanding and analysis.	Malinka et al. (2023)
Moral aspects of automating the interaction of participants in the educational process	The introduction of AI may raise questions about the morality of using technology, especially in the context of automatic assessment and interaction. For example, the ethical aspects of automatic plagiarism detection may raise questions about the fairness and transparency of such decisions.	Wach et al. (2023)
Insufficient transparency of algorithms	The lack of transparency in the functioning of AI algorithms can create a risk of losing trust in this technology among participants in the educational process. If users do not understand how decisions are made by algorithms, this can lead to doubts about the reliability of the results and even refusal to use them.	Grimmelikhuijsen (2023)
Unreliability of information bases	A breach in the AI training system can lead to the appearance of unreliable data in the relevant information databases. This may be due to inadequate data filtering, errors in the input data, or lack of transparency in the algorithms. Such a case can lead to unforeseen consequences, such as incorrect estimates and even an increased risk of inaccurate information.	Sison et al. (2023)

Source: authors' own development.

All the identified aspects (advantages and disadvantages) are taken into account when developing practical recommendations for the implementation of AI in the Ukrainian educational space.

Sample / Participants / Group

In order to develop practical recommendations for the modernisation of Ukrainian education, the following specialised organisations were selected as an expert community - **Table 4**.

Table 4

List of expert organisations in the field of AI application for education

Organisation.	Description.	Link
Appinventiv	Appinventiv is an expert organisation specialising in software and technology solutions. One of their resources is a blog that analyses how artificial intelligence is transforming the education industry. Their articles help to understand how technology is affecting education and provide perspectives on transformation.	Appinventiv (2023)
eLearning Industry	eLearning Industry is a leading online resource dedicated to e-learning and technology in education. They focus on analysing innovations in learning, including the use of artificial intelligence. Their articles and materials reveal the impact of technology on the transformation of the education sector.	Mistry (2023)
Global Market Insights Inc.	Global Market Insights Inc. is a leading analytical company that specialises in market research and forecasting for various industries. One of their areas of expertise is researching the AI in education market. They provide analyses and data to help understand the trends and prospects for AI in education.	Global Market Insights (2023)
Grand View Research, Inc.	Grand View Research, Inc. is a leading expert organisation specialising in market research. One of its key areas of expertise is researching the artificial intelligence market in education. They provide a comprehensive analysis of market dynamics, collect statistics, identify trends, and forecast development. The results of their research are valuable for business, academia, and investors interested in the use of artificial intelligence in education.	Grand View Research (2021)
HolonIQ	HolonIQ is an influential analytical company specialising in researching the global education and technology market. One of their most recent publications is Artificial Intelligence in Education 2023: Survey Insights, which covers trends and forecasts for the use of artificial intelligence in education.	Education Intelligence Unit (2023)
Market Research Future	Market Research Future is a leading market research company specialising in providing forecasts and analysing market trends. They study a variety of industries, including the artificial intelligence market in education. One of their most recent publications is the Artificial Intelligence Education Market research report.	Munde (2023)
Soocial	Soocial is a resource specialised in analysing and providing statistics on the use of artificial intelligence in education. their data and analyses provide important insights into trends and forecasts of AI in education.	Soocial (n.d.)
U.S. Department of Education, Office of Educational Technology	The U.S. Department of Education, Office of Educational Technology is the official structural unit of the U.S. Department of Education that deals with educational technologies. The organisation researches and develops strategies for the use of technology, including artificial intelligence, in education. Their report “Artificial Intelligence in Education” analyses the role of artificial intelligence in education.	Office of Educational Technology (2023)
V7	V7 is an expert organisation specialising in the research and development of artificial intelligence technologies. Their blog	Sajid (2023)

Organisation.	Description.	Link
	analyses the role of artificial intelligence in education. They provide articles and materials that reveal the prospects of using AI in the field of education.	
West Agile Labs Blog	The West Agile Labs Blog is a platform owned by West Agile Labs, a software development and technology consultancy. Their blog analyses the use of artificial intelligence in the education sector. They provide articles that reveal eight ways artificial intelligence can be used in education.	West Agile Labs (n.d.)

Source: author's own development

The analytical data of the above expert organisations (Table 4) describe the technologies used to modernise the global education system.

Instrument and Procedures

The study was carried out in several iterations:

1. A list of relevant expert organisations has been compiled (**Table 4**), which contains up-to-date data and professional assessments of the impact of certain AI technologies on the education sector.
2. Each of the expert organisations involved in the study has formed a cross-sectional field of individual ratings of each of the educational AI solutions.
3. According to the analysis of individual rating scores, a relative ranking by the frequency of references to educational AI solutions in the expert community was formed - (1):

$$RRMF_i = \frac{\sum_{i=1}^n IR_i}{FM_i}, \quad (1)$$

where $RRMF_i$ is the relative ranking by the frequency of mention of educational AI solutions in the expert community; $\sum_{i=1}^n IR_i$ is the sum of the individual ratings of each expert organisation for educational AI solutions; FM_i is the frequency of mention of educational AI solutions in the expert community.

4. According to the number of times each of the considered educational AI solutions took the leading position according to the individual assessment of each of the expert organisations involved in the study, a relative priority rating is formed - (2):

$$RRP_i = RRMF_i \times \left(1NTO1LP + \frac{1}{2}NTO2LP + \frac{1}{3}NTO3LP + \frac{1}{4}NTO4LP + \frac{1}{5}NTO5LP \right), \quad (1)$$

where RRP_i is the priority ranking of each of the considered educational AI solutions; $NTO1LP...NTO5LP$ is the number of times each educational AI solution was ranked first and fifth in

the individual ranking according to the rating organisations, respectively.

5. Based on the results of the priority ranking (2), the optimal nomenclature of educational AI solutions has been formed, which is advisable to implement in the educational sector of Ukraine.

6. In accordance with the established digital software solutions, practical recommendations for the AI modernisation of the Ukrainian educational system have been developed.

7. Analytical conclusions on the future development of the Ukrainian education sector in the context of global digitalisation and the implementation of educational AI solutions are formed.

The proposed research scheme allowed us to identify the most appropriate vectors of development of Ukrainian education, taking into account global educational trends and technologies, which will allow Ukrainian educators to train students in accordance with the best international standards.

Data Analysis

Based on the results of the individual assessment of educational solutions by each of the expert organisations involved in the study, an array of digital software solutions and tools was formed, which is further analysed in accordance with the proposed methodology (Table 5).

Table 5

General Nomenclature of Educational AI Solutions

An AI solution for education	Brief description
AI-driven Education Ecosystem	AI-driven Education Ecosystem is an integrated education system that uses AI technologies to optimise and improve all aspects of the learning process. This ecosystem includes intelligent analytical tools, personalised curricula, adaptive platforms, and other innovative solutions that facilitate effective learning, assessment, and interaction between all participants in the learning process.
AI-powered Chatbot	An AI-powered chatbot is an application or system that uses AI technology to interact with users in an automated manner via text or voice messages. These chatbots are capable of understanding and analysing questions, providing answers, performing tasks, and providing information using trained AI algorithms and models.
AI-powered Virtual Assistants	AI-powered Virtual Assistants are applications or systems that use AI technology to provide support and perform tasks for users through text or voice interfaces. These virtual assistants can perform a variety of tasks, including answering questions, managing tasks, making recommendations, and interacting with users using intelligent algorithms.
Automated Assessment & Grading Tasks	Automated Assessment & Grading Tasks is the process of using automated technologies, including AI, to evaluate and grade various tasks and works in the learning process. These technologies allow you to automatically analyse and evaluate student work, providing a quick and objective reconciliation of results.
Cloud Technology	Cloud Technology is a system architectural solution that enables the use of cloud resources and infrastructure to provide the computing power and data storage required for the implementation and development of AI in educational programmes and platforms.
Computer Vision	Computer Vision is a branch of AI that focuses on the development of algorithms and models for computers capable of detecting and recognising visual objects depicted in images or videos.

An AI solution for education	Brief description
Digital Skills	Digital Skills are the skills that enable learners to use AI technologies for effective learning and interaction. This may include the ability to analyse data, use AI tools for personalised learning, understand and interact with intelligent systems, and use digital resources to acquire new knowledge and skills.
EdTech	EdTech is an educational system that includes the use of technologies, including AI, to improve the learning process, provide access to knowledge, and develop skills.
Edutainment	Edutainment is an educational system that uses AI technologies to create learning programmes and platforms that combine the learning process with entertainment elements.
E-learning	E-learning is a form of learning where AI technologies are used to create personalised and adaptive curricula, analyse the knowledge gained, and ensure effective interaction between students and learning resources.
Fraud & Risk Management	Fraud & Risk Management is the process of identifying, analysing, and mitigating possible fraud and risks in learning environments. The use of AI technologies helps to detect inappropriate actions, fraud, or other negative situations that can affect the learning and safety of students, teachers, and other participants in the educational process.
Intelligent Adaptive Learning	Intelligent Adaptive Learning is an approach to learning that uses AI technology to create personalised and tailored learning programmes that adapt to the needs and abilities of each learner, ensuring more effective and efficient learning.
Intelligent Tutoring System (ITS)	ITS is a digital educational system that uses AI to provide individualised and personalised support to students during their studies.
Learning Platform & Virtual Facilitators	Learning Platforms & Virtual Facilitators are systems and technologies (including AI) that provide learning platforms and virtual facilitators to support learning and facilitate interaction between participants in the educational process. These solutions allow educational institutions to create effective learning environments, including interactive online courses, collaborative learning, and interaction through virtual interfaces.
Machine Learning (ML)	ML is a branch of AI that studies the development of algorithms and models that allow computers to learn from data and improve their performance over time without explicit programming.
Natural Language Processing (NLP)	NLP is a branch of AI that develops algorithms and models for understanding and interacting with natural language, such as human speech. It allows computers to analyse, interpret and generate human speech, enabling them to interact with systems and applications through language.
Personalised Education	Personalised Education is an approach to learning in which the learning process and materials are adapted to the individual needs and capabilities of each student. The use of AI technologies helps to create personalised curricula, recommendations, and assignments, ensuring a more efficient and engaging learning process.
Smart Content	Smart Content is a body of data, such as learning materials, resources, or platforms, that uses AI and analytics technologies to improve access to knowledge and learning. It can be personalised, interactive, and tailored to the needs of learners, facilitating effective teaching and learning.
Virtual & Augmented Reality (VR/AR)	VR/AR are technologies that create immersive virtual or augmented environments for users. They allow you to interact with objects and information in the virtual world (VR) or augment the real world with digital elements (AR), providing new opportunities for learning and interaction.

An AI solution for education	Brief description
Vision & Voice Applications	Vision & Voice Applications is a system of technological solutions that combines computer vision and voice interaction to improve the learning process. This may include recognising objects in images in educational materials, interacting with platforms using voice commands, creating interactive voice questions and answers to assess student knowledge, etc.

Source: authors' own development.

The identified information array (Table 5) covers the entire range of AI applications in education and allows for a subject-specific analysis to determine the optimal range of digital software tools for the modernisation of Ukrainian education.

Research Results

In accordance with the proposed methodology, we will set up a cross-reference field for the individual rating of each of the educational AI solutions according to the assessments of the involved expert organisations (Table 6).

Table 6

Cross-Referencing Individual Rankings of Educational AI Solutions

Digital technologies of AI education	Grand View Research, Inc.	HolonIQ	Market Research Future	Social	Global Market Insights Inc.	Appinventiv	West Agile Labs Blog	eLearning Industry	V7	Office of Educational Technology
EdTech	1	7		4		2				
Edutainment	2							10		
Intelligent Tutoring System (ITS)	3				6		6	5	3	
Cloud Technology	4		4			5	2			
Machine Learning (ML)	5	1	1		10	10	1			1
Natural Language Processing (NLP)	6	3	2	1	4	4			10	3
Smart Content	7			5	7	6	5	4		
Virtual & Augmented Reality (VR/AR)	8		3		3	3	7			
Computer Vision	9								5	2
Intelligent Adaptive Learning		2						9		
Vision & Voice Applications		4					3		6	
Digital Skills		5								
AI-driven Education Ecosystem	11	6	5	3	2	8		7	9	5
AI-powered Chatbot		10		2		9				
AI-powered Virtual Assistants					1	7	4	3	1	

Digital technologies of AI education	Grand View Research, Inc.	HolonIQ	Market Research Future	Soocial	Global Market Insights Inc.	Appinventiv	West Agile Labs Blog	eLearning Industry	V7	Office of Educational Technology
Fraud & Risk Management	10	8			8					
Learning Platform & Virtual Facilitators	12	9			5			8	7	
E-learning					9	1		1	8	
Automated Assessment & Grading Tasks								2	4	4
Personalised Education								6	2	

Source: author's own development.

According to the data presented in Table 6, we observe a randomised distribution of rating scores for each digital educational solution using AI technology, which indicates the independence and absence of bias among the selected and involved in the current study members of the expert community. The wide range of educational AI solutions indicates that the research sample is interested in a wide range of modern possibilities of using the technology under study to modernise the field of education and science.

Using the system of cross-evaluation by frequency of mention and individual ranking of educational solutions using artificial intelligence, which is denoted in the corresponding mathematical apparatus (f , f), we will form the corresponding analytical plane (Table 7).

Table 7

The Analytical Plane of Educational Solutions Using Artificial Intelligence

Digital technologies of AI education	Frequency of mention	Relative Ranking by Mention Frequency	Number of Times of Occupying the First Leading Position	Number of Times Occupying the Second Leading Position	Number of Times Occupying the Third Leading Position	Number of Times Occupying the Fourth Leading Position	Number of Times Occupying the Fifth Leading Position	Relative Ranking by Priority
EdTech	4	0.0476	1	1	0	1	0	0.083
Edutainment	2	0.0238	0	1	0	0	0	0.012
Intelligent Tutoring System (ITS)	5	0.0595	0	0	2	0	1	0.051

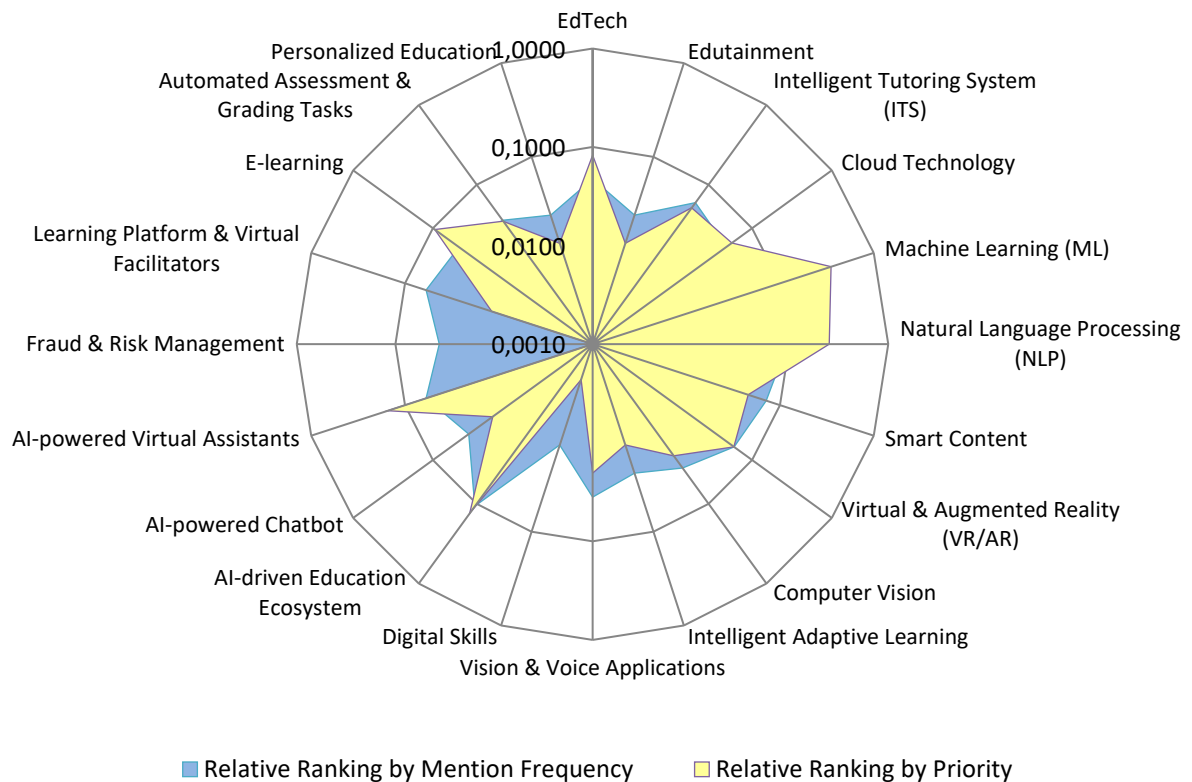
Cloud Technology	4	0.0476	0	1	0	2	1	0.056
Machine Learning (ML)	7	0.0833	4	0	0	0	1	0.350
Natural Language Processing (NLP)	8	0.0952	1	1	2	2	0	0.251
Smart Content	6	0.0714	0	0	0	1	2	0.046
Virtual & Augmented Reality (VR/AR)	5	0.0595	0	0	3	0	0	0.059
Computer Vision	3	0.0357	0	1	0	0	1	0.025
Intelligent Adaptive Learning	2	0.0238	0	1	0	0	0	0.012
Vision & Voice Applications	3	0.0357	0	0	1	1	0	0.020
Digital Skills	1	0.0119	0	0	0	0	1	0.002
AI-driven Education Ecosystem	9	0.1071	0	1	1	0	2	0.132
AI-powered Chatbot	3	0.0357	0	1	0	0	0	0.018
AI-powered Virtual Assistants	5	0.0595	2	0	1	1	0	0.153
Fraud & Risk Management	3	0.0357	0	0	0	0	0	0.000
Learning Platform & Virtual Facilitators	5	0.0595	0	0	0	0	1	0.012
E-learning	4	0.0476	2	0	0	0	0	0.095
Automated Assessment & Grading Tasks	3	0.0357	0	1	0	2	0	0.035
Personalised Education	2	0.0238	0	1	0	0	0	0.012

Source: authors' own development.

The results of the relative cross-ranking by the frequency of mention and the number of times the leading positions of individual expert ratings (top 5) were occupied (Table 7) allow us to form an indirect and independent rating of educational solutions and tools based on the use of artificial intelligence, according to which it is possible to determine the optimal nomenclature of digital software solutions for the modernisation of education in Ukraine (Figure 1).

Figure 1

Determining the Optimal Nomenclature of AI-Based Digital Software Tools for the Modernisation of the Ukrainian Education Sector



Source: authors' own development.

The analysis of the ranking data (Figure 1) shows that in the context of AI education, the importance of certain digital technologies varies depending on the frequency of mention and the priority of their use. In particular, technologies such as Machine Learning (ML) and Natural Language Processing (NLP) have a high level of mention and a higher priority, which may indicate their importance for the development of educational solutions.

In addition, AI-driven Education Ecosystem is also noted as a technology with a high level of mention and a medium level of priority, which may indicate its potential as an integrated system for optimising learning. It is worth noting that some concepts, such as Fraud & Risk Management, have a low priority, which may reflect their lower impact on the learning process.

In general, the conclusion is that Machine Learning, Natural Language Processing, and AI-driven Education Ecosystem appear to be key technologies with high potential in the application of artificial intelligence in education.

In contrast, some concepts, such as Edutainment, Intelligent Adaptive Learning, and Personalised Education, show that they are less frequently mentioned, but may still have significant potential to transform the educational process. Such innovations can help to increase engagement and learning effectiveness for each individual student.

According to the data, Cloud Technology, and Learning Platform & Virtual Facilitators also have a relatively high level of mention and priority. This reflects the growing popularity of online learning and the use of virtual platforms for collaborative learning.

Based on the analysis, it can be concluded that the development and implementation of educational solutions based on artificial intelligence technologies has great potential to improve the

educational process, taking into account the specifics of each technology and its impact on education.

In addition, it is important to note that some concepts, such as Virtual & Augmented Reality (VR/AR) and Computer Vision, show relatively average levels of recall and priority. These technologies can provide immersive and more adaptive learning environments, which can help improve learning.

In the context of education, AI-powered Chatbots and AI-powered Virtual Assistants have also proved to be important as they can support students and teachers in real-time by answering questions and helping with tasks.

Overall, the data analysis indicates a multifaceted approach to the use of AI technologies in education, with a focus on the importance of each specific technology in improving learning and student engagement.

According to the ranking (Figure 1), the best educational AI solutions for modernising Ukraine's education sector are:

- Machine Learning (ML):
 - Machine Learning (ML); $RRMF = 0,0833$ $RRP = 0,350$: the ability to analyse and summarise large amounts of data can improve individualised learning, as well as provide a deeper understanding of learners' cognitive needs;
 - Natural Language Processing (NLP): ; $RRMF = 0,0952$ $RRP = 0,251$: the use of NLP technologies facilitates the understanding and analysis of textual information, which allows for improved communication and interaction between participants in the learning process;
 - AI-powered Virtual Assistants: ; $RRMF = 0,0595$ $RRP = 0,153$: this solution provides individual support and advice to students and teachers in real-time;
 - AI-driven Education Ecosystem: ; $RRMF = 0,1071$ $RRP = 0,132$: integration of various aspects of education into a single system contributes to a more organised and efficient learning process;
 - E-learning: ; $RRMF = 0,0476$ $RRP = 0,132$: the use of electronic learning platforms provides access to knowledge for a wider range of students and ensures flexibility of learning.

Other AI tools that were singled out from the overall ranking are also useful in the process of modernising the Ukrainian education sector:

- EdTech: ; $RRMF = 0,0476$ $RRP = 0,083$: promotes changes in learning formats by providing access to digital tools and resources for effective learning;
- Virtual & Augmented Reality (VR/AR): ; $RRMF = 0,0595$ $RRP = 0,059$: the use of virtual and augmented reality creates immersive learning environments where students can immerse themselves in and interact with realistic situations;
- Cloud Technology: ; $RRMF = 0,0476$ $RRP = 0,056$: the use of cloud technology facilitates access to learning resources from any device and location, improving learning and collaboration;
- Intelligent Tutoring System (ITS): ; $RRMF = 0,0595$ $RRP = 0,051$: intelligent tutoring systems provide individualised learning and support for each student, helping to grow their abilities and competencies;

- Smart Content: ; $RRMF = 0,0714$ $RRP = 0,046$: the use of interactive and adaptive learning materials creates conditions for a more effective learning process.

It is worth noting that digital software solutions that increase the automation of the educational process are also useful for the modernisation of the Ukrainian education sector based on AI solutions:

- Automated Assessment & Grading Tasks: ; $RRMF = 0,0357$ $RRP = 0,035$: automate the process of grading student assignments and papers, ensuring accuracy and speed of assessment;
- Computer Vision: ; $RRMF = 0,0357$ $RRP = 0,025$: allows you to analyse visual data such as images and videos, which can contribute to the creation of interactive and enriched learning materials;
- Vision & Voice Applications: ; $RRMF = 0,0357$ $RRP = 0,020$: open up opportunities for using voice and visual interfaces in educational processes, which contributes to the convenience and accessibility of learning for different groups of students.

These digital software solutions can greatly enhance the learning process by providing greater objectivity, efficiency and interactivity. However, it is important to remember that successful implementation of these tools requires proper training, consideration of the specifics of the learning context, and support for the appropriate infrastructure.

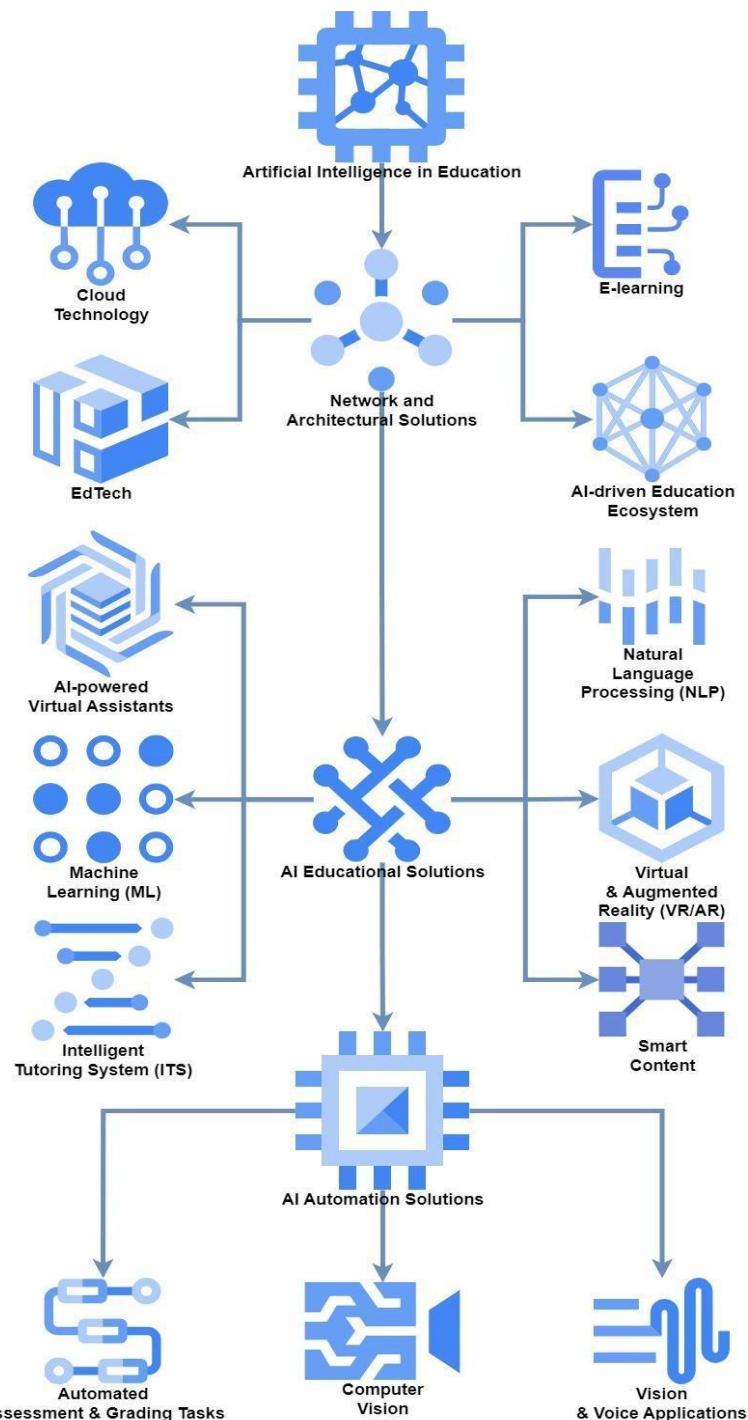
Based on the optimal nomenclature of AI tools, we will formulate practical recommendations for the modernisation of Ukraine's educational system:

- develop national standards on systemic and ethical norms for the use of AI in the educational space;
- to develop system-architectural educational structures that ensure the effective functioning of educational processes and their improvement using AI optimisation: E-learning, EdTech, AI-driven Education Ecosystem, Cloud Technology;
- to implement tools to improve the efficiency of the educational space: AI-powered Virtual Assistants, Virtual & Augmented Reality (VR/AR), Intelligent Tutoring System (ITS), Smart Content;
- to automate the educational process support system by reducing routine tasks and in-depth interaction with AI: Automated Assessment & Grading Tasks, Computer Vision, Vision & Voice Applications; Machine Learning (ML); Natural Language Processing (NLP).

2. The general concept of modernising the Ukrainian educational system with AI is shown in **Figure 2.**

Figure 2

The Concept of AI Modernisation of Ukrainian Education



Source: authors' own development.

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The proposed system of modernisation of Ukrainian education by means of artificial intelligence (Figure 2) contains three logical levels of deployment:

1. System and architectural level: development and implementation of infrastructure for AI functioning.
2. The level of optimisation and improvement of the quality of educational processes: the use of adapted and individualised digital educational environments.
3. The level of automation of educational processes: implementation of solutions to

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reduce and optimise routine tasks to support educational processes using AI technologies.

The developed practical recommendations provide a holistic approach to the modernisation of Ukraine's education system, focusing on ensuring national standards, personalised learning, and the effective use of AI to automate learning processes and interact with students. This approach helps to ensure quality and individualised education in line with the modern requirements and challenges of the education sector.

Discussion

The following theses established in the current study are put forward for discussion:

- AI technologies have significant potential to modernise Ukraine's educational system;
- A wide range of AI technologies that can be used in the educational space has been installed;
- The author identifies moral and ethical threats arising from the uncontrolled use of AI in the educational sector;
- Based on the analysis of individual expert ratings, an optimal nomenclature of educational AI solutions was formed, based on which practical recommendations for the modernisation of the Ukrainian educational space were developed;
- The optimal strategy for implementing AI mechanisms in the educational space is a three- tiered deployment system that involves the formation of infrastructure and architecture, filling the educational space with effective learning tools, and integrating system solutions for automating the support of educational processes.

The results of the study confirm the adaptability of educational AI solutions identified in the publication (Xie et al., 2022): intelligent AI systems can customise content and tasks according to learning progress, contributing to a more efficient learning process.

Architectural and system solutions have also been established that confirm the possibility of forming specialised analytical arrays on the parameters of educational processes, as reported in Ouyang et al. (2023): the use of AI allows collecting and analysing educational data, which contributes to the improvement of the educational process by the teachers and administrators involved.

The results of the current study have established the importance of developing immersive learning environments implemented by means of Virtual & Augmented Reality (VR/AR). Similar conclusions were reached by researchers in the publication (Rusillo-Magdaleno et al., 2023): the use of AI enables students to explore virtual environments in more depth or use augmented reality technology for learning.

The elements of immersiveness of the educational space are also confirmed by the solutions for gamification of the educational space, as described in the study (Modi & Gochhait, 2023): the introduction of game components and tasks helps to generate interest and stimulates the desire to learn.

The importance of system-architectural solutions is confirmed in the publication (Rangel-de Lázaro & Duarte, 2023), in which researchers focus on the development of cloud infrastructure for the deployment of AI educational services: AI-based online educational platforms allow to obtain high-quality education from any location, regardless of geography.

Among the solutions that improve the efficiency and quality of educational processes, which are

established as practical recommendations for the modernisation of the Ukrainian education sector, are support, assistance, and quick feedback. The need to develop the support aspect is emphasised in the study (Hooda et al., 2022): AI provides instant feedback and advice to help students realise their mistakes and correct them.

Among the factors identified in this study that demonstrate the need to integrate AI technologies into the educational space is the need to automate learning processes and reduce routine tasks of the same type. This aspect is confirmed by the results described in Rensfeldt and Rahm (2023): thanks to the use of AI, it is possible to automate everyday tasks, which allows teachers to allocate more time for individual work with students.

This study also emphasises the possibility of increasing the efficiency of educational processes with AI solutions aimed at personalising learning materials. This has also been reported in (Xiao & Yi, 2023): with the help of AI, it is possible to develop personalised curricula, taking into account the individual needs, level of knowledge, and pace of learning of each student.

At the same time, studies (Esplugas, 2023; Tan, 2023) point to the significant innovative potential of the subject area in terms of developing integrated educational systems that will help to improve the efficiency of educational processes and the involvement of a wide range of stakeholders.

Based on the results of the development of practical recommendations for the modernisation of the Ukrainian educational sector, it was established that it is necessary to take into account the moral and ethical aspects of the use of AI, which should be reflected in the relevant national standard. The following aspects should be taken into account:

- the uncontrolled use of AI by students to solve individual tasks, which was also noted in the publication (Shidiq, 2023);
- modernisation of the assessment system to prevent a shift in emphasis from the learning process to its effectiveness, i.e., the lack of detailed and meaningful perception of learning materials among students, which was also highlighted by researchers in the publication (Malinka et al., 2023);
- uncontrolled use of educational process automation solutions threatens to reduce the quality of education due to the lack of appeal to students' creative abilities, which is confirmed by the results of the study (Wach et al., 2023);
- There are also a number of technical problems: the risk of becoming dependent on technology (this aspect is confirmed in Fitria (2021); lack of understanding of the principles of AI functioning, which can cause various consequences (Grimmelikhuijsen, 2023); uncontrolled and unsystematic AI training, which leads to the use of false data in advance (as noted in Sison et al., 2023).

At the same time, the main difference between the current study and the aforementioned ones is the formation of a systematic, rational, and balanced approach to the implementation of AI technologies in the educational space.

Further research will focus on detailing the proposed conceptual scheme for modernising the Ukrainian education sector, in particular, developing optimal mechanisms for integrating each of the educational AI solutions.

It is also important to investigate the effectiveness and efficiency of various AI tools in teaching, comparing them to traditional methods. Further research could reveal which aspects of the student learning experience can be improved by AI, as well as identify the limitations and challenges that

educational institutions may face when implementing these technologies.

In addition, it is important to study the impact of AI on the development of skills and competences that students acquire in the course of their education. This may include analysing changes in critical thinking, creativity, collaboration, and other key aspects of education.

Research can also be conducted on the effectiveness of integrating AI into different levels of education, from primary school to higher education. This will help identify the best approaches and strategies for implementing these technologies at different stages of education.

To summarise, further research in the field of artificial intelligence in education should be aimed at unlocking the potential of these technologies to improve educational processes, as well as addressing ethical, methodological, and practical issues that arise during their implementation.

Conclusions and Implications

The study has revealed a number of important theses on the use of artificial intelligence in the modernisation of the Ukrainian education system. First, artificial intelligence is receiving considerable attention as a potential means of improving the educational space. A wide range of artificial intelligence technologies that can be used in education is noted. However, it is important to consider the ethical aspects of integrating these technologies to avoid negative consequences.

The results of the analysis of expert ratings show that the selected optimal range of artificial intelligence solutions has great potential for modernising the education sector. The use of Machine Learning can contribute to the individualisation of learning and a deeper understanding of students' needs. The use of Natural Language Processing will improve communication between participants of the educational process. AI-powered Virtual Assistants will help to provide individual support for students and teachers. AI-driven Education Ecosystem will facilitate more organised learning. The use of E-learning will provide access to knowledge for everyone.

It is also important to consider other artificially intelligent tools that also have great potential for modernising the educational space. EdTech is changing learning formats, VR/AR is creating interactive environments, Cloud Technology is facilitating the availability of resources, and ITS and Smart Content are contributing to individualisation and learning efficiency.

In general, the developed nomenclature of artificial intelligence solutions and recommendations for their implementation are aimed at creating a modern, efficient, and individualised educational system in Ukraine. Taking into account the technological capabilities of artificial intelligence and their integration into the educational process will help improve the quality of education and train modern specialists.

In order to modernise the Ukrainian educational system based on artificial intelligence, it is necessary to develop national standards of use, develop systemic educational structures to optimise processes, implement solutions to improve efficiency and automate learning support. Such steps will help create a modern and efficient educational system that takes into account the capabilities of artificial intelligence.

This study confirms that the optimal strategy for implementing artificial intelligence mechanisms in the educational space is a three-level deployment system. This strategy provides for a holistic approach to the introduction of artificial intelligence into the educational process and ensures a high level of efficiency and harmony of functioning.

The first level, system-architectural, includes the development and implementation of infrastructure for the use of artificial intelligence in the educational space. This includes the creation of technical tools and infrastructure that will ensure interaction between different artificial intelligence systems.

The second level, the level of optimising and improving the quality of educational processes, involves the introduction of effective learning tools using artificial intelligence. This includes individualised and adaptive learning environments, the use of virtual and augmented reality, intelligent learning support systems, and other solutions that improve the quality of learning and knowledge acquisition.

The third level, the level of automation of educational processes, includes the implementation of system solutions to automate the support of educational processes using artificial intelligence. This helps to reduce routine tasks, increase the accuracy and speed of assessment, and provide feedback to students and teachers.

This three-level implementation strategy allows for a comprehensive approach to the use of artificial intelligence in the educational space. It contributes not only to improving the efficiency of the educational process, but also to creating a modern and individualised educational system that meets the requirements of modern society and trains competent specialists of the future.

The integration of AI in education may lead to a transformation in the types of jobs and skills in demand. Graduates with proficiency in AI-related fields could be sought after, while traditional roles may evolve or diminish. This shift underscores the importance of aligning educational curricula with emerging AI trends to ensure graduates remain relevant.

Moreover, a workforce equipped with AI-enhanced skills may bolster Ukraine's competitiveness internationally. It can attract more investment from tech companies looking for a skilled talent pool, potentially boosting economic growth. However, it also highlights the necessity for continuous learning and adaptability in the face of evolving technologies.

In summary, the study's implications encompass the potential for AI integration to reshape the Ukrainian job market, influence the skills graduates need, and enhance the nation's competitiveness on the global stage, emphasizing the need for strategic planning and adaptability in response to these changes.

Suggestions for Future Research

This study confirmed that the optimal strategy for implementing artificial intelligence mechanisms in the educational space is the three-level deployment system. This strategy provides for a holistic approach to the introduction of artificial intelligence into the educational process and ensures a high level of efficiency and harmony of functioning.

Future research should investigate the long-term impact of implementing artificial intelligence (AI) in education. It should illustrate how these changes may affect the job market, the skill sets demanded of future graduates, and the overall competitiveness of the workforce, both within Ukraine and on a global scale.

Another crucial area of research pertains to the economic implications of AI in education. Analysing the AI improvements driven in education and its potential of boosting the economic growth, attracting tech investments, and stimulating innovation in other sectors will be valuable. Additionally, researchers can explore AI integration and its contribution to the skills gap closing and enhancing

workforce productivity.

The societal adaptation to AI in education is a significant area of interest. Future studies should focus on the acceptance, resistance, and ethical considerations associated with AI-driven educational changes. Investigating the role of policy frameworks and regulations in addressing societal concerns and ensuring equitable access to AI-enhanced education is essential.

Research efforts should also assess the preparedness of teachers and students for AI integration. This includes investigating the training and support mechanisms required for educators to effectively use AI tools in classrooms and analysing the AI capacity to empower students becoming active learners.

Moreover, there should be a focus on assessing the effectiveness of AI in educational assessment and evaluation. Investigating AI-powered assessment methods, their reliability, and their impact on learning outcomes will be of great value. Researchers can also explore innovative ways in order to provide timely and constructive feedback to students using AI.

The integration of AI into educational curricula across various subjects and levels is another area that warrants investigation. Research can delve into best practices for developing AI-focused learning modules and ensuring that students acquire essential AI-related skills and knowledge.

Ethical considerations are crucial, and future research should explore the ethical dimensions of AI adoption in education. This includes analysing the responsible use of AI, data privacy, and potential biases in AI-driven learning systems. Researchers can also explore frameworks for ensuring that AI technologies prioritise fairness and equity.

To gain comprehensive insights, international comparative studies should be conducted, comparing Ukraine's approach to AI in education with other countries. By identifying global best practices and success stories, researchers can assess the transferability of strategies to the Ukrainian context.

Lastly, research should explore the role of AI in enabling lifelong learning and ups-killing. Investigating the AI support ongoing education throughout individuals' careers is essential for the future of learning.

The culmination of this research should result in the development of actionable policy recommendations that facilitate the responsible integration of AI in Ukrainian education, aligning with national goals and international standards.

In summary, future research on AI in education should encompass economic, societal, pedagogical, ethical, and technical dimensions. By adopting a holistic approach and involving various stakeholders, researchers can contribute to the informed and responsible integration of AI into the educational landscape in Ukraine and beyond.

References

- Alqahtani, T., Badreldin, H. A., Alrashed, M., Alshaya, A. I., Alghamdi, S. S., bin Saleh, K., ... Albekairy, A. M. (2023). The emergent role of artificial intelligence, natural learning processing, and large language models in higher education and research. *Research in Social and Administrative Pharmacy*, 19(8), 1236–1242. <https://doi.org/10.1016/j.sapharm.2023.05.016>
- Al-Worafi, Y. M. Hermansyah, A. Goh, K. W., Ming, L. C. (2023). *Artificial intelligence use in university:*

should we ban ChatGPT?. Preprints. <https://doi.org/10.20944/preprints202302.0400.v1>

- Office of Educational Technology. (2023). *Artificial intelligence and the future of teaching and learning: Insights and recommendations*. U.S. Department of Education. <https://www2.ed.gov/documents/ai-report/ai-report.pdf>
- Appinventiv. (2023, November 22). *10 Ways AI in education is transforming the industry*. <https://appinventiv.com/blog/10-ways-artificial-intelligence-transforming-the-education-industry/>
- Baidoo-Anu, D., & Owusu Ansah, L. (2023). *Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning*. SSRN. <http://dx.doi.org/10.2139/ssrn.4337484>
- Bezzina, S., & Dingli, A. (2023, July). Rethinking gamification through artificial intelligence. In X. Fang (Ed.), *HCI in Games. HCII 2023. Lecture notes in computer science* (Vol. 14046, pp. 252–263). Cham: Springer. https://doi.org/10.1007/978-3-031-35930-9_17
- Bhutoria, A. (2022). Personalized education and artificial intelligence in the United States, China, and India: A systematic review using a human-in-the-loop model. *Computers and Education: Artificial Intelligence*, 3, Article 100068. <https://doi.org/10.1016/j.caeai.2022.100068>
- Bilanych, M. M., & Bokotey, O. M. (2013). To the issue of environmental upbringing in the system of preschool education and in family. *Scientific and Methodological Bulletin «Pedagogical Search»*, (4), 6–8. <https://cutt.ly/owhuc16z>
- Celik, I. (2023). Towards Intelligent-TPACK: An empirical study on teachers' professional knowledge to ethically integrate artificial intelligence (AI)-based tools into education. *Computers in Human Behavior*, 138, Article 107468. <https://doi.org/10.1016/j.chb.2022.107468>
- Chen, D. C., Chen, Y. T., Wen, K. C., Deng, W. L., Lu, S. W., & Chen, X. W. (2023). The course of precision measurements from the incorporation of precision machinery and artificial intelligence and the learning effects of its learning materials. In Y. M. Huang & T. Rocha (Eds.), *International Conference on Innovative Technologies and Learning ICITL 2023. Lecture Notes in Computer Science* (Vol. 14099, pp. 22–36). Cham: Springer. https://doi.org/10.1007/978-3-031-40113-8_3
- Cheng, X. J., Dunn, R., Holt, T., Inger, K., Jenkins, J. G., Jones, J., ... & Wood, D. A. (2023). *Artificial intelligence's capabilities, limitations, and impact on accounting education: Investigating ChatGPT's performance on educational accounting cases*. SSRN. <http://dx.doi.org/10.2139/ssrn.4431202>
- Chiu, T. K., Moorhouse, B. L., Chai, C. S., & Ismailov, M. (2023). Teacher support and student motivation to learn with Artificial Intelligence (AI) based ChatBot. *Interactive Learning Environments*. <https://doi.org/10.1080/10494820.2023.2172044>
- Cribben, I., & Zeinali, Y. (2023). *The benefits and limitations of ChatGPT in business education and research: A focus on management science, operations management and data analytics*. SSRN. <http://dx.doi.org/10.2139/ssrn.4404276>
- Crompton, H., & Burke, D. (2023). Artificial intelligence in higher education: the state of the field. *International Journal of Educational Technology in Higher Education*, 20(1), Article 22. <https://doi.org/10.1186/s41239-023-00392-8>
- Decuyper, M., Alirezabeigi, S., Grimaldi, E., Hartong, S., Kiesewetter, S., Landri, P., ... & Broeck, P. V.

- (2023). Laws of Edu-automation? Three different approaches to deal with processes of automation and artificial intelligence in the field of education. *Postdigital Science and Education*, 5(1), 44–55. <https://doi.org/10.1007/s42438-022-00360-x>
- Dogan, M. E., Goru Dogan, T., & Bozkurt, A. (2023). The use of artificial intelligence (AI) in online learning and distance education processes: A systematic review of empirical studies. *Applied Sciences*, 13(5), Article 3056. <https://doi.org/10.3390/app13053056>
- Education Intelligence Unit. (2023, February 27). *Artificial intelligence in education. 2023 survey insights: Vision, voice, language and analytics AI transforming the way the world learns*. HolonIQ. <https://www.holoniq.com/notes/artificial-intelligence-in-education-2023-survey-insights>
- Esplugas, M. (2023). The use of artificial intelligence (AI) to enhance academic communication, education and research: A balanced approach. *Journal of Hand Surgery (European Volume)*, 48(8), 819–822. <https://doi.org/10.1177/17531934231185746>
- Filgueiras, F. (2023). Artificial intelligence and education governance. *Education, Citizenship and Social Justice*. <https://doi.org/10.1177/17461979231160674>
- Fitria, T. N. (2021, December). Artificial intelligence (AI) in education: Using AI tools for teaching and learning process. *Prosiding Seminar Nasional & Call for Paper STIE AAS*, 4(1), 134–147. <https://prosiding.stie-aas.ac.id/index.php/prosenas/article/view/106>
- Flores-Vivar, J. M., & García-Peñalvo, F. J. (2023). Reflections on the ethics, potential, and challenges of artificial intelligence in the framework of quality education (SDG4). *Comunicar*, 31(74), 37–47. <https://doi.org/10.3916/C74-2023-03>
- Fuhrmann, T., & Niemetz, M. (2023). Ideas on digitally supported individualization of teaching and learning for evolving competency requirements. In *Ninth international conference on higher education advances (HEAd 23)* (pp. 1399-1406). Universitat Politècnica de Valencia. <http://dx.doi.org/10.4995/HEAd23.2023.16232>
- García-Peñalvo, F. J. (2023). The perception of Artificial Intelligence in educational contexts after the launch of ChatGPT: Disruption or Panic?. *Education in the Knowledge Society*, 24, Article e31279. <https://doi.org/10.14201/eks.31279>
- Global Market Insights. (2023). *AI in education market size – By component (solution, service), by deployment (on-premise, cloud), by technology (machine learning, deep learning, natural language processing), application, end-use & forecast, 2023–2032*. <https://www.gminsights.com/industry-analysis/artificial-intelligence-ai-in-education-market>
- Grand View Research. (2021). *AI in education market size, share & trends analysis report by component (solutions, services), by deployment, by technology, by application, by end-use, by region, and segment forecasts, 2022–2030*. <https://www.grandviewresearch.com/industry-analysis/artificial-intelligence-ai-education-market-report>
- Grimmelikhuijsen, S. (2023). Explaining why the computer says no: Algorithmic transparency affects the perceived trustworthiness of automated decision-making. *Public Administration Review*, 83(2), 241–262. <https://doi.org/10.1111/puar.13483>
- Holmes, W., Bialik, M., & Fadel, C. (2023). Artificial intelligence in education: Promises and implications for teaching and learning. In *Data ethics: Building trust: How digital technologies can serve humanity* (pp. 151–180). Globethics Publications.

<https://doi.org/10.58863/20.500.12424/4276068>

- Hooda, M., Rana, C., Dahiya, O., Rizwan, A., & Hossain, M. S. (2022). Artificial intelligence for assessment and feedback to enhance student success in higher education. *Mathematical Problems in Engineering*, 2022, Article 5215722. <https://doi.org/10.1155/2022/5215722>
- Huang, A. Y., Lu, O. H., & Yang, S. J. (2023a). Effects of artificial intelligence – Enabled personalized recommendations on learners’ learning engagement, motivation, and outcomes in a flipped classroom. *Computers & Education*, 194, Article 104684. <https://doi.org/10.1016/j.compedu.2022.104684>
- Huang, X., Zou, D., Cheng, G., Chen, X., & Xie, H. (2023b). Trends, research issues and applications of artificial intelligence in language education. *Educational Technology & Society*, 26(1), 112–131. <https://www.jstor.org/stable/48707971>
- Järvelä, S., Nguyen, A., & Hadwin, A. (2023). Human and artificial intelligence collaboration for socially shared regulation in learning. *British Journal of Educational Technology*, 54(5), 1057–1076. <https://doi.org/10.1111/bjet.13325>
- Karyy, I. N., Kis, Y., Kulyniak, I., & Adamovsky, A. (2023). Model of educational process organizing using artificial intelligence technologies. In O. Cherednichenko, L. Chyrun, & V. Vysotska (Eds.), *Proceedings of the 7th International conference on computational linguistics and intelligent systems. Volume III: Intelligent systems workshop* (pp. 332–347). CEUR Workshop Proceedings. <https://ceur-ws.org/Vol-3403/paper27.pdf>
- Kassymova, G. K., Malinichev, D. M., Lavrinenko, S. V., Panichkina, M. V., Koptyaeva, S. V., & Arpentieva, M. R. (2023). Ethical problems of digitalization and artificial intelligence in education: A global perspective. *Journal of Pharmaceutical Negative Results*, 2150–2161. <https://doi.org/10.47750/pnr.2023.14.S02.254>
- Kooli, C. (2023). Chatbots in education and research: A critical examination of ethical implications and solutions. *Sustainability*, 15(7), Article 5614. <https://doi.org/10.3390/su15075614>
- Lamb, R., Choi, I., & Owens, T. (2023). Artificial intelligence and sensor technologies the future of individualized and differentiated education. *International Journal of Psychology and Neuroscience*, 9(1), 30–36. <https://doi.org/10.56769/ijpn09102>
- Lampropoulos, G. (2023a). *The role of educational technology, artificial intelligence, and gamification in improving education and students’ cognitive and social-emotional development: development and evaluation of educational applications and serious games using extended reality and learning analytics* [Unpublished doctoral dissertation]. International Hellenic University. <https://doi.org/10.12681/eadd/54240>
- Lampropoulos, G. (2023b). Augmented reality and artificial intelligence in education: Toward immersive intelligent tutoring systems. In V. Geroimenko (Ed.), *Augmented reality and artificial intelligence: The fusion of advanced technologies* (pp. 137–146). Cham: Springer. https://doi.org/10.1007/978-3-031-27166-3_8
- Liu, S., & Wang, J. (2021). Ice and snow talent training based on construction and analysis of artificial intelligence education informatization teaching model. *Journal of Intelligent & Fuzzy Systems*, 40(2), 3421–3431. <https://doi.org/10.3233/JIFS-189380>
- Ma, L. (2021). An immersive context teaching method for college English based on artificial intelligence

- and machine learning in virtual reality technology. *Mobile Information Systems*, 2021, Article 2637439. <https://doi.org/10.1155/2021/2637439>
- Malek, M., Nitsche, J., Dinand, C., Ehlers, J., Lissek, V., Böhm, P., ... & Halek, M. (2023). Interprofessional needs analysis and user-centred prototype evaluation as a foundation for building individualized digital education in dementia healthcare supported by artificial intelligence: A study protocol. *Healthcare* 11(10), Article 1508. <https://doi.org/10.3390/healthcare11101508>
- Malinka, K., Peresíni, M., Firc, A., Hujnák, O., & Janus, F. (2023, June). On the educational impact of ChatGPT: Is Artificial Intelligence ready to obtain a university degree?. In *Proceedings of the 2023 conference on innovation and technology in computer science education* (Vol. 1, pp. 47–53). <https://doi.org/10.1145/3587102.3588827>
- Martínez, I. G., Batanero, J. M. F., Cerero, J. F., & León, S. P. (2023). Analysing the impact of artificial intelligence and computational sciences on student performance: systematic review and meta-analysis. *NAER: Journal of New Approaches in Educational Research*, 12(1), 171–197. <https://dialnet.unirioja.es/descarga/articulo/8765676.pdf>
- Masters, K. (2023). Ethical use of artificial intelligence in health professions education: AMEE Guide No. 158. *Medical Teacher*, 45(6), 574–584. <https://doi.org/10.1080/0142159X.2023.2186203>
- Mistry, P. (2023, January 27). *How AI is responsible for the transformation of the education industry*. eLearning Industry. <https://elearningindustry.com/how-ai-is-responsible-for-the-transformation-of-the-education-industry>
- Modi, T., & Gochhait, S. (2023). Impact of artificial intelligence on gamification: Current applications. In *2023 International conference on innovative data communication technologies and application (ICIDCA)* (pp. 287–290). IEEE. <https://doi.org/10.1109/ICIDCA56705.2023.10099771>
- Munde, S. (2023). *Artificial intelligence in education market research report information – Market forecast till 2030*. Market Research Future. <https://www.marketresearchfuture.com/reports/artificial-intelligence-education-market-6365>
- Nemorin, S., Vlachidis, A., Ayerakwa, H. M., & Andriotis, P. (2023). AI hyped? A horizon scan of discourse on artificial intelligence in education (AIED) and development. *Learning, Technology*, 48(1), 38–51. <https://doi.org/10.1080/17439884.2022.2095568>
- Nguyen, A., Ngo, H. N., Hong, Y., Dang, B., & Nguyen, B. P. T. (2023). Ethical principles for artificial intelligence in education. *Education and Information Technologies*, 28(4), 4221–4241. <https://doi.org/10.1007/s10639-022-11316-w>
- Ouyang, F., Wu, M., Zheng, L., Zhang, L., & Jiao, P. (2023). Integration of artificial intelligence performance prediction and learning analytics to improve student learning in online engineering course. *International Journal of Educational Technology in Higher Education*, 20(1), 1–23. <https://doi.org/10.1186/s41239-022-00372-4>
- Park, J. (2023). *A case study on enhancing the expertise of artificial intelligence education for pre-service teachers*. Preprints. <https://doi.org/10.20944/preprints202305.2006.v1>
- Rangel-de Lázaro, G., & Duarte, J. M. (2023). You can handle, you can teach it: systematic review on the use of extended reality and artificial intelligence technologies for online higher education. *Sustainability*, 15(4), Article 3507. <https://doi.org/10.3390/su15043507>

- Rensfeldt, A. B., & Rahm, L. (2023). Automating teacher work? A history of the politics of automation and artificial intelligence in education. *Postdigital Science and Education*, 5(1), 25–43. <https://doi.org/10.1007/s42438-022-00344-x>
- Rusillo-Magdaleno, A., Ruiz-Ariza, A., Suárez-Manzano, S., & Martínez-Redecillas, T. (2023). Artificial intelligence, augmented reality and education. In V. Geroimenko (Ed.), *Augmented reality and artificial intelligence: The fusion of advanced technologies* (pp. 93–121). Cham: Springer. https://doi.org/10.1007/978-3-031-27166-3_6
- Saghiri, M. A., Vakhnovetsky, J., & Nadershahi, N. (2022). Scoping review of artificial intelligence and immersive digital tools in dental education. *Journal of Dental Education*, 86(6), 736–750. <https://doi.org/10.1002/jdd.12856>
- Sajid, H. (2023, March 3). *AI in education: 5 practical applications*. V7 Labs. <https://www.v7labs.com/blog/ai-in-education>
- Shidiq, M. (2023, May). The use of artificial intelligence-based chat-gpt and its challenges for the world of education; from the viewpoint of the development of creative writing skills. In *Proceeding of International conference on education, society and humanity* (Vol. 1, No. 1, pp. 353–357). <https://ejournal.unuja.ac.id/index.php/icesh/article/view/5614>
- Sison, A. J. G., Daza, M. T., Gozalo-Brizuela, R., & Garrido-Merchán, E. C. (2023). *ChatGPT: More than a weapon of mass deception, ethical challenges and responses from the human-centered artificial intelligence (HCAI) perspective*. arXiv. <https://doi.org/10.48550/arXiv.2304.11215>
- Tan, S. (2023). Harnessing Artificial Intelligence for innovation in education. In *Learning intelligence: Innovative and digital transformative learning strategies: Cultural and social engineering perspectives* (pp. 335–363). Singapore: Springer. https://doi.org/10.1007/978-981-19-9201-8_8
- Soocial. (n.d.). *20 AI in education statistics to rethink how you teach 2023*. <https://www.soocial.com/ai-in-education-statistics/>
- Teng, Y., Zhang, J., & Sun, T. (2023). Data-driven decision-making model based on artificial intelligence in higher education system of colleges and universities. *Expert Systems*, 40(4), Article e12820. <https://doi.org/10.1111/exsy.12820>
- Udvaros, J., & Forman, N. (2023). Artificial intelligence and Education 4.0. In L. G. Chova, C. G. Martínez, & J. Lees (Eds.), *INTED2023 proceedings* (pp. 6309–6317). IATED. <https://doi.org/10.21125/inted.2023.1670>
- Uunona, G. N., & Goosen, L. (2023). Leveraging ethical standards in artificial intelligence technologies: A guideline for responsible teaching and learning applications. In M. Garcia, M. Lopez Cabrera, & R. de Almeida (Eds.), *Handbook of research on instructional technologies in health education and allied disciplines* (pp. 310–330). IGI Global. <https://doi.org/10.4018/978-1-6684-7164-7.ch014>
- Voskoglou, M. G., & Salem, A. B. M. (2020). Benefits and limitations of the artificial with respect to the traditional learning of mathematics. *Mathematics*, 8(4), Article 611. <https://doi.org/10.3390/math8040611>
- Wach, K., Duong, C. D., Ejdays, J., Kazlauskaitė, R., Korzynski, P., Mazurek, G., ... Ziembra, E. (2023). The dark side of generative artificial intelligence: A critical analysis of controversies and risks of ChatGPT. *Entrepreneurial Business and Economics Review*, 11(2), 7–24. https://www.researchgate.net/publication/371987305_The_dark_side_of_generative_artificial_i

- West Agile Labs. (n.d.). *How Artificial Intelligence (AI) is transforming education: 8 cutting-edge applications*. <https://www.westagilelabs.com/blog/8-applications-of-artificial-intelligence-in-education/>
- Xiao, M., & Yi, H. (2021). Building an efficient artificial intelligence model for personalized training in colleges and universities. *Computer Applications in Engineering Education*, 29(2), 350–358. <https://doi.org/10.1002/cae.22235>
- Xie, C., Ruan, M., Lin, P., Wang, Z., Lai, T., Xie, Y., ... Lu, H. (2022). Influence of artificial intelligence in education on adolescents' social adaptability: A machine learning study. *International Journal of Environmental Research and Public Health*, 19(13), Article 7890. <https://doi.org/10.3390/ijerph19137890>
- Xu, W., Meng, J., Raja, S. K. S., Priya, M. P., & Kiruthiga Devi, M. (2023). Artificial intelligence in constructing personalized and accurate feedback systems for students. *International Journal of Modeling, Simulation, and Scientific Computing*, 14(01), Article 2341001. <https://doi.org/10.1142/S1793962323410015>
- Yang, Q. F., Lian, L. W., & Zhao, J. H. (2023). Developing a gamified artificial intelligence educational robot to promote learning effectiveness and behavior in laboratory safety courses for undergraduate students. *International Journal of Educational Technology in Higher Education*, 20(1), Article 18. <https://doi.org/10.1186/s41239-023-00391-9>

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A Comparative Analysis of Karplus Learning Cycle Model and Ausubel Meaningful Learning Model on Children's Environmental Pollution Cognition

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Abstract: Environmental education aims to raise individuals who have the necessary environmental knowledge, positive environmental attitudes, and active participation in the solution of environmental problems. It is necessary to use an effective teaching model in environmental education. The study aims comparing the academic success of secondary school students in teaching environmental problems in the light of Karplus's learning cycle model (Inquiry) and Ausubel's meaningful learning model (Direct) in terms of metropolitan-centred students (experimental group) and rural-centred students (control group). In addition, the important thing in questioning is to reveal the relationship of prior knowledge with open-ended questions asked by metropolitan-centred students. In this study, 164 5th-grade students' thoughts on environmental problems, their level of producing solutions, and their academic achievements were examined. A mixed design was used in the research. A case study, which was one of the research methods, was used for qualitative data, and an independent sample t-tests and paired sample t-tests were used for quantitative data. During the data collection process, the experimental and control groups were given a pre-test before the application, then news videos containing environmental problems were watched by the experimental group, while

the control group was taught with universal visuals. At the end of the lesson, the same achievement test was applied to both groups as a post-test and the change was examined. The whole application took a total of 8 lesson hours for both groups. As a result of the study, a statistically significant difference was found between the achievements of the experimental group students and the success of the control group students. In the qualitative data of the experimental group students, it was observed that they mostly commented on water pollution, air pollution, and forest destruction. In addition, the problems that individuals perceived least correctly were the visual pollution, noise pollution, and light pollution, accepted as the normality of big city life intertwined with daily life. It is clear that student-centred teaching models, like the Karpus Learning Cycle model will further increase the learning and student's awareness.

Keywords: environmental pollution, learning cycle model, meaningful learning model.

Introduction

The change of vision in the field of education is one of the most important changes marking the era. The goal in this era is to raise our children as science literate. In short, a science-literate individual has the ability to find solutions to problems encountered in daily life by approaching them from a scientific point of view. Citizens of all ages in society can understand and explain some scientific knowledge at the most basic level and follow technological developments and use them in their lives. The basic principle of achieving this goal is to learn scientific knowledge. In the context of this learning, 2 views come to the fore. The first one is "Inquiry", that is, the view that to learn scientific knowledge, the student reaches their knowledge by researching and questioning like a scientist and using scientific process skills. Since the 1930s, the views of scientists such as Dewey, Bruner, and Karplus have formed the basis. The other view is "Direct", that is, the view that it is difficult for the student to access information in the classroom environment by themselves and that the teacher should go down to the level of the student and explain with plenty of examples and then wait for feedback from the student. Since each student is special and it is time-consuming and difficult for them to access information in the classroom due to individual differences. This view is based on the views of scientists such as Gagne and Ausubel. While the Direct teaching model is combined with passive, rote, lecture, and traditional teaching models at the same conceptual level, the Inquiry teaching model is used in combination with hands-on, active learning (Alozie et al., 2010; Dori et al., 2007; Kanter & Konstantopoulos, 2010), on the contrary, some studies conclude that the Direct teaching model is not equivalent to passive reception and didactic lecture and that the Inquiry model is not equivalent to hands-on (Ausubel et al., 1986; Heppner et al., 2006; Novak, 1979).

In general, the Inquiry-based science teaching has been widely advocated worldwide in recent years through various national and international science education standards, although Direct forms of teaching have dominated past practice. What both perspectives have in common is that the learner realizes that the knowledge to be learned is part of life. If considering that all scientific knowledge is interrelated, it can be said that one of the most important factors affecting learning is the student's existing knowledge. The more this knowledge overlaps with the new scientific knowledge to be learned, the easier learning becomes. For this reason, teaching plans should be made accordingly. In inquiry-based science teaching, the individual's rich prior knowledge is more prominent because it is easier for them to make inferences and attribute meaning to the data students obtain while using scientific process skills in the discovery process (Hattie, 2009). In Direct teaching models, on the other hand, prior knowledge is secondary as long as the teacher can transfer knowledge to the level of the student and enriches it with plenty of examples. One of the easiest subjects to integrate the scientific knowledge with

life is the achievements that include environmental problems and solutions in the context of the "Human & Environment" unit. Since its existence, human beings have been making inventions and discoveries to make their lives easier. As a result of this, a human being, who has reached the position of a creature that dominates nature with his mind, has started to change nature in line with his desires instead of living in harmony with nature. By demanding more from nature than is needed and ignoring the effects of our actions on the environment, people are causing various environmental problems. Today, many elements have started to deplete, many of planet water resources have been polluted, energy shortages have started and the world has started to warm up rapidly. In this context, it is necessary to search for solutions to prevent this negative relationship that harms nature and thus harms people. Considering that a lack of respect for nature and not knowing the importance of nature are among the main reasons for this damage, it is thought that providing environmental education to individuals may be an effective solution (Hoeg & Bencze, 2014; Mahidin & Maulan, 2010; Yörük et al., 2010). Although problems cannot be eliminated with environmental education, it is promising as it can be reduced to a great extent.

The first time the concept of environmental education was used during the International Union for the Conservation of Nature Conference held in Paris in 1948 (Ünal & Dımişki, 1999). Environmental awakening, on the other hand, began in the 1960s and was popularised by the 1972 Stockholm Environment Conference (Hulme, 2016). According to the 1977 UNESCO-UNEP declaration, environmental education aims raising individuals with high environmental awareness and sensitivity, with the necessary environmental knowledge, positive environmental attitudes, and the ability to be active participants in solving environmental problems (Yücel & Özkan, 2014). This definition has been expanded over the years. Palmberg and Kuru (2000) stated that environmental education should aim providing individuals with attitudes, values, skills, knowledge, motivation, and the ability to solve environmental problems. Şimşekli (2004) stated that the main purpose of environmental education was to protect nature and natural resources, to create positive changes in individuals behaviours in addition to the information to be given to individuals, and to enable individuals to effectively participate in solving problems, while Ors (2012) emphasised that environmental education should aim to instil environmental awareness in individuals of all ages and segments and to create permanent changes in their behaviour. According to Karataş and Aslan (2012), environmental awareness can be developed in individuals throughout their lives, but it makes a big difference if its foundation is formed in childhood. This point of view reflects that it is recommended that environmental education should be included as an environmental education course in teacher training and the secondary school science curriculum and that teachers should make lesson plans by extensively using out-of-school environments (Yılmaz et al., 2016). The research with teacher's participation revealed that there are many practical obstacles to using out-of-school environments in the context of environmental education. These barriers were identified as 'administrators, administrative support, planning difficulties, costs, student management problems, lack of knowledge and skills related to outdoor teaching, and safety concerns'. In this case, the best solution is to bring nature into the classroom with the help of technology if there is no possibility to take children out into nature (Jose et al., 2017). Children, who are already a part of nature, have been found in studies to have an impact on children's perception of the environment not only through environmental education and practices but also through their cultural context. Many cultural elements such as the places children go to, the opinions of their families, their daily routines, the movies they watch, and neighbourhood patterns shape the environmental perceptions of individuals (Aguirre-Bielschowsky et al., 2011). Recently, it has been concluded that students are particularly influenced by the media and daily life and that these have an impact on environmental concepts. The media has the role of a mediator between science and society, enabling them to see the effects of science on society (Hulme, 2016).

Karplus's learning cycle model includes 3 phases.

Exploration; students conduct research, collect data and make sense of the data they collect by using scientific process skills.

The term Introduction; students share their inferences with their friends and reach scientific knowledge by discussing and being guided by the teacher.

The concept Application; students solve problems with the scientific knowledge they have acquired and apply it to daily life (Marek & Cavallo, 1997).

Ausubel's model of meaningful teaching includes 3 phases.

Phase 1. Advance Organiser; clarify the aim of the lesson and relate the organiser to students' prior knowledge.

Phase 2. Presentation of Learning Task or Material; the concept is explained with examples.

Illustrate the topic until it is understood and engage students in meaningful learning activities.

Phase 3. Strengthening Cognitive Organization; examples and problem solutions are made to show that the student has learned (Safdar et al., 2012).

In addition, the aim is to reveal the importance of the individual's prior knowledge and the importance of having this knowledge from students' immediate environment with videos containing current and regional environmental problems in the applications.

In literature, environmental studies mostly include research at the conceptual level of "environmental attitudes and behaviours", "environmental problems", "environmental awareness/environmental knowledge" and "environmental education" (Bahar & Kiris, 2017). Altın et al. (2014) studied secondary school students' awareness of environmental issues and problems. Their study showed a high level of environmental awareness among participant students. However, it is understood that environmental disclosures made in schools are insufficient and the participation level of students in environmental activities is low. Chaudhari (2015) examined the awareness of secondary school students about environmental pollution and environmental changes. He found that most of the students were familiar with the environment and environmental factors, were conscious of the environment and human existence, were familiar with the factors that polluted the environment, and were aware of the remedies to prevent environmental pollution. However, the students said that they had fewer activities at school, ordinary things were done, and out-of-school excursions were insufficient. A similar study was conducted by Salleh et al. (2016). They declared that secondary school students were found to possess substantial knowledge of environmental issues and good attitudes toward the environment. However, they have moderate awareness of environmental issues examined through their knowledge and attitudes. Yalçınkaya & Çetin (2018) examined the attitudes of secondary school students towards the environment and their views on environmental education (EE) and made suggestions for organising activities that would increase the environmental awareness and energy efficiency, where the education given in schools was insufficient. Ablak & Yeşiltaş (2020) studied to measure 524 students from 5–8 grades secondary school student's level of awareness about environmental education concepts and found that secondary school students had a high level of awareness about the concepts of environmental education overall. In Vemula and Devendar's (2021) study, the environmental awareness of public and private secondary school students was compared. As a result of their research, the environmental awareness was at a medium level, and private school students were more sensitive. For environmental education, public schools should organise exhibitions, activities such as tree planting, and movie/documentary screenings, and cooperate with non-governmental organisations in the environmental issues of understanding the subject and the principle

of teaching from close-to-far. The recent environmental education studies emphasizes conservation outcomes focusing on local issues, partnerships, and action in environment which is also called outdoor environmental education program. There is also some constructivist learning-based and active learning-based environmental education research in literature (Arik & Yılmaz, 2020; Jorgenson et. al. 2019; Mónus, 2022). There are no studies showing the effect of comparative current teaching models on children's learning about the environment.

Research Problem

Based on the carried-out literature analysis, many studies are the subject of studies at the conceptual level of environmental attitudes and behaviours, environmental problems, environmental awareness/environmental knowledge and environmental education. The comparative studies are almost non-existent in terms of teaching models. Thus, the research problem is "In the teaching of environmental problems, is the direct teaching perspective or the Inquiry teaching perspective more effective?"

Research Focus

In terms of teaching models related to environmental problems and comparative studies of Rural-Metropolitan-centred 5th-grade secondary school students are negligible, this is the focus of this study. This type of comparative research will contribute to which models should be used primarily for students' learning, especially in environmental studies, and will guide education administrators for reform studies.

Research Aim and Research Questions

This study aims to compare the academic achievement of middle school students in the teaching of 8 objectives in the context of Human & Environment unit in the light of Karplus's learning cycle model and Ausubel's meaningful learning model in terms of metropolitan-centred students (experimental group) and rural-centred students (control group) and to measure the preliminary thoughts of metropolitan-centred students about environmental problems with open-ended questions asked in the "Exploring" step, which is the first step of Karplus's learning cycle model. In this context, answers to the following questions were sought.

1. Is there a difference between the mean pre-test scores of the experimental and control group students in the Human & Environment unit achievement test?
2. Is there a difference between the mean achievement test scores of the experimental and control group students in the Human & Environment unit?
3. Is there a difference between the pre-test and post-test mean scores of the Human & Environment unit achievement test among the experimental and control group students?
4. What is the experimental group students' prior knowledge of current environmental problems?

Research Methodology

Research Design

In the study, a quasi-experimental design with pre-test and post-test control group was used in order to examine the effect of the teaching models used in learning 8 different acquisitions of the Human & Environment unit in 5th grade Science. In addition, the students in the experimental group were asked

open-ended questions about their knowledge and solution suggestions about the current environmental problems and were shown videos. This process, which is a case study, is also expressed as a type of design that allows an in-depth and detailed examination of the targeted situation and aims to reveal social facts (Creswell, 1998; Yıldırım & Şimşek, 2008).

Study Group

The population of the research consists of 5th-grade students studying in the centre and the rural area of a metropolitan city. The study group was selected by convenience sampling method. In convenience sampling, the researcher selects a situation that was easy to access and, in this context, the researcher gains speed and practicality (Yıldırım & Şimşek, 2008). The reason for choosing the students from the school in the city centre is that they are intertwined with environmental problems, and the reason for choosing the school students in the rural area is that they have encountered less environmental problems. While the experimental group students were selected from a secondary school in the centre of the metropolitan city, the control group students were selected from a secondary school in the rural area of the metropolitan city. The experimental group consisted of 98 students from 4 different branches of a metropolitan middle school and the control group consisted of 66 students from 3 different branches of a rural middle school. In total, 164 students participated in the study. In addition to the principle of volunteerism, the principle of confidentiality was also given importance in the research and each participant was given the codes K1, K2, K3, K96 codes were given to each participant respectively.

Data Collection Tools

As data collection tools, the achievement test developed by Çiçek Şentürk and Selvi (2021) in 2021 for the 5th grade "Human & Environment" unit was used for quantitative data, and the interview form developed by the researcher was used to collect qualitative data. The achievement test used for quantitative data consisted of 27 items. The item difficulty of the test was 0.62, the average item discrimination was 0.47, and the KR-20 reliability coefficient was 0.82.

Table 1

Unit Outcomes and Achievement Test Questions

Unit Outcomes	Questions
1. Questions the importance of biodiversity for natural life	1-27
2. Discusses the factors that threaten biodiversity based on research data	2-6-12-19-22
3. Expresses the importance of the interaction between "Human & Environment"	3-7-13-25
4. Offers suggestions for the solution of an environmental problem in their immediate environment or our country	15-17
5. Makes inferences about the environmental problems that may occur in the future as a result of human activities	9-20-23-24
6. Discusses benefit and harm situations in human-environment interaction on examples	5-16-18
7. Explains destructive natural phenomena caused by natural processes	4-10-21-26

8. Expresses ways of protection from destructive natural events	8-11-14
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Qualitative data consisted of 3 open-ended questions:

- (1) What do you think is the problem and its cause in this video?
- (2) How do you think this problem can be prevented?
- (3) Where did you learn the information?

The questions were included in the research process after being approved by 3 experts in the field. Open-ended questions were preferred because they enabled students to give original answers and make personal comments. In the 5th-grade science curriculum, environmental pollution under the Human & Environment unit is divided into 4 areas and these are defined as (1) water, (2) air, (3) noise, and (4) visual pollution. In addition, light pollution is specifically mentioned as a separate heading within visual pollution. The current issue of forest destruction is also included in the study. In this framework, 4 current news videos reflecting 6 environmental problems were used. In the video on water pollution, the content includes mucilage, sea pollution, dead fish washed up on the beach, oil waste leaking from the ship, and factory water entering the rivers. The video on air pollution included dark skies, people wearing masks, factory chimneys, and car exhaust fumes. The forest video includes images of fires, picnic areas, illegal logging, and zoning of forest areas. The Visual-Light-Noise video includes images of day and night work density in a metropolitan city and images of urbanisation.

Data Collection process

The achievement test of the Human & Environment unit was used as a pre-test before the start of the lesson for the experimental and control group students. Then, in the light of Karplus Learning Cycle model, current news videos were shown to the experimental group in silence mode (except for the noise pollution video) and open-ended questions were asked after each video. While each video lasted between 3-4 minutes, students were given an average of 5 minutes to answer the open-ended questions (Figure 1). In addition, the videos were played repeatedly while the students answered the questions. Each news video process took an average of 10-15 minutes, and a total of 2 lesson hours of data collection was realized. Then, students talked to each other about answers, and the topic was summarized in the term introduction phase. After that, the teacher asked some questions, matching, multiple choice, and concept cartoon-type questions, about the topic to check the students' learning, in the concept application phase.

Figure 1

Experimental Group Visuals from Media Videos

	
Water Pollution (Mucilage, Istanbul)	Air Pollution (Izmir)
	
Forest destruction (Izmir)	Light-Visual Pollution (Izmir)

In the control group, unlike the experimental group, the teacher clarified the aim of the lesson and relate the organiser to students' prior knowledge, then the Human & Environment unit concepts were explained with many examples. The teacher taught the lesson enriched with visuals in the context of the Ausubel teaching model through lectures and plenty of examples. The visuals were selected from distant countries that students were unlikely to have seen before (Figure 2). After that like the Karplus Learning cycle model of the last phase, the teacher asked some questions, matching, multiple choice, and concept cartoon-type questions, about the topic. In the end, the achievement test was used again as a post-test for both groups. The whole application took a total of 8 lesson hours for both groups.

Figure 2

Control Group Visuals

	
Water Pollution (India)	Air Pollution (China)
	
Deforestation (Rain forest Brasil)	Light-Visual Pollution (New York)

Data Analysis

Since the quantitative data obtained were normally distributed, an Independent sample t-test was used. In addition, the Levene test, which is a hypothesis test to evaluate the equality of variances for a variable calculated for two or more groups, was also applied. For qualitative data, the content analysis method was used to analyse the data to draw meaningful conclusions, explain the data and reveal the relationship between them. When conducting content analysis, the data must first be coded, then organized, and finally, themes must be created according to these codes (Yıldırım & Şimşek, 2018). Thanks to the themes created, the relationship between the data is easily revealed. A total of 3 themes were created within the scope of this study.

Research Results

According to the achievements of the Human and Environment unit and the results of the pre-test academic achievement test of the experimental and control group students, it is visible that there was no statistically significant difference ($p>0.05$) between the pre-test ($\bar{X}$: 8.47) score of the students in the experimental group and the pre-test ($\bar{X}$: 7.08) score of the students in the control group [$t(163)=2.63$, $p>0.05$]. The standard deviation was a statistical measure of the spread of data relative to the mean. If many data were close to the mean, the standard deviation was small. The standard deviation value of the control group (2.94) was smaller than the experimental group (4.74), because it was closer to its mean score. In addition, since the p-value found as a result of Levene's test was greater than $0.094>0.05$, it can be said that there was no difference between the groups, that was, the variances were not equal (homogeneous) (Table 2).

Table 2*Comparison of Pre-test Scores of Students in Experimental and Control Groups*

Group	N	$\bar{X}$	sd	df	t	P
Experimental group	98	8.47	4.74	163	2.63	.48
Control group	66	7.08	2.94			

Levene: 0.094

Considering the post-test results applied at the end of the lesson, the achievement test average result of the experimental group students was calculated as 23.07, and the achievement test average result of the control group students was calculated as 18.5. The standard deviation value of the control group (4.14) and the experimental group (3.98) were very close, both were close to their mean score. There was a statistically significant difference [$t(163) = 3.013, p < 0.05$] between the post-test mean achievement scores of the students in the experimental and control groups (Table 3).

Table 3*Comparison of Post-test Scores of Students in Experimental and Control Groups*

Group	N	$\bar{X}$	sd	Df	t	p
Experimental group	98	23.07	3.98	163	3.013	.018
Control group	66	18.5	4.14			

While there was a statistically significant difference in the comparison of the pre-test and post-test paired sample t-test for both groups of students, it is visible that the achievement means scores of the students in the experimental and control groups increased. While the pre-test and post-test standard deviation values (4.47-3.98) of the experimental group were close to each other, this situation increased in favour of the post-test (2.94-4.14) in the control group. The academic achievement mean score of the experimental group students increased from 8.47 to 23.7. The academic achievement mean score of the control group students increased from 7.08 to 18.5. It is seen that there is a greater increase in the number of students in the experimental group (Table 4).

Table 4*Comparison of Pre-test and Post-test Scores of Students in Experimental and Control Groups*

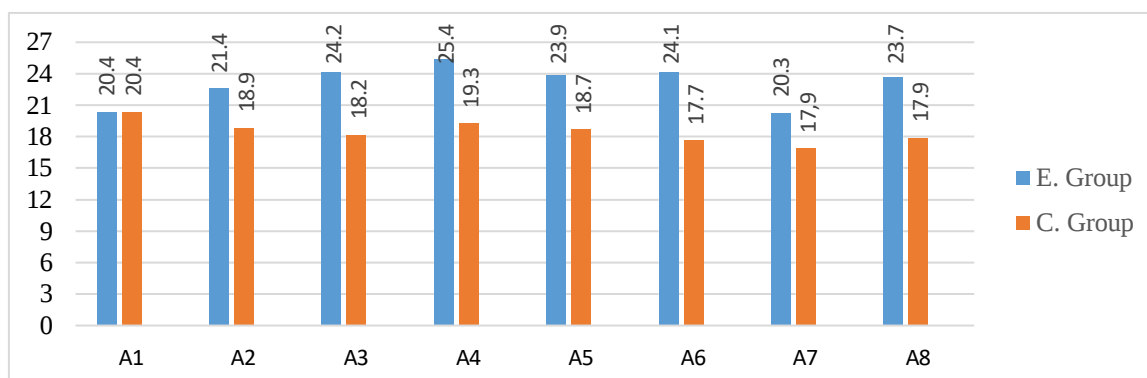
Experimental group	N	$\bar{X}$	sd	df	t	p
Pre-test	98	8,47	4.47	97	1.652	.00
Post-test	98	23.07	3.98			
Control group						
Pre-test	66	7.08	2.94	65	1.376	.00
Post-test	66	18.5	4.14			

When analysing the achievement post-test scores for both groups, it can be seen that the biggest differences are Achievement 3. Expresses the importance of the interaction between "Human & Environment" (difference 4); Achievement 4. Offers suggestions for the solution of an environmental problem in his/her immediate environment or our country (difference 6.1); Achievement 5. Makes inferences about environmental problems that may occur in the future as a result of human activities (difference 5.2); Achievement 6. Discusses the benefit and harm situations in human-environment interaction on examples (difference 6.4); Achievement 8. Expresses ways of protection from destructive natural events (difference 4.8). This result is especially related to scientific knowledge about the

definition, causes, and solutions of 6 different environmental problems.

Figure 1

Experiment & Control Group Academic Achievement Test Scores



Within the scope of the study, a total of 4 themes were formed "*students' perceptions about environmental pollution*", "*students' level of knowledge about the effects of environmental pollution*", "*students' level of knowledge about the solutions to environmental pollution*" and "*source of information*". In order to ensure the external validity of the research, direct quotations from the participants' opinions were included under each table.

Perceptions of Environmental Pollution

Students were asked to define the problem in the news video with water pollution. From this point of view, it was investigated whether the students perceived the problems of water pollution. Considering the data obtained, all students observed and defined water pollution. Water pollution was analysed in 2 themes water pollution caused by chemical waste and water pollution caused by garbage. It is seen that students are mostly aware of water pollution caused by garbage. As the cause of water pollution, the answers of littering (f:73), marine pollution (f:34), gasoline-oil-oil spillage (f:28), and pollution of water resources (f:27) (Table 5).

Table 5

Students' Perceptions of the Water Pollution Video

Themes	Correct perceptions	f	Misperceptions	f
Water pollution from chemical waste	Spilling gasoline-oil-oil into the sea	34		-
	Pollution of water resources	27		-
Water pollution from garbage	Littering in the sea	73		-
	Bad-dirty scene	17		-
	Disposing of waste materials into the sea	8		-

P21: "*It is very obvious that the sea is filthy, garbage has been thrown into it, caretta caretta can eat this garbage and die.*"

P45: "*At the beginning, the sea looked very beautiful and clear, but then there was waste and the oil leaking from the ship would kill the fish.*"

P61: "*I think that foam in the sea is dirt, especially in the scene inside the sea, even the fish and algae cannot be seen.*"

Students were asked to interpret the problem related to the video about air pollution. While the number of students who could perceive the problem of air pollution was 87, eleven students could not perceive the problem. Participants who have a misperception about air pollution confuse the problem with light pollution and visual pollution. They also did not see fog and the abundance of factories and buildings as a problem. In addition to saying air pollution directly, students attributed pollution to car and factory fumes (Table 6).

Table 6

Students' Perceptions of the Air Pollution Video

Correct perceptions	Codes	f	Misperceptions	Codes	f
	Air pollution	41		Light pollution	6
	Smoke from car exhausts	25		Fog	3
	Factory fumes	21		Visual pollution	
	No view of the landscape	10		The high number of factories/buildings	1
	Unhealthy air	8		No problem	1

P26: "There is a lot of light pollution and it catches people's eyes."

P55: "There are factory chimneys, if there are no filters installed on them, filters should be installed."

P47: "I've seen it in Aliaga, but I've never seen so much fog in Folkart. Yes, there is a problem here, a weather problem."

In the news video on forest destruction, students' answers were grouped under the themes of forest destruction and forest fires. While there was no misperception about forest fires, 12 students could not define the problem in the theme of forest destruction. While the forest fire was clearly defined, failures to protect nature and animal deaths were also mentioned, cutting down trees (f:77), mining exploration in the forest (f:33), failure to protect nature (f:22), building houses in the forest (f:17), decreased rainfall (f:16) and failure to plant trees (f:15) were mentioned in the theme of forest destruction, (Table 7).

Table 7

Students' Perceptions of the Forest Destruction Video

Correct perceptions			f	Misperceptions		f
Forest Fire	Forest fire		98	No problem		12
	Failure to protect nature		52			
	Animals die		41			
Forest destruction	Cutting of trees		77			
	Mining exploration in the forest		33			
	Failure to protect nature		22			
	A house in the forest		17			
	The rains diminish		16			
	Failure to plant trees		15			

P8: "Our forests were burned, trees and animals died".

P11: "Yes there is a problem, houses have been built instead of trees, and the trees seem to have dried up, which reduces rainfall".

P77: "They have literally carved the mountain to search for minerals, what if they don't find any".

The latest news video shown to the students contains light and noise pollution as well as visual pollution.

It was observed that 26 students had wrong perceptions about general visual pollution, while 72 students had no perceptual problem with visual pollution. The wrong perceptions were landslides (f:13), earthquakes (f:8), small houses (f:2), and no problem (f:3). Under the theme of correct perceptions, two sub-themes were formed as the direct effects of visual pollution and the effects of urbanization. The answers with the highest frequency under the themes were found to be visual pollution (f:60) and the fact that the houses are intertwined (f:24) (Table 8).

Table 8

Students' Perceptions of the Problem of Visual Pollution

Correct perceptions		f	Misperceptions	f
Direct effects	Visual pollution	60	Landslide	13
	Crowd-crowded scene	13	Earthquake	8
	Unattractive scene	11	Small Houses	2
Effects of urbanization	Intertwined houses	24	No Problem	3
	Lack of trees	12		
	Overbuilding	11		
	Destruction of nature	11		
	Animals losing their home	2		

P5: "Since they build houses everywhere, it looks bad and nature is being destroyed. Animals' homes are disappearing, this is important."

P21: "There might have been an earthquake in these photos."

P27: "There are also tall buildings, but there are more small houses. Big buildings should be built."

While 42 students were aware of the problem of light pollution, 56 were not. The most frequent answers of the individuals who perceive light pollution as a problem are as follows, respectively: light pollution (f:31), excessive use of light (f:17), visual pollution (f:13), waste of electricity (f:12) and general environmental pollution (f:9) (Table 9).

Table 9

Students' Perceptions of the Problem of Light Pollution

Correct perceptions	f	Misperceptions	f
Light pollution	31	No problem	56
Excessive use of light	17		
Visual pollution	13		
Electricity waste	12		
Environmental pollution	9		

P5: "Yes, too much light is used everywhere for nothing."

P7: "There is a problem here. There are lights everywhere, those lights are always on in the buildings, so there is no need for those lights at night. I don't think this is beautiful, it is also visual pollution."

It is seen that noise pollution is the area with the most problems in perception. The 59 students confused noise pollution with general environmental pollution. The 39 students who identified noise pollution were defined as direct noise pollution (f:29), sound pollution (f:15), horn sounds (f:12), and car sounds (f:7) (Table 10).

Table 10

Students' Perceptions of the Noise Pollution Problems Shown in Photographs

Correct perceptions	f	Misperceptions	f
Noise pollution	29	Environmental pollution	59
Sound pollution	15		
Honking horns	12		
Car sounds	7		

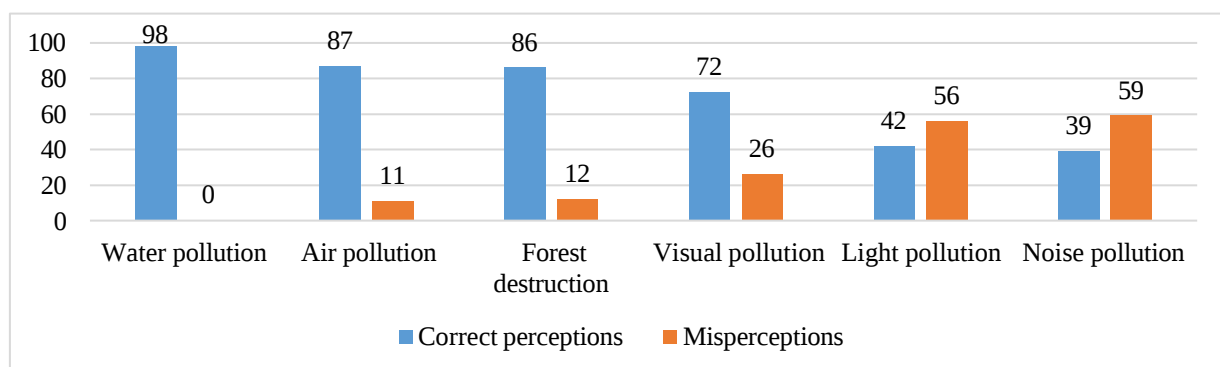
P26: "Garbage is thrown on the ground, there is both environmental pollution and too many cars here, cars should be reduced."

P58: "The problem here is noise pollution; cars make too much noise. When cars make too much noise, it can harm people."

Regarding the 6 environmental problems in the news video containing 4 current environmental problems, students correctly perceived 100% water pollution, 89% air pollution, 88% deforestation, and 73% visual pollution, while this rate decreased to 43% for light pollution and 40% for noise pollution (Graph 2).

Figure 2

Right-Wrong Perceptions About Environmental Issues



The level of knowing the effects of environmental pollution and solutions

The answers given by the students about the effects of water pollution were grouped under 3 themes; personal discomfort, effects on living life, and effects on nature. The most common answers given under these 3 themes were as follows; not being able to swim (f:55), death of fish (f:77), and depletion of water resources (f:12). The solutions suggested to prevent were also combined under the 3 themes; ways to prevent garbage, ways to prevent waste and educational solutions. The most common

answers under each theme are listed respectively; garbage should not be thrown into the sea (f:69), sewage should not be poured into the sea (f:41), and people should be warned (f:33) (Table 11).

Table 11

Level of Knowledge of Water Pollution Problem, Its Effects, and Solutions

Levels of knowing the effects of environmental problems			f	Levels of knowing the solutions		f
Personal discomfort	Not being able to go to the sea	55	Ways to prevent litter	Garbage should not be thrown into the sea	69	
	Getting infected - getting sick	33		The sea must be cleaned	34	
Effects on living life	Fish dying	77		Garbage must be collected	26	
	Dying of moss	37		Garbage should be thrown in the garbage bin	14	
	Poisoning fish and humans	32		Nets should be installed in the sea	10	
	Negative impact on land animals	24		Organize garbage collection events	10	
Impact on nature	Depletion of water resources	12		Fine	9	
	Pollution of the environment	11	Ways to prevent waste	Sewage should not be dumped into the sea	41	
	Garbage odour	7		Oils should not be dumped into the sea	21	
				Installing purification in factories	31	
			Educational solutions	People should be warned	33	
		People should be made aware		11		

P8: "When we enter the sea to swim, we encounter a lot of garbage and it is difficult to swim.

P88: "We should not throw garbage or a net can be attached to the sea. After a week, when the net is removed, the garbage is cleaned.

The answers obtained from the students about the effects of air pollution were grouped under 2 themes; individual effects and effects on living things. The most common answers under these 2 themes are as follows; damage to the eyes (f:63), inability to breathe clean air (f:42), damage to living things (f:55), death of birds (f:42) are the codes with the highest frequency. When the answers obtained regarding the solutions were analysed, 4 themes were formed. Respectively, legal regulations, educational-attractive, light pollution solutions, and not specifying a solution. The most frequently given answers regarding the 5 themes are; filters should be installed in factories (f:62), people should be warned (f:41), light sources should be reduced (f:10), and there is no solution (f:2). One of the interesting points here is that students integrated the concept of light pollution into the concept of air pollution (Table 12).

Table 12

Level of Knowledge of Air Pollution Problem, Its Effects, and Solutions

Levels of knowing the effects of environmental problems		f	Levels of knowing the solutions		f
Individual effects	Damage to the eyes	63	Legal regulations	Install filters in factories	62
	Inability to breathe fresh air	42		Stoves and nuclear power plants should not be used	32
	Poisoning-death	22		Complaining to the municipality	31

	Inability to go out	18	Educational- Attention- grabbing	People should be warned	41
				A banner should be prepared	11
Effects on living things	Damage to living things	55	Solutions to light pollution	Reducing light sources	10
	Birds dying	42		Less use of light	9
	Disorientation	11	Failure to specify a solution		2

P13: *"Both our eyes will be damaged and the birds will be affected, they will not be able to find their destinations."*

P43: *"As a solution, filters should be installed in factory chimneys"*

P59: *"It does not affect us, but we can use less light to fix it"*

Impacts and solutions to forest degradation were categorized under three themes. The themes are as follows respectively: effects on living things, effects on nature, and solutions to protect forests. While the codes with the highest frequency in the themes determined under the effects of forest destruction were the destruction of the habitat of living things (f:39) and the decrease in oxygen (f:45), the codes with the highest frequency in the theme determined for the solutions were determined as trees should be planted (f:68) and trees should not be cut down (f:49) (Table 13).

Table 13

Level of Knowledge of the Problem of Forest Destruction, Its Effects, and Solutions

Levels of knowing the effects of environmental problems			f	Levels of knowing the solutions			f
Impact on living things	Destruction of habitat		39	To protect forests	Trees should be planted		68
	The inability of living things to feed		37		Trees should not be cut down		49
	Animals dying		33		Nature must be protected		35
	Psychological distortion		22		Forest area should be increased		33
Impact on nature	Decreased oxygen		45		Nature must not be polluted		20
	Destruction of natural areas		44		Buildings should not be built		20
	There may be a landslide		27		Call the fire brigade		18
	Tree depletion		25				
	Disasters happen		19				

P8: *"If there is not plenty of greenery, natural disasters will happen frequently. Living things cannot feed".*

P11: *"Animals' homes have been destroyed."*

P58: *"We should protect nature instead of building houses and cutting down trees".* P71: *"I would build a huge forest and it would be home to all animals".*

In line with the data obtained from the students, the effects of the visual pollution problem were collected under 2 themes; direct effects, effects of urbanisation, and solutions were gathered under 4 themes; to protect the equal area, to prevent clutter/chaos other, and no solution. The codes with the highest frequency in the themes created on the effects are eye strain (f:54), decrease in living comfort

(f:26). The codes with the highest frequency in the themes related to solutions are trees should be planted (f:34), fewer buildings should be built (f:30), large buildings should not be built (f:31), no solution (f:15) (Table 14).

Table 14

Level of Knowledge of the Effects and Solutions to the Problem of Visual Pollution

Levels of knowing the effects of environmental problems		f	Levels of knowing the solutions		f
Direct effects	Eye strain	54	To protect green space	Trees should be planted	34
	Creating a bad scene	22		Build houses in treeless areas	11
Effects of urbanization	Decreased comfort of life	26	To avoid confusion	Fewer buildings	30
	Deforestation and oxygen depletion	24		Proper planning is needed	24
	Damage to living things	13	Constructi on sector No solution	Big buildings should not be built	31
	Decrease in natural areas	12			15
	Demolition of buildings	9			

P9: "There is a very complex scene, it tires our eyes."

P9: "If there were fewer buildings and more trees, our eyes would not get tired and we would be more comfortable."

Students' answers about the effects of light pollution were combined under 2 themes; its effect on living things and its effect on the environment. The codes related to these themes are harming living things (f: 44), tiring and spoiling the eyes (f: 34), wasting energy (f: 34), and causing accidents (f: 32). When the solutions produced were analysed, 4 themes were formed; direct solutions, solutions to attract attention, legal regulations and no solution. Examples of the codes belonging to these 4 themes are as follows; reducing the use of light at home (f:52), reducing the lighting of buildings (f:31), taking action (f:23), the municipality should turn off the lights (f:17), no solution (f:23) (Table 15).

Table 15

Level of Knowledge of the Problem of Light Pollution, Its Effects, and Solutions

Levels of knowing the effects of environmental problems		f	Levels of knowing the solutions		f
Impact on living things	Harm to living things	44	Direct remedies	Reduce the use of light at home	52
	Tiring and deteriorating eyes	32		Building lighting should be reduced	31
	It prevents living things from navigating	12		Savings must be made	14
	Animals cannot sleep	17	For attracting attention	The necessary lights must be turned on	10
Impact on the Environment	Rapid shedding of tree leaves	11		Action must be taken	23
	Energy waste	34		The complaint must be filed	22
	Causing accidents	32	Legal regulation	The municipality should turn off the lights	17

	Creating visual pollution	11	No solution		23
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P15: "Too much light can spoil our eyes and disturb living things, they need to sleep in the dark too.

P15: "Not every building has to be lighted, this problem will disappear if only the necessary lights are turned on. We can protest in front of the governorship or Gediz Electricity

Based on the answers given by the students, the effects of noise pollution were grouped under 2 themes, and the solutions were grouped under 4 themes. The themes created about the effects are the effect on hearing and the effect on living things. The most frequent codes of these themes were deafness (f=12) and disturbance of living things (f=14). The themes created for solutions were solutions to traffic-related noise pollution, solutions to human-induced noise pollution, solutions to construction sector noise pollution, and no solution. The codes with the highest frequency for these 4 themes are: not honking (f:64), not shouting (f:44), noiseless building construction (f:37), and no problem (f:13) (Table 16).

Table 16

Level of Knowledge of the Problem of Noise Pollution, Its Effects, and Solutions

Levels of knowing the effects of environmental problems			Levels of knowing the solutions		
Impact on hearing	Deafness	12	Solutions for traffic-related noise pollution	Failure to honk the horn	64
	Ear and head diseases	8		Reduction of cars	21
Impact on living things	Disturbance of living things	14		Cars without horns	9
	Spooking of animals	8		Replacing car exhausts	9
	Interferes with communication	4	Solutions to human-induced noise pollution	Not shouting	44
				Don't talk unnecessarily	15
			Construction industry noise pollution solutions	Noiseless building construction	37
			No solution		13

P6: "People cannot even understand what each other is saying because of the noise. "

P15: "It will be solved if people don't shout "Come sister, come sister" and honk their horns in the markets."

P8: "Cars without horns should be produced. "

P7: "The world population is increasing every day and noise pollution will continue to increase. It cannot be prevented

Environmental Pollution Information Source

When the knowledge level of the questions asked about the 4 current news videos and the source of their solutions were questioned, the answers received from the students were gathered under 4 themes, which were social environment, visual media, written media, and social media. The highest frequency as a source of information was TV (f:70), followed by parents (f:57), and the lowest frequencies were newspapers (f:9) and books (f:5) (Table 17). It was interesting to note that social media has a frequency that is not underestimated in this age group.

Table 17*Students' source of information*

Theme	Codes	f	%
Social environment	Parents	57	22
	Friends	36	13.8
Visual media	TV	70	27
Written Media	Journal (Science-technical)	25	9.6
	Newspaper	9	3.4
	Books	5	1.7
Social Media	Tik-Tok / Reel video	34	13.1
	Instagram	23	8.8

Discussion

Due to the comparative nature of the study, it was seen that there was no difference between the academic achievement pre-test results of metropolitan-centred students and rural students. This ultimately gave us the opportunity to apply teaching models with two different perspectives. After the applications, a significant difference was found between the pre-test and post-test comparisons of both experimental and control groups. This result shows that both Karplus's learning cycle teaching model and Ausubel's meaningful teaching model contribute to students' learning. This is a parallel result of Archer and Hughes (2011), Peterson (2011), Lins et al. (2020), and Nurhasanah et al. (2022) studies, which found this accelerated students' learning and problem-solving in the use of "direct" teaching perspective. On the other hand, many of articles, such as Secker (2002), Tretter and Jones (2003), Minner et al. (2010), Furtak et al. (2012), Oliver et al. (2021) supporting for its effectiveness in improving content learning, science process skills, and student attitudes, have been published on inquiry instruction in the sciences. In addition, when the post-test results of the experimental and control groups were compared, there was a statistically significant difference in favour of the experimental group. That means Karplus's learning cycle teaching model gives a more effective result than Ausubel's meaningful teaching model. This result is similar to Johnson and Lawson (1998) Vlassi and Karaliota (2013), Ramnarain and Schuster (2014) studies.

The current environmental problem videos used in the research and the student's level of readiness clearly affected this success. Among the 8 achievements in the achievement test, there was a big difference in favour of metropolitan students, especially in the achievements related to the interaction between humans and the environment and the formation of environmental problems as a result of this interaction (A3), and producing solutions (A4-8) to these problems.

When the results obtained from the open-ended questions are analysed it is seen that the problem that the students make the most comments about is water and air pollution, while the environmental problems that students have the lowest correct perception are noise pollution and light pollution. Students correctly perceived water pollution, especially water pollution caused by garbage, and mentioned its harm to living things. In addition, personal discomforts caused by water pollution were mentioned and creative solution suggestions were presented. Based on the fact that individuals stated

not being able to go to the sea as a result of water pollution as a personal discomfort, we can attribute the reason why individuals are more sensitive about water pollution to because of their regional close relationship with the sea. The fact that individuals are living in a metropolis with a seashore and close to coastal areas may be a factor. In support of this idea, many studies show that children develop an emotional connection with nature through their experiences with nature (Aguirre-

Bielschowsky et al., 2011). When the data on air pollution are analysed, it is seen that the level of perception of the problem of air pollution ranks second. The perception of air pollution, especially factory fumes and car exhausts come to the forefront, while students who confuse it with light and visual pollution and fog stand out at a small rate. Air pollution continues to increase today and is widely discussed in the media. It is seen that the effects of these events taking place in their environment on humans and animals and the reasons that cause this are put forward. Interestingly, since the students live in a metropolitan city and the heating is natural gas, the dirty smoke coming out of the chimneys of the houses is not mentioned in the reasons for air pollution. Although this reason is not a part of their lives in this data, the dense industrial zones around them, especially the large number of factories, concentrated the perception on dirty gases coming out of factory chimneys rather than houses. As a result, it is natural that they are sufficiently aware of this. It cannot be expected to propose a solution to a problem that is not recognised. In addition, the other problem with a high level of correct perception is forest destruction. The fact that these events, such as cutting down trees related to forest destruction and opening areas for mining exploration, building Hydroelectric Power Plants, even cutting down even limited trees in the city and building shopping malls, and forest fires in the region, are talked about a lot in visual and written media as well as in social media, is the possibility that individuals have heard or seen these problems at least once. Considering the answers given by the students as a solution to this situation, it is noteworthy that the answer with the highest frequency is 'planting trees'. Based on this, it can be concluded that individuals are aware of how trees and forests are being slaughtered and that trees are a source of life for both us humans and other living things, and they see the reduction of green areas in natural environments as a serious problem. Mahidin and Maulan (2010) stated that a lack of respect for nature and not knowing the importance of nature are the main sources of crimes against nature. In this context, the fact that the individuals participating in the study are aware of the importance of trees and appreciate nature promises hope for preventing the problems experienced. What is missing here is that the environmental problems experienced by the individuals are not given as a whole under a cause-and-effect relationship. It is possible reaching the environmental awareness one aims for in children only when individuals make sense of problems under the cause-and-effect relationship.

Based on the findings, it seems that the problem of noise pollution is a part of individuals' daily lives and this situation is accepted. Considering that one of the most basic activities in human life is communication and that the ear can hear sounds above 20 decibels, this noise pollution will inevitably cause health problems in the future, but it is seen that the students do not care much. Light pollution, on the other hand, is seen as a part of normal life with the excess of large buildings and the colourful lighting of not only shopping stores but also normal residential buildings with neon or led lights under the name of modernity. From this point of view, it can be interpreted that individuals cannot associate light pollution with large buildings. Based on both problems, it has been determined that the problem that individuals are least aware of is that they cannot adequately see the problems they encounter most in their daily lives. This result contradicts the study of Yilmaz et al. (2016), which emphasises that individuals are more attentive to the problems they directly encounter in their environment.

As a result, it is seen that students have an undeniable level of prior knowledge about environmental pollution. While the source of these knowledge levels of individuals is generally their immediate environment and TV, the use of social media, which is the popular source of information of the age, is undeniably high. While this media monitoring contributes to the student's level of readiness, the fact that they are fully aware of what is going on in their environment reveals an interesting situation. As metropolitan children, it is sad that they do not pay attention to light and noise pollution and see the situation as normal.

These findings are important for informing those planning to develop environmental education programs or curricula. The Ministry should inform their teachers about more learning-centred and

inquiry-based teaching models in their science curricula by providing in-service training to teachers and enable them to teach more concrete-oriented lessons in their science lessons. This process should be accelerated, especially as students gain concrete experiences through field trips.

Conclusions and Implications

In this study, the achievements of 5th-grade students in the context of the Human and Environment unit were compared with the difference in academic achievement between students in metropolitan cities and students in rural areas in the perspective of Karplus's learning cycle model and Ausubel's meaningful learning model. In addition, the perception, foreknowledge, and solution status of the current environmental problem videos shown in the discovery step of the learning cycle model of the metropolitan-centred (experimental group) students were investigated.

It is obvious that learning becomes easier when current events are presented to students in a solid way, especially in the context of close-to-far teaching principle. If teaching the scientific information, it should be taught to students by using student-centred teaching models such as Karplus's learning cycle model. By allowing them the access to the information and techniques that include current and concrete problems/examples within these models, it is obvious that students' learning and awareness will increase even more. On the other hand, it is certain that using instructional technologies in planning will speed up the process, taking into account what the age of developing technology brings. In some cases, problems may arise in the environment, in such cases technology is always the closest helper.

When the effects of environmental problems were analysed in general terms, it was observed that individuals mostly talked about the reflections of environmental problems on their own lives and relatively less about their effects on other living things. From this point of view, it can be inferred that individuals have deficiencies in seeing the environment as a whole and see humans at the centre of the world. While efforts are made to raise environmental awareness in individuals, mentioning only the effects on their lives would support this naive view. In this context, one should also be able to reflect to individuals that humans occupy a small place in the world and that the world does not consist of us.

Although today's environmental problems are scientifically proven, individuals will have difficulty accepting these problems unless they can see the reflections of events in society. Therefore, the first thing to do is to help individuals improve their perception of what is happening around them, to help them recognise existing problems, and to encourage them to use problem-solving skills.

Suggestions for Science Teachers

- Teaching models should be used in the way they enable students to access scientific information on their own.
- It is important to support each environmental issue with concrete examples in order to ensure meaningful learning for students.
- While explaining environmental problems, it is necessary adopting the principle of cause-effect relationship and the examples or events given in a close-to-far teaching principle, that are, examples from the daily lives of individuals should be used first.

Suggestions for Future Research

Based on the study findings, there are some recommendations for further studies. The level of prior knowledge that may affect the results of the study can be compared with the qualitative methods for the experimental and control groups. The study could also be extended in the light of larger subjects and factors such as socioeconomic gender.

References

- Ablak, S., & Yeşiltaş, E. (2020). Secondary school students' awareness of environmental education concepts. *Review of International Geographical Education Online*, 10(3), 445–466. <https://doi.org/10.33403/rigeo.745951>
- Alozie, N. M., Moje, E. B., & Krajcik, J. S. (2010). An analysis of the supports and constraints for scientific discussion in high school project-based science. *Science Education*, 94(3), 395–427. <https://doi.org/10.1002/sce.20365>
- Altin, A., Tecer, S., Tecer, L., Altin, S., & Kahraman, B. F. (2014). Environmental awareness level of secondary school students: A case study in Balıkesir (Turkey). *Procedia - Social and Behavioral Sciences*, 141, 1208–1214. <https://doi.org/10.1016/j.sbspro.2014.05.207>
- Archer, A. L., & Hughes, C. A. (2011). *Explicit instruction: Effective and efficient teaching*. New York: The Guilford Press.
- Arık, S., & Yılmaz, M. (2020). The effect of constructivist learning approach and active learning on environmental education: A meta-analysis study. *International Electronic Journal of Environmental Education*, 10(1), 44–84. <https://dergipark.org.tr/en/pub/iejeegreen/issue/49969/605746>
- Ausubel, D. P., Novak, J. D., & Hanesian, H. (1986). *Educational psychology: a cognitive view* (2nd ed.). New York: Werbel & Peck.
- Bahar, M., & Kiris, B. (2017). General analysis of articles and theses on environmental education published in Turkey. *Abant İzzet Baysal University Journal of Faculty of Education*, 17(4), 1702–1720. <https://doi.org/10.17240/aibuefd.2017.17.32772-363962>
- Aguirre-Bielschowsky, I., Freeman, C., & Vass, E. (2011). Influences on children's environmental cognition: A comparative analysis of New Zealand and Mexico. *Environmental Education Research*, 18(1), 91–115. <https://doi.org/10.1080/13504622.2011.582093>
- Chaudhari, D. (2015). Awareness towards environment among Secondary School students. *International Journal for Research in Education*, 4(8), 15–18. https://www.raijmr.com/ijre/wp-content/uploads/2017/11/IJRE_2015_vol04_issue_08_04.pdf
- Creswell, J. W. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Sage Publications, Inc.
- Çiçek Şentürk, Ö., & Selvi, M. (2021). Science course “Human and Environment” unit academic achievement test development: Reliability and validity study. *Gazi University Journal of Gazi Education Faculty*, 41(2), 601–630. <https://dergipark.org.tr/en/download/article-file/1779635>
- Dori, Y., Hult, E., Breslow, L., & Belcher, J. (2007). How much have they retained? Making unseen concepts seen in a freshman electromagnetism course at MIT. *Journal of Science Education and Technology*, 16(4), 299–323. <https://doi.org/10.1007/s10956-007-9051-9>
- Furtak, E. M., Seidel, T., Iverson, H., & Briggs, D. C. (2012). Experimental and quasi-experimental studies of inquiry-based science teaching. *Review of Educational Research*, 82(3), 300–329. <https://doi.org/10.3102/0034654312457206>
- Hattie, J. A. C. (2009). *Visible learning: a synthesis of over 800 meta-analyses relating to achievement*. Oxon and New York: Routledge.
- Heppner, F. H., Kouttab, K. R., & Croasdale, W. (2006). Inquiry: does it favor the prepared mind?. *American Biology Teacher*, 68(7), 390–391. <https://doi.org/10.2307/4452024>
- Hoeg, D., & Bencze, L. (2014). Counter-cultural hegemony: Student teachers' experiences implementing STSE-activism. In J. Bencze & S. Alsop (Eds.), *Activist science and technology education* (pp. 575–596). Springer Dordrecht. https://doi.org/10.1007/978-94-007-4360-1_32
- Hulme, M. (2016). *Why We Aren't Understood About Climate Change*. Istanbul: Alfa Science Publishing.
- Johnson, M. A., & Lawson, A. E. (1998). What are the relative effects of reasoning ability and prior

knowledge on biology achievement in expository and inquiry classes?. *Journal of Research in Science Teaching*, 35(1), 89–103. [https://doi.org/10.1002/\(SICI\)1098-2736\(199801\)35:1<89::AID-TEA6>3.0.CO;2-J](https://doi.org/10.1002/(SICI)1098-2736(199801)35:1<89::AID-TEA6>3.0.CO;2-J)

- Jorgenson, S. N., Stephens, J. C., & White, B. (2019). Environmental education in transition: A critical review of recent research on climate change and energy education. *The Journal of Environmental Education*, 50(3), 160–171. <https://doi.org/10.1080/00958964.2019.1604478>
- Jose, S., Patrick, P. G., & Moseley, C. (2017). Experiential learning theory: The importance of outdoor classrooms in environmental education. *International Journal of Science Education*, 7(3), 269–284. <https://doi.org/10.1080/21548455.2016.1272144>
- Kanter, D. E., & Konstantopoulos, S. (2010). The impact of a project-based science curriculum on minority student achievement, attitudes, and careers: the effects of teacher content and pedagogical content knowledge and inquiry-based practices. *Science Education*, 94(5), 855–887. <https://doi.org/10.1002/sce.20391>
- Karataş, A., & Aslan, G. (2012). The role of environmental education in raising environmental awareness to primary school students [İlköğretim Öğrencilerine Çevre Bilincinin Kazandırılmasında Çevre Eğitiminin Rolü: Ekoloji Temelli Yaz Kampı Projesi Örneği]. *Journal of World of Turks*, 4(2), 259–276.
- Lins, L. D., Coelho, M. C., Lins, S. V. S., Gomes, R. da S., Melo, S. A., & Coelho, M. C. (2020). Indigenous intercultural physics teaching based on David Ausubel's meaningful learning theory. *International Journal of Advanced Engineering Research and Science*, 7(3). <http://journal-repository.theshillonga.com/index.php/ijaers/article/view/1769>
- Mahidin, A. & Maulan, S. (2010). Understanding children preferences of natural environment as a start for environmental sustainability. *Procedia – Social and Behavioral Sciences*, 38, 324–333. <https://doi.org/10.1016/j.sbspro.2012.03.354>
- Marek, E. A., & Cavallo, A. M. (1997). *The learning cycle: Elementary school science and beyond*. Portsmouth, NH: Heinemann.
- Minner, D., Levy, A. J., & Century, J. (2010). Inquiry-based science instruction—what is it and does it matter? Results from a research synthesis. *Journal of Research in Science Teaching*, 47(4), 474–496. <https://doi.org/10.1002/tea.20347>
- Mónus, F. (2022). Environmental education policy of schools and socioeconomic background affect environmental attitudes and pro-environmental behavior of secondary school students. *Environmental Education Research*, 28(2), 169–196. <https://doi.org/10.1080/13504622.2021.2023106>
- Novak, J. D. (1979). Position papers: The reception learning paradigm. *Journal of Research in Science Teaching*, 16(6), 481–488. <https://doi.org/10.1002/tea.3660160602>
- Nurhasanah, A., Ramadhanti, S., Utami, S., & Putri, F. A. (2022). Improving elementary school students' understanding of the concept through meaningful learning in David Ausubel's perspective. *Jurnal Basicedu Research & Learning in Elementary Education*, 6(4), 5728–5734. <https://doi.org/10.31004/basicedu.v6i4.2935>
- Oliver, M., McConney, A., & Woods-McConney, A. (2021). The efficacy of inquiry-based instruction in science: A comparative analysis of six countries using PISA 2015. *Research in Science Education*, 51, 595–616. <https://doi.org/10.1007/s11165-019-09901-0>
- Ors, F. (2012). Environmental education and the role of media in environmental education in Turkey. *Procedia – Social and Behavioral Sciences*, 46, 1339–1342. <https://doi.org/10.1016/j.sbspro.2012.05.298>
- Palmberg, I. E., & Kuru, J. (2000). Outdoor activities as a basis for environmental responsibility. *The Journal of Environmental Education*, 31(4), 32–36. <https://doi.org/10.1080/00958960009598649>

- Peterson, P. E. (2011). Eighth-grade students learn more through direct instruction. *Education Next*, 11(3). <https://www.educationnext.org/eighth-grade-students-learn-more-through-direct-instruction/>
- Ramnarain, U., & Schuster, D. (2014). The pedagogical orientations of South African physical sciences teachers towards inquiry or direct instructional approaches. *Research in Science Education*, 44(4), 627–650. <https://doi.org/10.1007/s11165-013-9395-5>
- Safdar, M., Hussain, A., Shah, I. & Rifat, Q. (2012). Concept maps: An instructional tool to facilitate meaningful learning. *European Journal Of Educational Research*, (1)1, 55–64. <https://doi.org/10.12973/eu-jer.1.1.55>
- Salleh, M. F. M., Zuki, N. H. M., Ismail, M. H., & Abdullah, N. (2016). Secondary school students' knowledge and awareness on environmental issues. In C. Fook, G. Sidhu, S. Narasuman, L. Fong, & S. Abdul Rahman (Eds.), *7th international conference on university learning and teaching (InCULT 2014) proceedings* (pp. 563–577). Springer, Singapore. https://doi.org/10.1007/978-981-287-664-5_44
- Secker, C. V. (2002). Effects of inquiry-based teacher practices on science excellence and equity. *Journal of Educational Research*, 95(3), 151–160. <https://doi.org/10.1080/00220670209596585>
- Şimşekli, Y. (2004). Sensitivity of elementary schools to the environmental education activities for increasing environmental knowledge. *Journal of Uludağ University Faculty of Education*, 17(1), 83–92. <https://dergipark.org.tr/tr/download/article-file/153235>
- Tretter, T. R., & Jones, M. G. (2003). Relationships between inquiry-based teaching and physical science standardized test scores. *School Science and Mathematics*, 103(7), 345–350. <https://doi.org/10.1111/j.1949-8594.2003.tb18211.x>
- Ünal, S., & Dımışkı, E. (1999). Development of environmental education under the auspices of UNESCO-UNER secondary education environmental education in Turkey. *Hacettepe University Journal of Faculty of Education*, 16(17), 144–146. <http://efdergi.hacettepe.edu.tr/yonetim/icerik/makaleler/1117-published.pdf>
- Vlassi, M., & Karaliota, A. (2013). The comparison between guided inquiry and traditional teaching method. A case study for the teaching of the structure of matter to 8th grade Greek students. *Procedia - Social and Behavioral Sciences*, 93, 494–497. <https://doi.org/10.1016/j.sbspro.2013.09.226>
- Vemula, M., & Devendar, B. (2021). A study on the environmental awareness of secondary grade students. *Natural Volatiles & Essential Oils*, 8(6), 3327–3352. <https://www.nveo.org/index.php/journal/article/view/4085>
- Yalçinkaya, E., & Çetin, O. (2018). An investigation of secondary school students' environmental attitudes and opinions about environmental education (EE). *Review of International Geographical Education Online (RIGEO)*, 8(1), 125–148, <https://files.eric.ed.gov/fulltext/EJ1180034.pdf>
- Yıldırım, A., & Şimşek, H. (2008). *Qualitative research methods in the social sciences*. Seçkin Publishing, Ankara.
- Yılmaz, O., Bedur, S., & Uysal, R. (2016). Children's opinions on environment: The case of Salda Lake. *Hayef Journal of Education*, 13(2), 59–72. <https://dergipark.org.tr/tr/pub/iuhayefd/issue/24491/259578>
- Yörük, N., Morgil, I., & Seçken, N. (2010). The effects of science, technology, society, environment (STSE) interactions on teaching chemistry. *Natural Science*, 2(12), 1417–1424. <https://doi.org/10.4236/ns.2010.212173>
- Yücel, E. Ö., & Özkan, M. (2014). Evaluation of science and technology teachers' views on ecosystem, biodiversity and environmental problems in terms of instructional design. *Milli Eğitim Dergisi*, 44(201), 165–182. <https://dergipark.org.tr/en/pub/milliegitim/issue/36164/406526>

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Determining the Validity and Reliability of Business Studies Achievement Test for Senior Secondary Schools in Nigeria

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Abstract: The study aimed at ascertaining the validity and reliability of business studies achievement test for senior secondary schools in Nigeria. The study adopted an instrumentation design. The area of the study was Anambra State. The population of the study consisted of all the 23,077 students and 586 business studies teachers in two hundred and sixty-one senior secondary schools in Anambra State. Multi-stage sampling techniques involving two stages were adopted for this study. Thus

proportionate stratified and purposive sampling techniques were employed at the first and second stages respectively. This was used to determine the sample size of the study, which was 630 made up of 393 students in senior secondary school one and 238 business studies teachers in Anambra State. The instrument Business Studies Achievement Test (BSAT) was face validated by five experts, while the content validation was carried out by using a table of specifications which consisted of content areas and behavioral objectives structured after Bloom's taxonomy of cognitive domain. To generate items for Business Studies Achievement Test, the instruments were distributed to 238 business studies teachers by the researcher and his assistants in their respective schools during the 2021/2022 session. Business Studies Achievement Test (BSAT) was used for data collection, the BSAT was a single multiple-choice objective test with an expected response of either pass (1) or fail. This helped in determining the construct validity of the instrument as well generating items for the business studies achievement test. The generated instrument was pilot tested in six secondary schools in the six educational zones in Anambra state. The developed instrument was found to be valid and reliable with an estimate of 0.96 obtained for placing students in business studies in senior secondary schools in Nigeria. Based on the findings of the study it was recommended that teachers, researchers, and relevant agencies should endeavor to establish the validity of any instrument they develop for any educational purpose to ensure the items are valid and relevant to the subject objective also instrument for educational purposes should be reliable, this will facilitate the better decision for students' placement and achievement.

Keywords: Validity Reliability, Business Studies, Achievement Test

Introduction

Business Studies is an engaging course that introduces students to the business world in order to better prepare them for the 21st century challenges (Emeasoba & Igwe, 2016). Udoeye and Ndum (2013) posited that it is the area of education that focuses on preparing students for careers in the business world on a vocational and professional level. Business studies are one of the four fields of studies in senior secondary school education which comprises the pre-vocational subjects, namely the store management, accounting, and commerce, office Practice, book-keeping, insurance which prepares students for skilled manpower or to be self-employed. To measure and evaluate a student's performance at all stages and in all areas of education, Achievement tests, and written exams, among others, are utilised. Achievement tests are the assessment tools used to gauge students' progress in the cognitive domain (Sönmez & Alacapnar, 2013). In line with Sahin et al. (2023), while it has been one of the most popular approaches to determine students' level of achievement, educational evaluation can also serve purposes such as diagnosis, formalisation, and level identification.

When creating a test, specific procedures must be followed, including the item generation and the item validation, as well as the reliability test. Content definition, test specification creation, item creation, content validation/expert review, pilot testing, data analysis, and test item revision are all aspects of item development (Ukwuije & Opara, 2012). The processes for building a test, according to Ceniza and Cereno (2012) including the test planning, the test items creation, the test validation, conducting pilot and trial tests, reliability, item analysis, and putting the final test together. It is crucial for the content validity at this point to create a table of specifications, the table of specifications can be thought of as a more detailed version of the test plan (Cetin, 2019).

To ensure the construction of a valid and reliable test to measure an item and a person ability, each of these stages must be properly carried out. In line with this Janine et al. (2022) the metrics of reliability and validity pertain to how well a method or test measures an outcome. All assessments that strive to produce a genuine estimate of a test taker's competence and support legitimate inferences like

achievement are predicated on the principle of validity (Ado et al., 2019; Hamed, 2016; Sangoseni et al., 2013; Wong et al., 2012). While reliability examines how consistent test results are, it also considers one or more potential sources of inconsistency, such as the choice of particular questions, the choice of raters, and the day and time of testing (Livingston, 2018; Fraenkel & Wallen, 2009). To achieve the objectives of education at any level within society's educational system, monitoring and maintaining the quality of educational processes and outcomes is essential. Ensuring the validity and reliability of tests is crucial in this regard (Öksüz & C enç, 2021). According to Ikpa and Longjohn (2022), a test's usability or applicability is contingent upon its feasibility in real-world scenarios. These factors encompass the availability of a similar exam, clear instructions, simplicity in test administration and scoring, ease of interpreting and utilising the test results, and overall cost-effectiveness. These intrinsic and extrinsic aspects of validity, reliability, usability, administration, and scoring are not universally guaranteed by teacher-made achievement exams.

The senior secondary schools in Nigeria have not paid enough attention to the creation of valid and reliable tests in many subject areas. It is anticipated that schools will have a sufficient number of trustworthy and accurate tests to evaluate their pupils after they have completed the curriculum's topic areas and to help them get ready for external exams. The majority of teachers are poor at creating tests for their respective subject areas (Osadebe, 2012).

Teachers would use faulty Achievement Tests to evaluate pupils after covering the Senior Secondary certificate curriculum in commerce, accounting, office practice, and insurance. Most teachers create their summative accomplishment assessments in a hurry by copying questions from any previous exam paper. The majority of these examiners, who work as teachers in junior and senior secondary schools, develop not very valid tests (Onunkwo as cited in Osadebe, 2012). The majority of examiners believe that creating test items for the lower cognitive levels (knowledge and comprehension) is simpler than for the higher cognitive levels (application, analysis, synthesis, and evaluation). The text areas in business studies for senior secondary schools (commerce, accounting, store management, office practice, insurance) are not dispersed to cover the curriculum's subject matter. Because of the reading restrictions imposed by such assessments, children perform poorly in business studies.

Teachers as a result fail to establish the validity and reliability of such tests. The use of shoddy Achievement Tests is a serious issue since it affects students' interest in and performance on the subject. Poorly prepared assessments may cause students to lose interest in a specific subject. To solve this issue, the researchers created a valid and trustworthy multiple-choice Business Studies Achievement Test that can be used in classrooms and help students to get ready for public examinations like the West African Examination Council (WACE) and National Examination Council (NECO). The created test will significantly address the demand for senior secondary schools to have a valid and reliable Achievement Test for subject areas like commerce, accounting, store management, insurance, and office practice.

Statement of the Problem

Students seem to poorly perform in the field of business studies in senior secondary school and are unable to meet the requirements to proceed to higher institutions. This problem could be linked to a wrong placement, poor instructional method, students factors among other factors, many students choosing the right school subjects—defined as those that an individual can study easily—is not a good idea. Most frequently, students' selections are influenced by how much they enjoy their instructors, which subjects their friends and parents think are the best for them, and, of course, the possibilities the school offers. Senior secondary schools in Nigeria neglect the utilization of well-developed achievement instruments. This problem when not addressed is that the society and educational institutions might be misled in determining the qualified candidates for employment and admission. The lofty objectives of

business studies in Nigerian senior secondary school will be adversely affected and might not be achieved. The need to match the academic capabilities of the students with the requirements of business studies in senior secondary schools is what led to this study on determining the validation and reliability of business studies achievement tests.

Purpose of the Study

The main aim of this study is to develop, validate and establish the reliability a business studies achievement test for senior secondary schools in Nigeria. Particularly, the research intends to:

1. Determine the validity of the business studies achievement test for senior secondary schools in Anambra State.
2. Establish the reliability of the business studies achievement test for senior secondary schools in Anambra State.

Significance of the Study

This study when published, placed in the library, presented at seminars and conferences would be beneficial to the students, secondary school administrators, teachers, and future researchers.

The use of business studies achievement test in senior secondary schools will ensure that students go into a subject area that is compatible with their interests and ability which will enhance their chances of admission into tertiary institutions, in a long run, develop the right skills and competencies needed for employability thereby contributing to the socio-economic development of the society.

The secondary school administrators responsible for managing the affairs of the schools could adopt the developed test for assessing students in the field of business studies in Nigerian senior secondary schools. Adopting this instrument would save them the stress, time, cost of developing a new instrument for assessing achievements in the field of business studies.

The study will provide teachers more valid and reliable instruments for assessing students in business studies to ensure that instructional objectives are attained. It will also save them the stress being involved in the test development and validation. The developed test could also be used for baseline, diagnostic, or formative assessment purposes, especially by those teaching poorly resourced large classes, as a locally developed test, it will be readily available to Nigerian business studies teachers.

It is also envisaged that future researchers would use the procedure used in the development of this test to develop and validate similar assessment instruments.

Scope of the Study

The study covers the determination of the validity and reliability of business studies achievement test for Senior Secondary schools. The study is delimited to generating the items for the instrument, determine the validity of the instrument, determining the reliability index of the developed instrument. The study covers all the five subjects' areas in business studies in Nigerian senior secondary school namely commerce, financial accounting, office practice, store management, and insurance. SS1 students will be used for the study because they offer the introductory themes of these subjects before they specialise in SS2 where appropriate placement is required. The geographical scope is limited to secondary schools in Anambra State.

Research Questions

The study was influenced by the following research questions.

1. What is the validity of business studies achievement test for senior secondary schools in Nigeria?
2. What is the reliability of the developed instrument for measuring students achievement in business studies in senior secondary schools in Nigeria?

Research Methodology

General Background

The research aimed to assess the validity and reliability of a business Studies achievement test designed for senior secondary schools in Nigeria. The validity and reliability are crucial psychometric properties in educational research, especially when it comes to assessing the effectiveness of educational assessments like tests and exams. This research is crucial for several reasons. It ensures fairness and equity, improves the educational assessment, enhances accountability, guides curriculum development, supports educational research, and facilitates student learning. A reliable test helped identifying students' true abilities and knowledge, regardless of individual differences. It also supported educational research and facilitated meaningful learning experiences for students. The research on determining the validity and reliability of the Business Studies achievement test served as a foundational step in ensuring the quality and effectiveness of the assessment tool. It not only benefits the students and educators directly involved but also contributes to the improvement of the education system as a whole in Nigeria.

Research Design

The study was instrumentation in nature. This type of study was aimed at determining the validity and reliability of an instrument to measure achievement and traits. Instrumentation research design is employed for test construction for measuring and evaluating human abilities, social, psychological traits. The instrumentation design was appropriate for this study because the study was aimed at developing, validating and establishing reliability of an instrument for assessing students in business studies in senior secondary schools in Anambra state.

Population of the study

The *population* of the study consisted of all the 23,077 students and 586 business studies teachers in two hundred and sixty-one senior secondary schools in Anambra State. The choice of senior secondary school one students was based on the fact that they occupied the foundational level in senior secondary school. Where all subjects were offered and they must have been exposed to introductory themes of various fields of studies offered in senior secondary school one before they specialised in senior secondary school two where appropriate achievement through test is required. Business studies teachers having taught the subjects over time will participate in generating items for the business studies achievement test. Information on the number of teachers and students were gotten from Post Primary School Service Commission, Awka as 2021/2022 academic session.

Sample

In determining the sample size of the study which was 630, Taro Yamane formula was used. It was made up of 393 students in senior secondary school one and 238 business studies teachers in Anambra State. Multi-stage sampling techniques involving two stages were adopted for this study. Thus

proportionate stratified and purposive sampling techniques were employed at the first and second stages respectively

Stage 1: a proportionate stratified sampling technique was adopted in deriving the sample from different educational zones in Anambra State. In selecting the students, the stratification was based on the already existing education zones are Aguata, Awka, Otuocha, Nnewi, Ogidi, and Onitsha. Nworgu (2015) stated that a proportionate stratified sampling technique can be used when different layers in a population must be represented.

In drawing the sample, students in senior secondary school one were drawn from each zone using a proportionate stratified sampling technique. As a result of this procedure, 60 students were drawn from Aguata educational zone, 80 students were drawn from Awka educational zone, 80 students were drawn from the Nnewi zone, 53 students were drawn from Ogidi educational zone, 68 students were drawn from Onitsha educational zone and 52 students were respectively drawn from Otuocha educational zone. **Stage 2:** Purposive sampling technique was used to selecting students from schools that have the number that falls within the calculated proportion because they operate with the same curriculum irrespective of the school. For the teachers, having determined the sample size of teachers using Taro Yamane, 238 business studies teachers were purposively selected from the state because they use the same business studies curriculum irrespective of their educational zone.

Instrument and Procedures

Procedure for Development of the Instrument. The following steps were used in developing the business studies achievement test which comprised:

- 1 The isolation of instructional content from the curriculum
- 2 The development of table of specifications
- 3 The generation of items corresponding with instructional objectives
- 4 An initial validation of the drafted test items
- 5 The item review of the test items
- 6 A final validation of the Instrument for item generation
- 7 The administering of the business studies achievement test to students
- 8 The determination of the reliability of the business studies achievement test
- 9 The final assembling.

Step I – Isolation of instructional contents from the curriculum. Students who offer business studies at the senior secondary school are expected to possess the fundamental knowledge necessary to begin a career for those who may not have the opportunity for higher education, as well as the fundamental business knowledge necessary for one's own usage both now and in the future. Identifying the contents areas such as themes, topics, covered is to avoid concentrating on a few aspects of instructional objective and neglecting others.

The accounting subject has the following themes: introduction to financial accounting, the accounting equation and double-entry principles, accounting concepts, the final accounts of a sole trader/proprietorship, provisions and reserves, manufacturing accounts, control accounts and self-balancing ledgers, single entry, and incomplete records, accounts of not-for-profit making organizations,

partnership accounts, company accounts, departmental and branch accounts, public sector accounting, information technology in accounting, miscellaneous account, financial system. office practice has the following themes: the office, departments in an organisation, office equipment, office documents, office, correspondence, mail, filing, communication, meetings, report writing, information. while themes in-store management include an introduction to store management, functions of management, retailing and wholesaling, warehousing, transportation, stock, pricing, organisational policy, and insurance has the following themes: introduction to insurances, principles of insurance, documents used in effecting contract, insurance practice, non – life insurance product, insurance market (operators), insurance regulator, common insurance terminologies. These themes were analyzed to generate items for the business studies achievement test.

Step II- Development of table of specifications. Bloom's taxonomy of the cognitive domain was adopted at this stage which included the knowledge, comprehension, application, analysis, synthesis, and evaluation. This was to ensure that the developed test adequately reflect the subject contents which emphasised on coverage of various educational objectives as recommended by Blooms as follows

Knowledge- 30%

Comprehension- 20%

Application- 20%

Analysis- 10%

Synthesis - 10%

Evaluation- 10%

Step III- Generation of items corresponding with instructional objectives. The five subject areas covered in the instrument were commerce, accounting, office practice, store management, and insurance. Consequently, 200 items were generated following the Bloom taxonomy of cognitive domain and clustered into 5 sections which were titled Draft of Business Studies AchievementTest (DBSAT). Section A dealt with 65 items derived from the themes of commerce; Section B dealt has 50 items derived from the themes of accounting; Section C dealt 35 items derived from the themes of office practice; Section D consists of 25 items derived from the themes of store management while Section E has 25 items derived from the themes of insurance. A five-point Likert scale of Very Highly Suitable (VH), Highly Suitable (H), Moderately Suitable (MS), Lowly Suitable (LS), Very Lowly suitable (VLS) was drawn against each statement to enable the business studies teachers to identify levels of the appropriateness of each item generated for the instrument.

Step IV: Initial validation of the drafted test items. The draft of the business studies achievement test was drawn with a table of specifications based on the content of business studies curriculum for senior secondary school was submitted for face and content validation to five experts; three of the experts who were secondary school teachers in Anambra State that specialised in business studies; one of the experts is in business education programme while the remaining one is an expert in measurement and evaluation from the department of educational foundations. These experts were given the purpose of the study, table of specifications, the drafted instrument, and the business studies curriculum for senior secondary school accessed for the instrument for proper wordings, question format, sequence, The Two content experts calculated the content validity index (CVI) of the BSAT to independently appraise the relevance of each item to the type of content it is intended to measure. The ratings were given on a four-point scale with Not Relevant being assigned a score of one, Somewhat Relevant two, Quite Relevant three, and Very Relevant four. In similar study, in order to gather

information for determining content and construct validity, Haleema et al. (2021) utilised two assessment techniques that asked SMEs (subject-matter experts) to rate test items on their alignment with levels of Blooms Taxonomy were used outcomes.

Step V-Item review of the test items. This involved taking a careful look at various items, corrections suggested by the experts with the consultation of the supervisor were utilised to improve the instrument.

Step VI- Final validation of the instrument for item generation. Furthermore, the instruments were distributed to 238 business studies teachers by the researchers and his assistants in their respective schools during the 2019/2020 session. The respondents were given one week to respond to the instrument. At the end of the exercise, only 221 copies of the instruments were properly filled in and retrieved from the business studies teachers. This represented 93% rate of return. The data obtained from the exercise was subjected to factor analysis to determine the construct validity of the instrument as well generate items for business studies achievement test.

Step VII-Administering the business studies achievementtest to students to determine difficulty, discriminatory distracter index (Test Try Out). The draft of the newly created instrument was tested on 393 senior secondary school one students in the selected secondary schools in Anambra State under examination conditions however only 379 students were available throughout the exercise. Therefore only the data obtained from the activities of the 379 students were used for the study. The six teachers who also served as research assistants were given a short orientation by the researcher to enable them understanding the general requirements of the study and the modalities for using the instrument to rate the students. The researcher facilitated the smooth operation of the entire exercise by supplying all the materials required for administering the BSAT. The six research assistants used the developed business studies achievement test to access the performance of the students.

The students were briefed on how to undergo the assessment, One hour thirty minutes was allotted for the test which at the stipulated time, the students were stopped. At the end of the test, the researcher assistant collected the students' response sheets. The researcher with the help of the research assistant ensured that the test was administered in a conducive environment devoid of any form of examination malpractice. It took 14 days to complete the exercise in all the selected schools. The result obtained from the students were used as data for item analysis. To choose the items and make the necessary changes/improvements, specify the setting and conditions to administer the test, and specify the points that should be changed with the test form, conducting a pre-testing after creating the item pool is important. The pre-testing, in summary, allows one to determine the test's applicability and determine how it might be enhanced (Enago, 2022).

Step XI- Determine the reliability of the business studies achievementtest. Kuder-Richardson formula 20 was used to determine an estimate of the Business Studies Achievement Test (BSAT) reliability. The internal consistency of the points received from the test simultaneously applied was examined using the KR-20. This strategy was required because the BSPT is a single multiple-choice objective test with a pass or fail expectation. A dependability estimate will be attained as a result. This will help to establish the internal consistency of the BSAT. If BSAT has high reliability of about 0.70, it would be used. High reliability seems to explain the fact that the longer a test, the higher the reliability coefficient.

Step XII- Final Assembly of BSPT. The selected items were arranged and clustered based on the five subject areas. Commerce has 41 items; accounting has 31, office practice has 20 items; store management has 18 items while insurance has 15 items.

Data Analysis

In answering the first research question, a table of specifications that highlights the numerous business studies topic categories that were taken into account in this study will be used to establish a high content validity for the business studies achievement test in line with Bloom's taxonomy of the Cognitive domain. In addition to the table of specifications, the suggestions and comments from experts in the field of business studies and Measurement and Evaluation will also be used to establish face and content validity also the content validity index will be established using the CVI formula. The ratings were given on a four-point scale with Not Relevant being assigned a score of 1, Somewhat Relevant two, Quite Relevant three, and Very Relevant four. These two raters' data were utilized to calculate the CVI using the formula. The second research question which seeks to determine the reliability of the developed instrument for placing students in business studies will be analyzed using the Kuder-Richardson formula (The KR-20) to review the internal consistency of the test items.

Research Results Research Question 1

What is the validity of the business studies achievement test for senior secondary schools in Nigeria?

Table 1

Table of Specifications Evaluating the Extent of the Content Validity of the 65 Items of BAT – Commerce

	COGNITIVE LEVEL (BEHAVIOURAL OBJECTIVE)							
	Content area	Know 30%	Comp 20%	Applica tion 20%	Analysi s 10%	Synthe sis 10%	Evaluat ion 10%	Total 100%
1	Introduction to commerce (7 %)	2	1	-	1	-	1	5
2	The barter system (5%)	1		1			1	3
3	Occupation (4%)	1	-		1	-		2
4	Production (7%)	1	1	1		1	1	5
5	Trade (7%)	1	1	1	1	1		5
6	Middle men (5%)	1	1	1	-	-	-	3
7	Warehousing (4%)	1			1			2
8	Balance of trade and balance of payment (5%)	1	1	1	-	-	-	3
9	Documents used in foreign trade (4%)	1	-	1	1	-	-	3
10	Commodity Exchange (4 %)	1	-	-	-	1		2
11	Partnership (5%)	1	1	1	-	-	1	4
12	Cooperative Societies (7 %)	1	1	1			1	4
13	Public Enterprises (8%)	2	1	1	1			5
14	Limited liabilities Companies (7%)	1	1	1	-	1	-	5
15	Trade Association (6%)	1	2	1	-	1	-	4
16	Money (7%)	1	1	1	1		1	5
17	Transportation (4%)	1	1	-	-	1	-	3
18	Communication (4%)	1		1	-	-	-	2
		20	13	13	7	6	6	65

Table 2

Table of Specifications Evaluating the Extent of the Content Validity of the 50 items of BAT – Accounting

	COGNITIVE LEVEL (BEHAVIOURAL OBJECTIVE)							
	Content Area	Know 30%	Comp 20%	Application 20%	Analysis 10%	Synthesis 10%	Evaluation 10%	Total 100%
1	Introduction to Financial Accounting (9%)	2	1	1	-	-	1	5
2	The Accounting Equation (11%)	2	1	1	1	-	-	5
3	Double Entry Principles (11%)	2	1	-	-	-	1	4
4	Accounting Concepts (12%)	2	1	2		1	1	7
5	The Final Accounts of a Sole Trader/proprietorship (14%)	2	2	1	1	1	-	7
6	Provisions and Reserves (13%)	2	1	1	1	1	1	7
7	Preparation of bank reconciliation (13%)	2	1	2	1	1	-	7
8	Control Accounts and Self-balancing Ledgers (16%)	1	2	2	1	1	1	8
		15	10	10	5	5	5	50

Table 3

Table of Specifications Evaluating the Extent of the Content Validity of the 25 items of BAT – Store Management

	COGNITIVE LEVEL (BEHAVIOURAL OBJECTIVE)							
	Content Area	Know 30%	Comp 20%	Application 20%	Analysis 10%	Synthesis 10%	Evaluation 10%	Total 100%
1	Introduction to Store Management (10%)	1	1	-	1	-	-	3
2	Functions of Management (8%)	1	1	-	-	-	-	2
3	Retailing and Wholesaling (9%)	1	-	1	-	-	-	2
4	Warehousing (13%)	1	1	1	-	-	-	3
5	Transportation (12%)	1	1	-	1	-	-	3
6	Stock Control (18%)	1	1	1	1	1	1	5
7	Pricing (16%)	1	-	1	-	-	1	4
8	Organizational Policy (14%)	1	-	1	-	1	-	3
		8	5	5	3	2	2	25

Table 4

Table of Specifications Evaluating the Extent of the Content Validity of the 25 Items of BAT – Insurance

	COGNITIVE LEVEL (BEHAVIOURAL OBJECTIVE)							
	Content Area	Know w 30%	Comp 20%	Application 20%	Analysis 10%	Synthesis 10%	Evaluation 10%	Total 100 %
1	Introduction to insurances (25%)	2	1	1	1	1	-	6
2	Principles of insurance (24%)	2	1	2	1	-	-	6
3	Documents used in effecting contract (23%)	2	1	1	-	-	2	6
4	Insurance practice (28%)	2	2	1	1	1	-	7
		8	5	5	3	2	2	25

Table 5

Table of Specifications Evaluating the Extent of the Content Validity of the 35 Items of BAT – Office Practice

	COGNITIVE LEVEL (BEHAVIOURAL OBJECTIVE)							
	Content Area	Know 30%	Comp 20%	Application 20%	Analysis 10%	Synthesis 10%	Evaluation 10%	Total 100%
1	The office (17%)	2	1	2	-	-	1	6
2	Departments in an Organization (13%)	2	1	-	1	-	-	4
3	Office Equipment (24%)	2	2	2	1	1	1	9
4	Reception (14)	2	1	1	-		1	5
5	Office documents (17%)	2	1	1	1	1	-	6
6	Office, Correspondence (15%)	1	1	1	1	1	-	5
		11	7	7	4	3	3	35

Table 6

Summary of Distribution of Items Based on Blooms Taxonomy of Cognitive Domain

S/N	Bloom taxonomy of cognitive domain	No of test items retained	No of test items discarded	% of test items retained
1	Knowledge	42	20	33.6
2	Comprehension	23	17	18.4
3	Application	26	14	20.8
4	Analysis	12	8	9.6
5	Synthesis	10	9	8
6	Evaluation	12	7	9.6
	Total	125	75	100

Table 7*Validated Items of business studies AchievementTest*

S/N	Units	No of Items	Remark
1	Commerce	41	Valid
2	Accounting	31	Valid
3	Office practice	20	Valid
4	Store management	18	Valid
5	Insurance	15	Valid
	Total	125	Valid

Table 8*Content Validity Index of Business Studies AchievementTest*

Specialist 1				
Specialist 2		Item rated 1&2	Item rated 3&4	TOTAL
	Items rated 1&2	(a) 16	(b) 32	a+ b=48
	Items rated 3&4	(c) 24	(d) 128	c+ d=152
	TOTAL	a +c= 40	b+d=160	a+b+c+d=200
	CVI			0.80

The data in the Table 1–5 shows the Table of Specifications determining the severity of the Content Validity of commerce, accounting, store management, insurance, and office practice. The data in the Table 6 revealed the content validity of the instrument. The data shows the summary of the distribution of business studies achievement test items as contained in the table of specifications following six levels of Bloom's taxonomy of cognitive domain. The data revealed that 42 items (33.6%) were assessing the level of knowledge, 23 items (18.4) were assessing the level of comprehension, 26 items (20.8%) were assessing the level of application, 12 items (9.6%) were assessing the level of analysis, 10 items (8%) were assessing the level of synthesis, and 12 items (9.6%) were assessing the level of evaluation. For the face validity, comments of five experts (three business studies teachers in Nigerian secondary schools, one business educator, and a measurement and evaluation specialist who are academics in Nigerian universities) reviewed the instrument for proper phrasing, consistency, and representativeness was used to develop the instrument. For the table 6, at the end of the exercise, 125 items across five units of business studies were found valid thereby appropriate for inclusion in the business studies achievement test. Table 8 showed the content validity index of BSAT which was derived as 0.80. This implies that 80% of items were rated quite relevant and very relevant to the component objectives. Factor analysis was employed to determine the construct validity, and an index for acceptability was judged to be a factor loading of 0.30 or above.

Research Question 2

What is the reliability of the developed instrument for measuring students achievement in business studies in senior secondary schools in Nigeria?

Table 9*Internal Consistency of Business Studies Achievement Test for Senior Secondary Schools in Nigeria*

No of Students	No of items	Σpq	$\bar{x}$	SD	SD ²	r	r%	Decision
379	153	33.8225	89.44	29.04	893.32	0.96	96	Reliable

Table 8 demonstrates a Kuder-Richardson Formula 20 estimate of the business studies Achievement Test (BSAT) reliability. This method was required because the BSAT is a single objective multiple-choice exam with a pass or fail response being the expected outcome; as a result, a reliability estimate of 0.96 was obtained. This made it easier to prove that BSAT was internally consistent. This outcome demonstrates the excellent reliability of BSAT.

Discussion of Findings

The validity of business studies Achievement test for senior secondary schools in Nigeria

The findings on the validity of the business studies achievement test for senior secondary schools in Nigeria showed that 125 items were found to be valid and appropriate for inclusion in the business studies achievement test. These findings are in line with the works of Osadebe and Nwabeze (2018) who opined that the validity was a crucial psychometric characteristic in the creation of instruments. According to Umanah (2016) when an instrument is subjected to face, content, and construct validation, the instrument will naturally show a significant ability to fulfill the predictive validity requirements. The face validation involves a panel of experts in the field as well as measurement and evaluation taking a meticulous look at the instrument for proper wordings, consistency, and representativeness. The content validity refers to the area that an instrument covers or meets the instructional objective of the subject, it involves where a table of specifications is used to distribute items across the various level of the domain under consideration. In this study, first, the use of a table of the specification was employed, the 125 items were distributed following the six levels of Bloom taxonomy of cognitive domain. Accordingly, 42 items (33.6%) were assessing the level of knowledge, 23 items (18.4) were assessing the level of comprehension, 26 items (20.8%) were assessing the level of application, 12 items (9.6%) were assessing the level of analysis, 10 items (8%) were assessing the level of synthesis, and 12 items (9.6%) were assessing the level of evaluation. The items were presented to five experts (three business studies teachers in Nigerian secondary schools, one business educator, and an expert in measurement and evaluation who is a lecturer in Nigerian universities), who looked at the instrument for proper wording, consistency, and representativeness in order to improve it. This was the second strategy that was used. This approach is similar to Osiobe (2012). The construct validity requires rigorous mathematical exercises. However, Nworgu (2015) suggested the use of factor analysis to establish the construct validity. Ombugus (2013) and Umanah (2016) both utilised factor analysis in their study. Though there is no definite acceptable level of the factor loading, it's a rule of thumb that the higher the factor loading the better. In this study, a factor analysis was used to establish the construct validity and a factor loading of 0.30 and above was considered as an index for acceptance. At the end of the exercise, 125 items across five units of business studies were found valid thereby appropriate for inclusion in the business studies achievement test. To Kaigama (2022) establishing test validity is important for teachers and students because it allows them making sure that the subject matter being examined is thoroughly covered. It also gives them information that will be beneficial in developing habits of validating tests used to measure learners' achievement so they can be discriminated against based on their abilities while also being able to predict future results.

The reliability of business studies achievement test for senior secondary schools in Anambra State

The findings on the reliability of business studies achievement test for senior secondary schools in Nigeria indicated that the developed instrument (BSAT) yielded a reliability estimate of 0.96 using Kuder- Richardson formula 20. This approach became necessary because BSPT is was a single multiple-choice objective test with an expected response of either pass (1) or fail (0), this finding is consistent with the work of Hakkı and Görgülü (2022), they developed a cell achievement test and achieved a reliability coefficient of 0.89. Cumali et al. (2021), in their own study, reported a reliability coefficient of 0.81, which they deemed to be significant for their test. Osadebe and Nwabeze (2018) found that the Physics Aptitude Test (PAT) instrument exhibited a higher reliability of 0.94, surpassing the aforementioned reported coefficients. Additionally, Mamolo (2021) conducted a study involving the development of an Achievement Test to Measure Students' Competency in General Mathematics. The KR-20 reliability coefficient of this test was estimated to be 0.84. Similarly, in a study by Baruah and

Gogoi (2022), the reliability of the half test was found to be 0.76, and the reliability coefficient of the entire test, calculated using Spearman's Brown Prophecy formula, was 0.86. Consequently, the test's reliability and validity were determined to be quite satisfactory. This indicated that there was a great level of consistency among the different findings on the reliability of an instrument.

Conclusions and Implications

In conclusion, the researchers' devised business studies Achievement exam is a test with strong psychometric qualities. As a result, the test might be utilised as an assessment tool for determining the degree of achievement of secondary school students who are enrolled in business courses in their senior secondary schools. The BSAT was shown to be a viable assessment tool with a high level of internal consistency and a small standard error of measurement. One of the findings revealed that the developed instrument was found to be valid for measuring students achievement in business studies in senior secondary schools in Nigeria. The implication of this is that the secondary school management will now have a valid and reliable instrument to test students ability and appropriately advice them on their potential to succeed in the field of business studies. Thus the developed instrument will be used to decide students that inappropriately fit in the field of business studies. Also, the finding of the study revealed that the developed instrument was found to be highly reliable for measuring students in business studies in senior secondary schools in Nigeria. This implies that the results produced with this instrument to a great extent are consistent and can be replicated. The validity and reliability of this achievement instrument will help formulating better assessments in order to achieve educational goals. This study implied that the curriculum planning of business studies in Nigerian senior secondary schools should be organised to accommodate only students with capability and interest for the field of business studies. This will help in achieving the set goals and objectives of the programme.

Recommendations

Based on the findings of the study, it is recommended that

1. Relevant educational agencies, teachers, researchers should endeavor to establish the validity of any instrument they develop for any educational purpose to ensure the items that are valid and relevant to the subject objective.
2. Relevant educational agencies, teachers, researchers should ensure that the instrument they develop for educational purposes is reliable, this will facilitate the better decision for placement, achievement of students.

Limitations of the Study

The study on the validity and reliability of a business studies achievement test in senior secondary schools in Nigeria is a valuable endeavor, but like any research, it may have certain limitations, while the study may provide insights into the validity and reliability of the business studies achievement test in Nigerian senior secondary schools, the findings may not be applicable to other contexts or educational levels like the junior secondary schools, tertiary institutions among others. The study's timeline and resources limited the depth and the scope of the research. Despite these limitations, conducting a study on the validity and reliability of the test is crucial for improving the assessment tools used in education. The researchers acknowledged these limitations and made efforts to mitigate their impact on the study's findings and conclusions.

Suggestions for Future Research

The following suggestions are made for further Studies

1. The creation and validation of a valid instrument for evaluating pupils' practical abilities in business studies for business studies.
2. A similar study should be conducted for placing students in business education programme in Nigerian Tertiary institutions.
3. The study can be replicated using confirmatory factor analysis, Angoff method, test-retest method of establishing reliability.

References

- Ado, A. B., Rohaya, T., Noor, A. A, Halijah, I., & Sanitah, M. Y. (2019). Validation of a developed university placement test using classical test theory and Rasch measurement approach. *International Journal of Advanced and Applied Sciences*, 6(6), 22–29. <https://doi.org/10.21833/ijaas.2019.06.004>
- Baruah, P., & Gogoi, M. (2022). A construction and standardization of a concept achievement test in mathematics for class-VIII students. *Child Studies in Asia-Pacific Context (CSAC)*, 12(1), 184–191. <https://www.e-csac.org/index.php/journal/article/view/39>
- Ceniza, J. C., & Cereno, D. C. (2012). *Development of mathematic diagnostic test for DORSHS*. Scribd. https://www.scribd.com/document/179110384/Development-of-Mathematics-Diagnostic-Tests?language_settings_changed=English
- Çetin, B. (2019). Test geliştirme. In B. Çetin (Ed.), *Eğitimde ölçme ve değerlendirme [Measurement and assessment in education]* (pp. 105–126). Anı Publishing.
- Cumali, O. Galip, G and Makele, B. (2021) Development of A 4th grade achievement test about perimeter measures: Validity and reliability study. *Journal of Innovative Research in Teacher Education*, 2(2), 79–114. <https://doi.org/10.29329/jirte.2021.372.1>
- Eneasoba, N. C., & Igwe, J. N. (2016). Business studies teachers' perception of effective strategies for teaching business studies in promoting national sustainable development. *Journal of Emerging Trends in Educational Research and Policy Studies*, 7(3), 217–225. <https://hdl.handle.net/10520/EJC196813>
- Enago. (2022, April 29). *Why is a pilot study important in research?*. <https://www.enago.com/academy/pilot-study-defines-a-good-research-design/>

- Fraenkel, J. R., & Wallen, N. E. (2009). *How to design evaluate research in education* (7th ed.). McGraw-Hills.
- Hakki, C., & Görgülü, A. A. (2022). Development and validation of an achievement test in biology. *Journal of Social Sciences and Education*, 5(1), 64–75. <https://doi.org/10.53047/josse.1102697>
- Haleema, B., Muhammad, S., & Shaista, I. (2021) Development of valid and reliable mathematics achievement test. *Elementary Education Online*, 20(2) 1642–1658. <https://ilkogretim-online.org/fulltext/218-1642962934.pdf>
- Hamed, T. (2016, August 10). *Validity and reliability of the research instrument; How to test the validation of a questionnaire/survey in a research*. SSRN. <https://dx.doi.org/10.2139/ssrn.3205040>
- Ikpa, A. I., & Longjohn, I. (2022). Development and validation of financial accounting cognitive achievement test for senior secondary schools in Rivers State. *International Journal of Innovative Psychology & Social Development*, 10(4), 39–48. <https://seahipaj.org/journals-ci/dec-2022/IJIPSD/full/IJIPSD-D-4-2022.pdf>
- Janine, A. C., Idsøe, E., & Størksen, I. (2022). Screening for potential, assessing for achievement: A study of instrument validity for early identification of high academic potential in Norway. *Scandinavian Journal of Educational Research*, 67(4), 574–590. <https://doi.org/10.1080/00313831.2022.2042735>
- Kaigama, D. E. (2022). Assessment of teachers' attitude towards validation of non-standardized achievement test in secondary schools in Borno State, Nigeria. *Education Journal*, 11(4), 200–207.
- Livingston, S. A. (2018). *Test reliability — Basic concepts* [Research memorandum No. RM-18-01]. Princeton, NJ: Educational Testing Service.
- Mamolo, L. A. (2021). Development of an achievement test to measure students' competency in general mathematics. *Anatolian Journal of Education*, 6(1), 79–90. <https://doi.org/10.29333/aje.2021.616a>
- Nworgu, B. G. (2015). *Educational research: Basic issues and methodology*. University Trust Publishers.
- Öksüz, C., & Genç, G. (2021). Validity and reliability study of the geometric shapes achievement test for 4th grade. *Inonu University Journal of the Faculty of Education*, 22(3), 2232–2258. <https://doi.org/10.17679/inuefd.879853>
- Ombugus, D. A. (2013). *Development and validation of workshop-based process skill tests in mechanical engineering craft for assessing students in technical colleges in Nassarawa State, Nigeria*. [Unpublished PhD dissertation]. University of Nigeria.
- Osadebe, P. U. (2012). *Procedures for construction, validation and standardization of test* [Seminar paper]. Delta State University.
- Osadebe, U. P., & Nwabeze, P. C. (2018). Construction and validation of physics aptitude test as an assessment tool for senior secondary school students. *International Journal of Assessment Tools in Education*, 5 (3), 461–473. <https://doi.org/10.21449/ijate.442406>
- Osiobe, G. A. (2012). *Construction and Standardization of Geography Objective Test for Senior Secondary Schools in Delta State* [Unpublished PhD dissertation]. Delta State University.

- Şahin, M. G., Yıldırım, Y. And Boztunç Ö. N. (2023). Examining the achievement test development process in the educational studies. *Participatory Educational Research*, 10(1), 251–274. <https://doi.org/10.17275/per.23.14.10.1>
- Sangoseni, O., Hellman, M., Hill, C. (2013). Development and validation of a questionnaire to assess the effect of online learning on behaviors, attitude, and clinical practices of physical therapists in the United States regarding evidence-based practice. *The Internet Journal of Allied Health Sciences and Practice*, 11(2), Article 7. <https://nsuworks.nova.edu/ijahsp/vol11/iss2/7/>
- Sönmez, V., & Alacapınar, F. G. (2013). *Örneklendirilmiş bilimsel araştırma yöntemleri* (2nd ed.). Anı Yayıncılık.
- Udoeye, N. R., & Ndum, V. E. (2013). Reinvigorating business teacher education towards self-reliance in Nigeria. *International Letters of Social and Humanistic Sciences*, 3(9), 130–139. <https://www.scipress.com/ILSHS.19.130>
- Ukwuije, R. P. I., & Opera, M. I. (2012). *Test and measurement for teachers*. Chadik Press.
- Umanah, R. A. (2016). *Development and validation of an instrument for assessing basic electronic process skills in senior secondary schools in Lagos Nigeria* [Unpublished PhD dissertations]. University of Nigeria.
- Wong, K.-L., Ong, S. F., & Kuek, T. Y. (2012). Constructing a survey questionnaire to collect data on service quality of business academics. *European Journal of Social Science* 29(2), 209–221. <http://eprints.utar.edu.my/860/1/6343.pdf>

APPENDIX

A VALID AND RELIABLE BUSINESS STUDIES ACHIEVEMENT TEST FOR SENIOR SECONDARY SCHOOLS

Name of the Student.....
 Gender.....
 School.....
 Class.....

Instruction: attempt all questions

Time: 1hr:30 minutes

- What among the following constitutes the elements of commerce
 (I) Trading and advertising
 (II) warehousing and transportation
 (III) packaging and branding
 (IV) Insurance and Banking
 (a) I and II (b) I and III (c) I, II and IV (d) II, III and IV
- The central focus of commerce is.....(a) distribution (b) buying and selling (c) exchange (d) trade
- The sustainable expansion of commerce is mostly a result of (a) marketing (b) advertising (c) exchange (d) branding
- One of the most crucial elements that influences the decision to choose a occupation is (a) skill (b) training (c) interest (d) education
- Which of the following sets has middlemen at all (a) Manufacturers, consumers, and retailers (b) Wholesalers, retailers, and agents (c) Retailers, manufacturers and wholesalers (d) Wholesalers, agents, and consumers
- The role of a wholesaler in the channel of distribution is to..... (a) develop products in huge amounts and sell them in small quantities (b) purchase products directly from manufacturers (c)

- purchase products in large quantities (d) resell them to consumers
7. the method of manufacturing that combines two or more raw components to produce a single finished good is (a) conditioning (b) blending (c) merging (d) synthesis
 8. Reward for land is (a) capital (b) revenue (c) rent (d) interest
 9. A country that offers tourism can be said to be involved in (a) visible exports (b) invisible exports (c) tangible imports (d) intangible imports
 10. The term PLC implies that the shares are (a) made public on the stock exchange (b) made public in a commercial bank (c) privately on the stock exchange (d) available to the public at the company
 11. The following documents are available for public sale: (a) an invoice (b) an open indent (c) a prospectus (d) a closed indent.
 12. A private limited liability business differs from a public one in that the former (a) cannot offer shares to the public (b) cannot declare and pay a dividend (c) has more shareholders (d) pays its manager higher wages.
 13. Unpaid import duties-related goods are maintained in the following warehouses: (a) ordinary warehouse (b) public warehouse (c) private warehouse (d) bonded warehouse.
 14. The major types of warehouse are (a) manufacturer, bonded, departmental and private (b) bonded, public, cold room and private (c) wholesaler, manufacturer, public and bonded (d) manufacturer, bonded, public, and departmental
 15. What number of the following cooperative societies provides both direct and indirect credit facilities?? (a) cooperative and thrift society (b) Retail cooperative society (c) Consumer cooperative society (d) Wholesalers cooperative society
 16. A major benefit of a cooperative society is that it (a) gives members the chance to make money (b) brings members closer to the government (c) develops member awareness (d) and (e) promotes member thrift.
 17. The traditional way of paying cooperative dividend is to distribute profit in proportion to members' (a) subscriptions (b) total savings (c) volume of purchases (d) total savings
 18. Freight note is a document (a) used by a government to transport goods from one country to another (b) issued by a shipping company giving details of charges (c) used for payment of imported goods (d) given by an importer to pay for goods at a future period
 19. If an importer wants a freehand to obtain goods from any manufacturer, he needs to provide (a) A consular invoice (b) a closed indent (c) an open indent (d) a freight note
 20. The document that indicates obligation that is transferable by delivery and endorsement is a (a) bill of lading (b) bill of exchange (c) documentary evidence (d) negotiable instrument
 21. The exchange of gifts of goods and services of a specified value is called (a) balanced reciprocity (b) exchange (c) barter (d) generalized reciprocity
 22. Chambers of commerce is not restricted to a particular industry while trade association consists of (a) Highly regulated government agencies (b) Members engaged in same trade (c) Made up of members that are Registered (d) Made of firms in the banking industry
 23. The major functions of a trade association is that it (a) Liaises with foreign trade association (b) Helps to promote foreign trade (c) Facilitates members access to credit facilities (d) Helps to promote research on behalf of members
 24. The main objective of trade association is to (a) protect its members against litigation (b) boost the trade of its members (c) secure credit for its members (d) protect its members against victimization
 25. The concept that refers to the sale, transfer or exchange of goods and services is (a) industry (b) trade (c) tariff (d) marketing
 26. In international trade, exchanging goods for other goods and services purchased instead of paying in foreign currency is known as (a) countertrade (b) balance of trade (c) balance of payments (d) terms of trade.
 27. Foreign trade also involves (a) providing services for other countries (b) specialization and the exchange of goods in a country (c) buying and selling within a country (d) the exchange of goods and services between firms
 28. A limitation to international trade is (a) trade imbalance between countries (b) availability of local market (c) quantity of labour (d) cost of finance
 29. The overriding advantage of home trade over foreign trade is (a) accessibility of seller to buyer (b) absence of many documents (c) ease in language of transaction (d) ease in form of payment
 30. The two main forms of communication are (a) oral and written (b) verbal and non-verbal (c) e-mail

and fax (d) traditional and modern media

31. The major aim of establishing a public corporation is to (a) establish monopoly (b) provide essential services (c) provide employment opportunities (D) encourage specialization

32. The federal government made efforts at rendering public enterprises more efficient and profit – oriented thorough the process of (a) privatization (b) commercialization (c) indigenization (d) nationalization

33. Public enterprises are owned by: (a) government (b) joint stock company (c) private entrepreneur's (d) multinational corporations

34. Which of the following is not a form of organization of public sector enterprises? (a) departmental undertaking (b) government company (c) statutory corporation (d) sole proprietorship

35. A Corporation established under a special law of parliament is (a) public enterprise. (b) departmental undertaking. (c) government company (d) joint sector.

36. Money is generally acceptable for transactions due to (a) the legal backing (b) the rule of law (c) its acceptability in the global market (d) the central bank governors' signature

37. Which is of the following is a quality of money (a) availability (b) Indivisibility (c) General acceptability (d) Convertibility

38. A form of money with face value which is greater than value of the metal content is..... (a) legal tender (b) bank notes (c) token money (d) commodity money

39. Which is the following is not an advantage of partnership (a) Diversified managerial talents (b) Greater financial resources (c) freedom to terminate business (d) Account is not more public

40. Which is the following is not contained in a deed of partnership (a) Names and addresses of partners (b) Ratio for sharing profits and losses (c) investment of each partner (d) Rate of taxation

41. Partnership are most suitable where (a) the partners are family friends (b) professional are involved (c) members can easily raise enough capital

42. The maximum number of persons who are legally allowed to operate in a partnership is (a) 2 (b) 20 (c) there is no legal limit (d) 100

43. Which of the following is not an advantage of warehousing (a) matching supply with demand better (b) increase lead times through product travelling longer distances to consumers (c) consolidate product in distribution center (d) provide value added processing through delayed different distribution

44. Goods discharged from ships on which import duties have not been paid are kept in the (a) Ordinary warehouse (b) public warehouse (c) private warehouse (d) bonded warehouse

45. An effective accounting system should provide information (a) for customer feedback and requirement (b) on new products and method (c) for promoters, directors, labor unions and distributors (d) on internal and external reporting for managers and third party.

46. The rule of accounting equation requires that account payable should be placed under (a) Liabilities (b) equities (c) assets (d) capital

47. The accounting equation can be expressed as (a) $N1000 + N500 + N1500 = N3000$ (b) $N1000 - N500 + N1500 = N2000$ (c) $N1000 + N500 = N1500$ (d) $N1500 + N500 = N2000$

48. To which class of account would you post each of the following amounts receipt from sale of goods (a) capital (b) income (c) asset (d) Expense

49. To which class of account would you post each of the following amounts (ii) Receipt of capital from the owner of the business (a) Capital (b) Income (c) Asset (d) Expense

Use the information below to answer

July 1- started business with N10, 000

July 31- paid Agrotech N6000 owing them

50. The double entry for July 31 would be

- (a) debit Agrotech and credit cash
- (b) debit equipment and credit Agrotech
- (c) credit capital and debit cash
- (d) credit cash and debit purchases

51. The concept which states that revenue should be recognized at the point when the sale is deemed to have been made is (a) matching (b) consistency (c) going concern (d) realization

52. The basis upon which assets of an organization is valued is the..... concept (A) historical (b) business entity (c) periodicity (d) materiality

53. Which of the following accounting conventions suggests that accountants should use a method of valuation that understates rather than overstates results? (a) conservatism (b) historical (c) monetary (d) cost
54. Stationery which will be used over a long period of time is usually recorded as an expense instead of an asset. This concept is called (a) entity (b) realization (c) accrual (d) materiality
55. Assigning revenues to the accounting period in which goods are sold or services rendered and expenses incurred is known as (a) matching concepts (b) consistency convention (c) adjusting for revenue (D) passing of entries
56. Micheal is a retailer. He recorded sales representing 95% cash and 5% credit. He took the total cash sales of N19000 from the business tray and banked it, the credit sales for the period would be (a) N5000 (b) N1900 (c) N1000 (d) N950
57. The transaction in number 66 would be recorded in the cash book as debit (a) cash and credit bank (b) bank and credit bank (c) cash and credit cash (d) bank and credit bank
- Use the information below to answer question 58 and 59

	N
Sales	232, 000
Opening stock	28, 000
Purchases	128, 000
Carriage inwards	4000
Carriage outwards	6000
Closing stock	10, 000
Discount received	18, 000
Expenses	20, 000

58. Calculate the gross profit (a) N100, 000 (B) N 86, 000 (C) N 76, 000 (D) N82, 000
59. Calculate the expenses debited to the profit and loss account (a) N 17, 000 (b) N 23, 000 (c) N30, 000 (d) N 26, 000
60. Jude mistakenly entered N 7, 000 as credit sales in Abba's account instead of Baba account. This is (a) an error of principles (b) an error of commission (c) a compensating error (d) an error of omission
61. The major focus of the trading account is to show (A) net profit (b) gross margin (c) total purchases (d) total sales
62. Provision for discount allowed can be recorded as a debit to (a) the profit and loss account and a credit to provision for discount allowed (b) provision for discount allowed and a credit to the profit and loss account (c) discount allowed and a credit to the profit and loss account (D) expenses and a credit to customers account
63. An amount or percentage deducted from the normal selling price of something is..... (a) profit (b) discount (c) depreciation (d) accounting
- Use the information below to answer questions below 64 and 65
- A machine bought for N35, 000 was estimated to have a life span of 5 years with a scrap value of N9000
64. If the scrap value is presently N15, 000 what will be the yearly depreciation using the straight line method (a) N 4000 (b) N 7,000(c) N 11, 000 (d) N 24, 000
- Use the information below to answer questions below
- | | |
|------------------------|-----------|
| Sundry debtor | N 20, 000 |
| Provision for bad debt | N 500 |
- Provision for bad debt at 4% of sundry debtors
65. Determine the provision for bad debts to profit and loss account (a) N 500 (b) N 820 (c) N 1300 (d) N 300
66. Calculate the provision to be taken to the balance sheet (a) N 780 (b) N 800 (c) N 1200 (d) N 200
67. The depreciation on motor vehicle that is being used for manufacturing and administration is charged to the (a) debit side of manufacturing and profit and loss account (b) debit side of profit and loss only (c) credit side of profit and loss account only (D) debit side of manufacturing and balance sheet
68. The process of reconciling cheque between banks is termed cheque (a) truncation (b) clearing (c) holding (d) confirmation
69. An item credited in the bank statement but yet to be recorded in the firms' cashbook is (a) bank loan (b) contract payment (c) standing order (d) direct deposit
70. In a bank reconciliation statement, interest charged for overdrawn balances should be added to the

- (a) balance as per bank statement (b) bank balance as per adjusted cash book (b) aggregate balance as per cash book (d) bank balance as per cash book
71. Given that the balance as per cash book after adjustment was N6315, unpresented cheques N1000 and the bank statement balance N3240. What was the balance of the uncredited cheques (a) N4075 (b) N4240 (c) N3315 (d) N3075
72. A debtors' control account includes which of the following? (a) Accounts payable (b) Total of the sales journal (c) Detailed entry for each debtor (d) General ledger entries
73. Where are the details behind the control account values captured? (a) On the general ledger (b) In a subsidiary ledger (c) In a spreadsheet (d) They are not required; simply add totals to the control account
74. The control account is also known as
I Total account
II. Adjustment account
III. Suspense account
IV. Self-balancing ledger
(a) I and II (b) I and III (c) II and III (d) I and IV
75. Which of the following is in a creditors control accounts? (a) Cash purchases (b) Credit sales (c) Credit purchase (d) Cash Sales
76. _____ is general ledger accounts containing summary of all debtors and creditors' balances
(a) Convention Books (b) Journal Accounts (c) Control Accounts (d) Subsidiary Accounts
77. Outgoing mail should be (a) recorded in the register (b) recorded in the dispatch book (c) left unread (d) all of the above
78. The information sent out from one organization is called (a) outward mails (b) outgoing mails (c) internal mails (d) return outwards
79. The mail sent from one department to another within the some organization is called (a) incoming mail (b) outgoing mail (c) internal mail (d) none of the above
80. The document showing the data of all the staff in an organization is called (A) nominal roll (b) pay roll (c) catalogue (d) voucher
81. The document that shows records of discussion or events and proceedings that took place in particular meeting is called (a) minutes (b) motion (c) bye-laws (d) report
- 82 A receipt is a legal evidence of (a) payment (b) supply (c) profit recorded (d) loss recorded
83. _____ is used to communicate with individuals outside of the office. (a) Business Letter (b) Memo (c) Business Report (d) Invoice
84. To present a professional image of the company a receptionist should: (a) Have pointless and casual conversations about the weather with all visitors. (b) Point out to visitors any shortcomings in their dress style (c) Leave confidential paperwork lying on the reception desk where everyone can see it. (d) Be calm and polite at all times, and deal with all of their enquiries in a professional and courteous manner
85. The receptionist handles the following documents except (a) diary (b) vouchers (c) visitors book (d) visitors slip
86. A receptionist should have a good memory for names and faces, so they can;
(a) Remember regular visitors and thereby offer them a quicker and more personal service
(b) Use computer equipment more effectively.
(c) Write letters more professionally.
(d) Learn to use new office equipment
87. A visitor wants to park their car in the company car park, what is appropriate thing to be done by the security man? (a) Make some polite conversation about their car (b) Point blank refuse, and tell them to park elsewhere. (c) If there is a space, issue them a car park pass (d) Tell them there are no spaces available, even when there are.
88. A dictating machine is normally used to.....message (a) record. (b) delete (c) type (d) decode
89. John wants to destroy a document that he wants no one to see, which office machine would he use? (a) dictating machine (b) computer (c) type writer (d) shredding machine
90. Which equipment is used to store files safely? (a) Computer (b) file equipment (c) photocopier (d) file cabinet
91. Three departments in office organization includes _____, _____ & _____ (a) control of stock,

- purchase department, staff training department (b) trade, cooperative , revenue department (c) control of stock, personnel department, account department (d) account department, purchase department and personnel department
92. The sales department (a) markets the products of the department (b) takes the stock of the company (d) plans and executes all production works (d) lays down company plan of business
93. The department that controls and directs the affairs of an organization is..... department (a) account (b) administrative (c) sales (c) planning
94. The department in an organization that performs the function of preparing of vouchers and payment of salaries and wages of staff is..... department (a) Account (b) personnel (c) marketing (d) administrative
95. Office layout is concerned with (a) open office (b) efficient utilization of available space in the office (c) essential furniture in the office (d) closed office
96. All offices perform a variety of (a) communications (b) functions (c) fractions (d) dictions
97. Another name for private office is (a) office layout (b) close office (c) office sub-division (d) open office
98. In organizing a store, the storekeeper must consider (a) cost paid for goods.(b) The nature of goods (c) value of goods (d) Obsolescence of goods.
99. Which of the following documents will be needed when goods are received in the store? (a). debit note. (b) Credit note (c) consignment note (d) delivery note
100. Which of the following is not important in store layout arrangement? (a) proper layout (b)proper lighting(c) adequate security(d) adequate staffing
101. A warehouse owned and controlled by an independent business firm is called (a) bonded warehouse (b) private warehouse (c) public warehouse(d) company warehouse
102. In receiving goods, the warehouse must (a) Inspect goods if required (b) Check for damage (c) Check the goods against on order and the bill of lading (d) All of above
103. A document which authorizes the issue of materials for use is (a) record requisition (b) materials requisition (c) bill requisition (d) maintenance
104. The purpose of taking inventory is to (a) ensure the store is not empty (b). keep the storekeeper busy (c) ensure regular flow of production activities (d) facilitate efficient use of funds
- 105 Which of the following is not an inventory? (a) machines (b) raw material (c)finished products (d) consumable tools
106. Which of the following is true for Inventory control? (a) Economic order quantity has minimum total cost per order (b) Inventory carrying costs increases with the quantity per order (c) ordering cost decreases with lo size (d)All of the above
107. _____ includes all the activities involved in selling products or services directly to final consumers for their personal, nonbusiness use. (a) brokering (b) franchising (c) wholesaling (d) retailing
108. The means that helps people to travel from one place to another are called mode of (a) protocol (b)organization © management (d) transport
109. Which of the following has a major influence on pricing decisions? (a) Customer demand (b) Actions of competitors (c) Costs (d) Political, legal and image-related issues
110. A legal maximum price at which a good can be sold is a price (a) floor (b) stabilization (c) support (d) ceiling
111. The market price of a share of common stock is determined by.....: (a) The board of directors of the firm (b) The stock exchange in which the stocked is listed (c) The president of the company (d) Individual buying and selling the stock
112. In marketing terms, _____ refers to what we get for what we pay: (a) revenue (b) cost (c) value (d) product
113. An organization general expression of its overall purpose is known as its (a) Objective (b) Vision (c) Goal (d) Mission
114. Organization is a process of..... (a) identifying and grouping of work to be performed (b) defining and delegating the responsibility and authority (c) both 'A' and 'B' (d) none of the above
115. The person who undertakes life assurance is said to be (a) assurer (b) insurer (c) insured (d) assured
116. The difference between indemnity insurance and non-indemnity insurance is that the latter provides..... (a) cover for exporters against risks (b) cover for importers against risks (c) full payment to the insured (d) consolation payment to the insured

117. Insurance companies operate on the principle of indemnity. This means that an insured person or firm collects (a) double the value of loss suffered (b) only half of loss suffered (c) the total sum of the premiums paid prior to the loss

Use the below to answer question 118 and 119

Name	Insured Amount (N)	Actual Value (N)	Actual loss (N)
Amobi	25, 000	100, 000	30, 000
Ray	30, 000	120, 000	40, 000
Micheal	40, 000	150, 000	50, 000

118. If Mr Amobi takes a fire insurance policy with average clause, his compensation will be (a) N 70, 000 (b) N75, 000 (c) N5, 000 (d) N 7, 000

119. What insurance principle has Mr Micheal violated if he decides to overstate the actual value of his property (a) uberrimae fidei (b) subrogation (c) indemnity (d) insurable interest

120. The right of an insurance company to stand in place of an insured against a third party, who is liable for the occurrence of a loss, is the principle of (a) proximate cause (b) insurable interest (c) insurance priority (d) subrogation

121. The temporary insurance certificate issued to the insured before drawing up a policy is a (a) testimonial (b) cover note (c) time policy (d) proposal form

122. Which of the following are essential features of a valid simple contract? (a) Offer and acceptance only (b) Offer, acceptance and duress (c) Offer, acceptance, privity, certainty and duress only (d) Offer, acceptance, consideration, intention to create legal relations and certainty of terms

123. The two main categories under which marine loss falls into are (a) total loss and partial loss (b) voyage policy loss and time policy loss (c) particular loss and average loss (d) actual loss and general loss

124. Endowment policy in insurance business is an aspect of (A) accident insurance policy (b) fidelity guarantee insurance policy (c) motor vehicle insurance policy (d) life assurance policy

125. The compensation that insured gets depends heavily on the (A) economic situation (b) premium paid (c) risk suffered (d) insurers buoyancy

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Resolving Misconception Challenges in the Teaching and Learning of Computer Science Amongst First-Year Undergraduate Students

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Abstract: Misconceptions in the field of computer science can lead to confusion and loss of confidence for students. These misconceptions are based on students' concepts that are not scientifically accurate interpretations. One of the major reasons why students find certain computing and scientific concepts so tough to acquire is because they suffer an inequality or gap between their early classification of a concept and the new learning framework. Resolving misconception challenges in the teaching and learning of sciences is not new because according to the past studies, it is believed to manifest throughout the life of individuals where students are greatly involved when it comes to teaching and learning sciences. The study aims to resolve and correct students' misconceptions using a practical approach and its impact on students' gender differences. To address these misconceptions, an experimental design study was conducted in order to examine the effects of practical approach correcting misconceptions among students in computing. The study compared students' scores on Pre-Test and Post-Test, comparing their perceptions of computing and the effectiveness of practical methods to address them. The population of the study consisted of all undergraduate students in higher education institutions in Lagos State. Through the use of random sampling method, 75 undergraduate students from Lagos State University of Education were selected. The instrument was subjected to reliability index after it was validated by experts in computing. An index of .887 results showed significant highly reliable instrument. The results of findings established significant differences between the pre-and post-test scores, but only a slight difference between male and female scores observed. The study recommends that students should be given the opportunity to investigate and test their own

findings of computer science components and software functions in order to build a deeper understanding without preconceptions from their prior experiences.

Keywords: Computer science, Learning, Misconceptions, Practical activities, Teaching.

Introduction

The misconception has been researched and addressed in depth by a number of scientists working in the field of scientific education. First the term "misconception" should be identified. An individual experiences misconception throughout their entire life and it interferes with learning and frequently makes people dislike science subjects (Rose et al., 2023). The concept of the topic "sciences" is in an abstract form, which may cause misunderstandings or finally cause pupils to lose trust in the actual knowledge the teacher is trying to pass to them. The early identification of misconceptions can encourage interest in the subject and promote self-assurance in the learner. Since science is a subject that is correlated with many other subjects, the identification and treatment of problems are crucial for the science teacher (Patil et al., 2019). The word "Misconception" is complicated in description and has been conceptualised by researchers at various educational levels and geographical places as substitute conceptions, predeterminations, different ideas, conceptual uncertain blocks, mistaken concepts, and alternative scoff folds in various situations. Due to a variety of circumstances, including cultural context, individual characteristics, teaching-learning processes, students' personal experiences, etc., identifying misconceptions can be difficult (Chavan & Khandagale, 2022). Concepts with strange interpretations and meanings in students' non-scientifically accurate articulations are referred to as misconceptions.

To some scholars, the "scientific community sees the word "conceptions" from the different views held by them " are referred to as misconceptions and alternative conceptions (Ajayi, 2017; Schmidt et al., 2020). All pupils hold misconceptions due to their earlier knowledge. Alternative conceptions among students can prevent new learning, which causes issues for instructors. Therefore, teachers are essential in assisting pupils in building new knowledge on top of any preexisting foundations (Schmidt et al., 2020). According to the current theories that have been established by studies conducted over the previous three decades, students often enter postsecondary institutions having pre-conceptual beliefs that are not always validated by present scientific theories. One might contend that during the tertiary-level teaching and learning activities, pre-instructional notions that conflict with modern scientific concepts can be easily eradicated. However, educators have a dilemma if these ideas are strongly held and it is difficult to change them, because the construction of these beliefs allowed pupils effectively navigating their way through earlier cognitive hurdles.

To this end, studies conducted all across the world revealed that students often have beliefs or notions that are at odds with what scientists and researchers know about the world in which we live. Now that is known, these false beliefs are frequently referred to as misconceptions, preconceptions, naive beliefs, alternative beliefs, or alternative frameworks. As a result, misunderstandings can also be referred to as preconceived notions, unscientific views, simple theories, confused conceptions or false conceptions, and competing concepts. Students throughout their life have these naive notions. According to Thomson et al. (2019), children's perspectives and meanings can significantly differ from those of scientists. Their interpretation of science topics differs, which causes confusion in their thoughts. The literal definition of a misperception is a false belief. Misconceptions, inaccurate views, and incorrect and premature understanding exist in all age groups of students and people worldwide. Misconceptions are erroneous beliefs that students form that differs from scientifically recognised concepts (Rose et al., 2023). These beliefs, often known as naive or alternate perceptions, are particularly resistant to modification. According to Inuwa and Varo (2019), misinformation can have a

significant impact on someone's career. An example of a misperception is the belief that software engineers can troubleshoot personal computing difficulties. Furthermore, Qian et al. (2019) discovered a distinction between the thoughtless mistakes everybody is making and misconceptions regarding scientific principles and methods. Students absorb concepts and, on occasion, misconceptions. Rose et al. (2023) explored some computer science myths and misconceptions. Their research addressed and aimed to dispel these myths in order to give prospective computer science students and the general

public a more realistic understanding of the field. According to Firat (2017), developing students' conceptions of technology beginning in elementary school is a fundamental approach to promoting technology literacy in society. Identifying and correcting students' misunderstandings is an essential skill for a computer science teacher (Qian & James, 2017).

Theoretical frameworks

Two frameworks are offered in this study. They aim to explain misunderstandings, so these frameworks are selected based on their relevancies to how a learner interacts with naïve information, to also explain the reason and the way in which misconceptions emerge or hinder knowledge creation. A learning theory called constructivism places a strong emphasis on how learners actively construct their own ideas. Instead of merely taking in information, students actively reflect on their experiences, make mental images, and add new information to their schemas. The constructivism encourages in-depth learning and comprehension (McLeod, 2023) while Concept Formation (CF) is an inductive teaching strategy that helps students form a clear understanding of a concept (or idea) through studying a small set of examples of the concept (Parker, 2023) or Concept Formation can be seen as the process by which a person learns to sort specific experiences into general rules or classes (Hunt, n.d.).

Constructivism

According to the constructivism, which is concerned with viewing human knowledge as a process in which individuals attempt making sense of their environment, students do not learn from scratch, nor do they learn as a result of knowledge that is simply transferred to them via an external source. Since prior beliefs are crucial to the learning process, depending solely on rote learning may result in misconceptions. Incoherent knowledge construction can lead to misconceptions, which can impede further cognitive growth. Under this constructivist framework, in the paper examine both domain-generalist and domain-specific theories were examined. The constructivist theory argues that people acquire knowledge and form meaning based on their experiences and the need for learner autonomy in the classroom (Sarbah, 2020; Mandaar & Vijayakumar, 2020). The constructivism is an important learning theory that educators employ to help students acquire knowledge, which is based on the concept that individuals actively construct or create their own knowledge and that their learning experiences determine the nature of reality. Learners use their prior knowledge as a foundation and build upon it as they acquire new information. The teacher acts as a guide in the learning process; therefore, constructivism supports student-centred learning. In a constructivist classroom, learning is viewed as constructed, active, reflective, collaborative, inquiry-based, and evolving. The psychological theory of constructivism originates from the rapidly expanding field of cognitive science, primarily from the constructivist perspectives of Jean Piaget, the socio-historical work of Lev Vygotsky, and the constructivist account of discovery learning by Jerome Bruner (Chand, 2023). When new knowledge is integrated into the learner's pre-existing knowledge structures, meaningful learning takes place (Ausubel et al., 1968). If a learner can't incorporate new knowledge into their previous knowledge structures, it compartmentalises and can't be effectively utilised, which could lead to misconceptions. Ausubel defines this as "verbatim, arbitrary, non-substantive incorporation of new ideas into cognitive structure" (Cakir, 2008). The rote learning is frequently the cause of the discrepancy between new

information and existing knowledge structures. Piaget asserts that learners employ mental patterns to speed up learning and comprehension, which is similar to Ausubel's position. To interpret new information, these preexisting patterns are utilised. Students experience disequilibrium when their preexisting knowledge patterns are unable to account for new information, and the "mental balance" needs to be restored. Until equilibrium is established, the learner will either create a new pattern of thought or alter an existing one (Cakir, 2008). Therefore, assimilation refers to making slight adjustments to an established thought pattern, whereas accommodation refers to fundamentally reorganising established patterns. As a result, "incorrect" inculcation or housing usually leads to misunderstandings. To explain the above with an example, a novice may simply conclude that, based on their understanding of intake, exhalation must also be an active process involving muscles since they do not understand how air pressure inside the lungs interacts with atmospheric pressure. Alternately, individuals can create a new mental model to convince themselves that exhalation is the result of the diaphragm "forcing" air out of the lungs in their attempt to understand the role of "pressure" in breathing out. In both situations, the learner develops a misunderstanding as a result of their inability to put cohesive information together, possibly as a result of their past knowledge that breathing may be understood as an active process. On the other hand, domain-specific theorists (conceptual change) contend that misconceptions develop as a result of pupils, for whatever reason, failing to go through the essential conceptual change process to accept current scientific knowledge. When pupils are exposed to counter-intuitive concepts, conceptual change refers to the process of moving away from naive assumptions (Vosniadou & Verschaffel, 2004). It entails rearranging preexisting concepts to support current knowledge supported by evidence. Although this theory is founded on Kuhn's idea of a paradigm shift, it significantly differs from the domain generalist viewpoint. According to Kuhn's (2012) theory, scientists adhere to a set of common assumptions, commitments, and practices. Certain notions can no longer be used to explain anomalies as new information is known. A paradigm shift is a process whereby scientists may need to create new notions. This idea is used by theorists in this discipline to describe the procedure when a student must swap out and rearrange key ideas because the old ones are no longer sufficient to explain particular scientific findings. Unlike Piaget, this process is seen as the need to reorganise mental structures to place information based on controlled data, rather than a core cognitive communication of the learner seeking to achieve equilibrium based on prior knowledge (Larsson & Halldén, 2010).

There are several theories that explain why misconceptions develop in domain-specific fields using conceptual change theory. For instance, researchers claim that some scientific concepts are challenging for students to understand because their existing understanding may be based on antiquated paradigms or frameworks that conflict with more modern, scientifically accepted paradigms (Sarbah, 2020; Mandaar & Vijayakumar, 2020; Chand, 2023). These simplistic frameworks are hard to alter because they give students a somewhat cogent explanation for some scientific occurrences and are frequently reinforced by real-world events. Typically, students don't recognise these errors in reasoning and just add new information to their preexisting cognitive frameworks, which leads to erroneous conclusions. Therefore, a profound and ontological category shift is necessary for the acquisition of scientific conceptions (Vosniadou & Verschaffel, 2004). The lack of critical thinking, knowledge fragmentation, a lack of transfer, poor instruction, and, most importantly, misconceptions that contradict the most current scientific results are frequently to blame for the learning problems that many students encounter when learning scientific material. Because their first worldview provides a "relatively coherent system of explanation" that is based on actual experience and years of confirmation, students have a difficult time modifying this framework. Teachers who work with multicultural students should be aware that some students still follow traditions that may be at odds with current scientific knowledge.

Due to the ontological transformations, they must make in order to categorise things, students may end up with competing beliefs between their past and new knowledge (Miller, 2022). Students find it difficult to grasp several scientific and computing concepts because their initial classification of a subject and the new learning context don't match. The incompatibility hypothesis is the name given to this idea of mismatch (Miller, 2022). Consider "Flash drive" and "Hard disc" as examples. Based on textbook illustrations, students can classify these topics as "Memory" of a computer system. The student must constantly switch between two conceptual categories in order to understand them as long as prior knowledge and new information are incompatible. It can be challenging to overcome naive notions by education or confrontation if new concepts are incompatible with an underlying assumption. Hence, the constructivism can build individual and social knowledge, it contributes a positive impact on educational progress to improve students' abilities because constructivism opens the learner's curiosity about something new (Suhendi & Purwarno, 2018). These beliefs remain across age groups, educational levels, and individual pupils, resulting in consistent misconceptions among students across historical periods.

Concept formation

This theoretical framework, which is concerned with the concept development, is related to the negotiation of new knowledge. One can trace the origins of views on concept formation to the philosophers Kant, Locke, and Mill, who contended that a concept is a cognitive unit with meaning. The definition of a concept as a "unit of knowledge" so includes mental symbols as well as abstract ideas. A more modern perspective to examine the function of threshold ideas is that concepts are mental representations that can be interpreted as either mental images or word-like symbols in a "language of thought", it is also important to understand concepts not as mental and neutral representations but as different and related perspectives that unfold through specific ways of speaking and thinking in a horizon of positioned meanings (Guzmán et al., 2022; Bakanauskas et al., 2020). Languages are mirror images of one another, concepts can be thought of as actual objects that relate to and are comprehended by symbols or words. An act from teacher or students can be used to represent abstract concepts. As a result, an abstract notion is not always an image or mental representation in the mind, but rather an abstraction of a formal concept derived from the activity it performs. As a result, one could argue that if medical students experience issues during the concept formation process (for example, having their mental models simplified based on two-dimensional illustrations in textbooks or having difficulty creating abstract concepts from their mental models), they may be experiencing concept formation problems. The language may also be crucial in this sense (Brun et al., 2023). The student could get a misperception if they lack the scientific and computing vocabulary needed to establish the concept. Based on the above background, this study sheds light on the applicability and importance of clearing up misconceptions in computer science instruction (Munck, 2023).

Research Problem

From observations in past studies, students often enter post-secondary institutions having pre-instructional beliefs that are not always validated by current scientific theories. One might contend that during the tertiary-level teaching and learning activities, pre-instructional notions that conflict with modern scientific concepts can be easily eradicated. However, higher learning educators have the challenge to alter these pre-instructional notions in line with current and more acceptable concepts and meanings. A series of approaches have been tested in the past to resolve misconceptions in sciences most especially in computer science. Therefore, this study uses a practical approach, which is believed to actively involve students' participation, to correct any misconceptions in computer science.

Research Focus

Past studies have established that misconceptions are commonly observed among students in sciences, engineering, and social sciences. Therefore, this study focused on the use of a practical approach to correct students' misconceptions in computer science. It also found out whether the gender difference among students has any significant implication on students' misconceptions.

Research Aim

This study specifically aimed to investigate ways to get rid of misconceptions in the teaching and learning of sciences, notably computer science. It also considered how to address or dispel the observed myths using a pragmatic approach. In essence, it examines whether student gender differences can affect trends in misconceptions.

Research Questions

The following research questions guide the study:

1. Is there any statistically significant mean difference between the Pre- and Post-Test scores of students in correcting some misconceptions in computing concepts?
2. Is there any statistically significant mean difference between male and female students' scores after exposing students to practicals as an approach to correct some misconceptions in computing concepts?

Research Hypotheses

The research hypotheses to be tested in this study comprised:

H1) There is no statistically significant mean difference between the Pre- and Post-Test scores of students in correcting some misconceptions in computing concepts; and

H2) There is no statistically significant mean difference between male and female students' scores after exposing students to practicals as an approach to correct some misconceptions in computing concepts.

Research Methodology

General Background

In order to examine the effects of practical activities in correcting misconceptions relating to computing fields among students in two distinct contexts (Pre-Test and Post-Test), experimental design technique was used in the study. The study compared the students' scores on the Pre-Test and Post-Test. The Pre-Test was used to gauge the extent of the students' computing misunderstandings, and the Post-Test was used to gauge the impact of using a practical approach to address the misconceptions after exposing the students to appropriate practicals. The population of the study was made up of all undergraduate students in higher education institutions in Lagos State.

Sample / Participants / Group

The study used a random sampling technique to select 75 undergraduate students at Lagos State University of Education. The term "sampling technique" means the process of selecting a sample of observations from a population in order to draw conclusions about the population; additionally known as probability sampling. Therefore, 25 students each were sampled from the department of computer

science, department of Library and information science, and the department of technology education randomly to remove being biased.

Instrument and Procedures

The instrument - Achievement Practical Assessment Test called "APAT"- consisted of two stages: A and B. Students' personal data, including the gender, class, and age, was requested in section A, while questions about hardware and software were included in section B to clear up any misconceptions about the concept. Each question was designed to address a specific flaw in the errors that students have been making for years. The duplicates of the instrument were used on two separate occasions, one before and one after the intervention or treatment. The instrument's contents were evaluated by computer science specialists for construct validity and content validity, and then the same instrument underwent face validity validation with a subset of the targeted students. Before the test was given, the instrument's final version contained all the corrections and observations. The test-retest methodology was used to determine the instrument's reliability, and 20 copies of the instrument were given to students who were not part of the study's sample but nonetheless members of the population. The findings were split into two groups for statistical analysis to determine the reliability coefficient. A good and high dependability instrument was indicated by the reliability index of 0.887.

Data Analysis

The acquired data were compiled and analysed using the T-Test statistical analysis through the use of tables and charts for the student demographic data as well as to test the formulated hypotheses raised for the study using the statistical package for the social sciences (SPSS).

Research Results

The research results are presented below:

Table1

Participants College

	Frequency	Per cent	Cumulative Percent
College of Information and Technology Education	39	52.0	52.0
College of Science Education	36	48.0	100.0
Total	75	100.0	

Source: author's own development.

Table 1 lists the participants' colleges within the institution. As is evident, a total of 75 students participated in the study, including 39 from the College of Information and Technology Education and 36 from the College of Science Education.

Table2

Gender of the Participants

	Frequency	Per cent	Cumulative Percent
Male	40	53.3	53.3
Female	35	46.7	100.0
Total	75	100.0	

Source: author's own development.

The gender disparity among the participants is shown in Table 2. It discloses that a total of 75 students, including 35 female and 40 male students, participated in the study.

Table3

Educational Level of the Participants

	Frequency	Per cent	Cumulative Percent
100 Level Students	37	49.3	49.3
200 Level Students	38	50.7	100.0
Total	75	100.0	

Source: author's own development.

Table 3 shows that 38 students from the 200-level participated, while 37 students from the 100 level did not. This suggests that both levels should have an equal sample size to prevent bias.

Table4

Paired Samples Statistics

		Mean	N	Std. Deviation
Pair 1	Pre-Test Scores	30.6933	75	10.49321
	Post-Test Scores	88.1200	75	9.21215

Source: author's own development.

Table5

Paired Samples T-test

	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Pair 1 Pre-Test Scores - Post-Test Scores	-57.42667	14.49713	-34.305	74	.000

Source: author's own development.

A paired-sample t-test was conducted in order to evaluate the significant mean difference between the Pre-Test and Post-Test scores of students in correcting some misconceptions in computing concepts. There was a statistically significant increase in students' scores from the Pre-Test scores ($M=40.17$, $SD=10.49$) to Post-Test scores [$M=88.12$, $SD=9.21$, $t(74) = -34.305$, $p < .0005$] of students. The eta squared statistic (.94) indicated a large effect size.

Table6*Group Statistics*

	Gender Group	N	Mean	Std. Deviation
Post-Test Gender Scores	Male Post-Test Scores	40	87.0000	9.79272
	Female Post-Test Scores	35	89.4000	8.45820

Source: author's own development.

Table7*Independent Samples Test*

		F	Sig.	t	df	Sig. (2-tailed)
Post-Test Gender Scores	Equal variances assumed	2.648	.108	-1.128	73	.263

Source: author's own development.

An independent-samples t-test was conducted to compare the students' practical scores for males and females to correct some misconceptions in computing concepts. There was no significant difference in scores for males ($M=87.00$, $SD=9.79$) and females [$M=89.40$, $SD=8.46$; $t(73) = -1.128$, $p=.263$]. The magnitude of the differences in the means was very small ($\eta^2=.0169$).

Discussion

Trying to give the answer the first research question: "Is there any statistically significant mean difference between the Pre- and Post-Test scores of students in correcting some misconceptions in computing concepts? the results showed statistically significant mean difference between the pre-test and post-test scores. This means that the empirical method is good for correcting misconceptions in sciences. This assertion is buttressed by what Marsh and Eliseev (2019) said since students frequently make mistakes while learning, one essential objective of education research is to identify the best methods for correcting these mistakes. The author used empirical methods for studying error correction, describes data to show what is most effective, and provides guidance for teachers on how to correct students' mistakes. On the contrary, the second research question says "Is there any statistically significant mean difference between male and female students' scores after exposing students to practicals as an approach to correct some misconceptions in computing concepts?" Was not significant. It implies that gender issue is not a factor to measure misconceptions of students towards learning computing or sciences. The study of Ajai and Imoko (2015) in assessing gender differences in mathematics achievement and retention by using Problem-Based Learning (PBL). The study revealed that male and female students taught algebra using PBL did not significantly differ in achievement and retention scores, thereby revealing that male and female students are capable of competing and collaborating in mathematics. In addition, this finding showed that performance is a function of orientation, not gender. Oribhabor (2020) examined the influence of gender on academic achievement in Mathematics among senior secondary school students in Bayelsa State. The result of the analysis revealed that there is a significant difference in the Mathematics achievement of the male and female students in favour of the males. Also, Adigun et al. (2015) studied the relationship between student's

gender and academic performance in computer science in New Bussa, Borgu local government of Niger state. The results of the study showed that male students did not perform better than females' counterparts except with slight differences.

In testing the formulated hypotheses, and with a t-value of -34.305 and a p-value of .0005, the results from Tables 4 and 5 demonstrate that there was a statistically significant rise in students' scores from the Pre-Test scores ($M=40.17$, $SD=10.49$) to the Post-Test levels ($M=88.12$, $SD=9.21$). In order to determine the effects of the differences, the eta squared statistic was used; the value of .94 indicates a significant effect size; implying that in two cases there were significant differences between the pre-test and post-test results. This implies that students' misconceptions were corrected and their level of understanding improved, which was reflected in their performance in the post-test score - eta squared statistic of .94 proved this. The Pre-test scores were used to know the level of students' misconceptions in various areas of computer science. The results were in consonance with past studies using different approaches like interviews, focus groups and other methods. Their previous knowledge and the current knowledge gap may be responsible for the stark disparity. Because of this, Qian and Lehman (2019) recommended that computer science instructors be aware of their students' misconceptions and ready to assist them in developing a thorough understanding of computing principles. Okorochoa et al. (2010) added that if kids are not provided with accurate information, they would become grossly deformed. The phrase "Information is power" lends credence to this viewpoint since when people lack knowledge, they become distorted. Marsh and Eliseev (2019) used a similar approach to identify and correct the misconceptions.

With a t-value of -1.128 and a p-value $>.05$ indicating its non-significant level of scores, Tables 6 and 7 demonstrated that there was no significant difference in the scores for males ($M=87.00$, $SD=9.79$) and females ($M=89.40$, $SD=8.46$). In order to determine the effects of the differences, the eta squared statistic was used; the value of .0169 indicated a very modest effect size; implying that the scores of men and women were just marginally different. According to the results no statistically significant difference was found. It suggests that the preconceptions about computing that the teacher needs to dispel using realistic or other effective strategies are present in both male and female students (Adigun et al., 2015; Oribhabor, 2020).

Conclusions and Implications

The study provided important insights into how misconceptions in computer science can impede the creation of coherent knowledge and possibly provide obstacles when students are expected to complete challenging cognitive tasks like scientific reasoning. The study also explored and made an effort to debunk a number of widespread myths and misconceptions that people, including students, tend to believe. Because researchers can delve deeper during them, especially in an interview, interviews and other instruments may reveal more details regarding the nature and causes of each misunderstanding. Contrarily, a wider range of misunderstandings can be dispelled through practical work since it prompts students to question their previous knowledge beliefs when they conflict with new ones.

Research Limitations

The number of participants in the study and the number of computer systems available to correct misconceptions were insufficient, limiting the generalisability of the study's findings. Additionally, there was insufficient monitoring of the students to ensure that they carried out their assigned tasks. Hence, given that this study was carried out in a classroom setting, there were numerous instances of some students seeking to dominate their peers while receiving practical guidance.

Research Recommendations

It is therefore recommended that students need to get a deeper understanding free from the misconceptions from their prior experiences, they must be given the opportunity to investigate and test their own findings of the computer science pieces and software operations as well as their boundaries. Teachers should address common misunderstandings about various areas of computing by learning more about their history and preparing for when they come up in the lab or classroom and since conceptual change does not happen immediately, teachers should be encouraged to review prevalent misconceptions.

Suggestions for Future Research

This study suggests that other studies employ the hypothesis testing using alternative approaches and dig deeper into misconceptions outside of computing. Misconceptions cut across various fields of learning from sciences to engineering to social science and even languages, so it is suggested that similar studies should be extended to the aforementioned fields of study. This study concentrates on the use of a practical approach to correct misconceptions. It is also suggested that further studies should use an integrated approach to carry out similar studies, by combining two methods together to achieve better results. It is recommended in future research studies, that researchers should increase the number of participants for easy generalisation of the findings. Critical attention must be paid to where the practical will take place, the resources available for the practicals and human resources for effective and efficient conduction of the practicals. Hence, attention must be channeled to issues of some students trying to dominate other students while practical activities are going on in the laboratories. A week or two must be set aside to brainstorm with students and staff regarding the use and ethics of the use of laboratory gadgets and equipment. It is vital to investigate through research and hypothesis testing how misconceptions can be corrected using different approaches apart from the above-mentioned methods.

References

- Adigun, J., Onihunwa, J., Irunokhai, E., Sada, Y., & Adesina, O. (2015). Effect of gender on students' academic performance in computer studies in secondary schools in New Bussa, Borgu Local Government of Niger State. *Journal of Education and Practice*, 6(33), 1-7. <https://files.eric.ed.gov/fulltext/EJ1083613.pdf>
- Ajai, J. T., & Imoko, I. I. (2015). Gender differences in mathematics achievement and retention scores: A case of problem-based learning method. *International Journal of Research in Education and Science*, 1(1), 45-50. <https://ijres.net/index.php/ijres/article/view/16>
- Ajayi, V. (2017). *Misconceptions*. Benue State University. https://www.researchgate.net/publication/320172303_Misconceptions
- Ausubel, D. P., Novak, J. D., & Hanesian, H. (1968). *Educational psychology: A cognitive view*. Holt, Rinehart and Winston.
- Bakanauskas, A., Kondrotienė, E., & Puksas, A. (2020). The theoretical aspects of attitude formation factors and their impact on health behaviour. *Management of Organizations: Systematic Research*, 83(1), 15-36. <https://doi.org/10.1515/mosr-2020-0002>
- Brun, G., Herfeld, C., & Reuter, K. (2023). Introduction to the topical collection: Concept formation in the natural and social sciences: empirical and normative aspects. *Synthese*, 201(3), Article 89. <https://doi.org/10.1007/s11229-023-04094-6>

- Cakir, M. (2008). Constructivist approaches to learning in science and their implications for science pedagogy: A literature review. *International Journal of Environmental & Science Education*, 3(4), 193–206. <https://files.eric.ed.gov/fulltext/EJ894860.pdf>
- Chand, S. (2023). Exploring the contributions of Piaget, Vygotsky, and Bruner. *International Journal of Science and Research*, 12(7), 274–278. <https://doi.org/10.21275/SR23630021800>
- Chavan, R., & Khandagale, V. (2022). Intricacies in identification of biological misconceptions. *Scholarly Research Journal for Interdisciplinary Studies*, 9(70), 16810–16819. <https://files.eric.ed.gov/fulltext/ED619540.pdf>
- Firat, M. (2017). Growing misconception of technology: Investigation of elementary students' recognition of and reasoning about technological artifacts. *International Journal of Technology and Design Education*, 27(2), 183–199. <https://doi.org/10.1007/s10798-015-9351-y>
- Guzmán, V. F., González-Palta, I., & Larrain, A. S. (2022). Concept formation. In V. P. Glăveanu (Ed.), *The Palgrave encyclopedia of the possible* (pp. 224–231). Palgrave Macmillan. https://doi.org/10.1007/978-3-030-90913-0_197
- Hunt, E. B. (n.d.). Concept formation. In *Encyclopedia Britannica*. Retrieved August 17, 2023, from <https://www.britannica.com/topic/concept-formation>
- Inuwa, M. I., & Varo, A. (2019, November 6–7). *The intensity of misconception in software engineering* [Conference paper]. 2019 1st international informatics and software engineering conference (UBMYK), Ankara, Turkey. <https://doi.org/10.1109/UBMYK48245.2019.8965596>
- Kuhn, T. (2012). *The structure of scientific revolutions*. University of Chicago Press.
- Larsson, Å., & Halldén, O. (2010). A structural view on the emergence of a conception: Conceptual change as the radical reconstruction of contexts. *Science Education*, 94(4), 640–664. <https://doi.org/10.1002/sce.20377>
- Mandaar, P. S. & Vijayakumar, B. (2020). Theoretical foundations of design thinking – A constructivism learning approach to design thinking. *Thinking Skills and Creativity*, 36, Article 100637. <https://doi.org/10.1016/j.tsc.2020.100637>
- Marsh, E., & Eliseev, E. (2019). Correcting student errors and misconceptions. In J. Dunlosky & K. Rawson (Eds.), *The Cambridge handbook of cognition and education* (pp. 437–459). Cambridge University Press. <https://doi.org/10.1017/9781108235631.018>
- Mcleod, S. (2023, June 15). *Constructivism learning theory & philosophy of education*. SimplyPsychology. <https://www.simplypsychology.org/constructivism.html>
- Miller, J. T. M. (2022). *Hyperintensionality and ontological categories*. *Erkenntnis*. <https://doi.org/10.1007/s10670-022-00646-3>
- Munck, G. L. (2023). *Democratic theory and concept formation: Ideals and realistic standards*. SSRN. <http://dx.doi.org/10.2139/ssrn.4365181>
- Okorochoa, K. A., Nwokonkwo, O. C., Kalu, O., & Iroegbu, A. N. (2010). Myths and misconceptions in the use of the terms – ICT and IT. *Proceedings of annual conference of IRDI research and development network*, 5(6).
- Oribhabor, C. (2020). The influence of gender on mathematics achievement of secondary school

students in Bayelsa State. *African Journal of Studies in Education*, 14(2), 196–206.

- Parker, W. (2023). *Concept formation*. Teachinghistory.org. <https://teachinghistory.org/teaching-materials/teaching-guides/25184>
- Patil, S. J., Chavan, R. L., & Khandagale, V. S. (2019). Identification of misconceptions in science: Tools, techniques & skills for teachers. *Aarhat Multidisciplinary International Education Research Journal (AMIERJ)*, 8(2), 466–472.
- Qian, Y., & James, L. (2017). Students misconceptions and other difficulties in introductory programming: A literature review. *ACM Transactions on Computing Education*, 18(1), Article 1. <https://doi.org/10.1145/3077618>
- Qian, Y., & Lehman, J. D. (2019). Using targeted feedback to address common student misconceptions in introductory programming: A data-driven approach. *SAGE Open*, 9(4). <https://doi.org/10.1177/2158244019885136>
- Qian, Y., Hambrusch, S., Yadav, A., Gretter, S., & Li, Y. (2019). Teachers' perceptions of student misconceptions in introductory programming. *Journal of Educational Computing Research* 58(2), 364–397. <https://doi.org/10.1177/0735633119845413>
- Rose, S., Kazuyo, M., Constancia, V. M., & Aoife, M. D. (2023). Misconceptions, misinformation, and misperceptions: A case for removing the “mis-” when discussing contraceptive beliefs. *Studies in Family Planning*, 54(1), 309–321. <https://doi.org/10.1111/sifp.12232>
- Sarbah, B. K. (2020). *Constructivism learning approaches*. <https://doi.org/10.13140/RG.2.2.28138.34241>
- Schmidt, T., Cloete, A., Davids, A., Makola, L., Zondi, N., & Jantjies, M. (2020). Myths, misconceptions, othering and stigmatizing responses to Covid-19 in South Africa: A rapid qualitative assessment. *PLOS ONE*, 15(12), Article e0244420. <https://doi.org/10.1371/journal.pone.0244420>
- Suhendi, A., & Purwarno, P. (2018). Constructivist learning theory: The contribution to foreign language learning and teaching. *KnE Social Sciences*, 3(4), 87–95. <https://doi.org/10.18502/kss.v3i4.1921>
- Thomson, M., & Zakaria, Z., & Radut-Taciu, R. (2019). Perceptions of scientists and stereotypes through the eyes of young school children. *Education Research International*, 2019, Article 6324704. <https://doi.org/10.1155/2019/6324704>
- Vosniadou, S., & Verschaffel, L. (2004). The conceptual change approach to mathematics learning and teaching. *Learning and Instruction*, 14(5), 445–548. <https://www.sciencedirect.com/journal/learning-and-instruction/vol/14/issue/5>

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Evaluation of the Effectiveness of the "Mathematica Application" in Examining and Graphing Quadratic Functions

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Abstract: The aim of this paper was to evaluate the effectiveness of the "Mathematica Application" in examining and graphically presenting quadratic functions. This study has the potential to improve teaching and to help choose the most effective tools for examining and presenting quadratic functions. The purpose of this research was to evaluate the effectiveness of the "Mathematica Application" in examining and graphing quadratic functions. The method used to evaluate the effectiveness of the "Mathematica Application" was a combination of qualitative and quantitative analysis. In the qualitative analysis, the students' experience with the Mathematica application in examining quadratic functions and presenting them graphically was examined. The users were music school students who have used the application in order to study quadratic functions in the context of learning mathematics. Also, the quantitative analysis was used to analyse the performance of the Mathematica application in the graphical representation of quadratic functions. The sample of the study is represented by students of the tenth grade, where it is a purposive sample, since these learning units are covered in this class. The results of this evaluation are important to the community of mathematicians and users of the Mathematica application. The findings of the study show a positive assessment by the students on the efficiency and performance of the Mathematica application in examining and graphing quadratic

functions. These findings provide implications for improving teaching and establishing the Mathematica application as a suitable tool for studying quadratic functions in the context of mathematics education. By incorporating the Mathematica application into the teaching and learning process of mathematics, students' interaction and understanding of this important mathematical topic can be increased.

Keywords: Application, effectiveness, graphic presentation, Mathematica, quadratic functions, students.

Introduction

Computer applications have become an integral part of many fields of study and work today. In the field of mathematics and education, they provide powerful tools to analyse represent and review mathematical functions (Aydın, 2005). One of these outstanding computer applications is the "Mathematica Application", developed by Wolfram Research. Mathematica is a specialised mathematics and programming environment that can be used to solve a wide range of mathematical problems and create graphical representations of functions. In recent years, the integration of technology, especially computers, into the teaching and learning of mathematics has gained considerable attention in education systems around the world. The use of computers has shown a great potential able to improve the learning experiences of students at various school levels. Theoretical and empirical evidence suggests that technology-integrated tools can create a more dynamic and interactive learning environment, promoting a deeper understanding of mathematical concepts and fostering students' critical thinking and problem-solving skills (Haleem et al., 2022). One of the main advantages of using computers in mathematics education is the ability to provide visual representations and simulations. Graphics tools, dynamic geometry software, and mathematical modelling applications allow students to visualize abstract mathematical concepts, such as quadratic functions, in a tangible and meaningful way. This visual approach helps students understand complex ideas more easily and enables them to explore different scenarios, making learning math more engaging and enjoyable (Velázquez & Méndez, 2021).

This paper aimed to evaluate the effectiveness of the "Mathematica Application" in examining and graphically presenting quadratic functions. Quadratic functions are important in mathematics and the applied sciences, and graphing them is a key tool for understanding their characteristics and patterns.

This study has the potential to improve future teaching and help choose the most effective tools to examine and present quadratic functions. By incorporating the Mathematica application into the process of teaching and learning mathematics, students' interaction and understanding of this important mathematical topic can be increased.

Research Problem

Until now, the examination and graphing of quadratic functions have been accomplished mainly by traditional methods, including the use of hand-drawn graphs, mathematical tables, or some other analogous tool (Nielsen, 2015). This can have limitations in how quadratic functions can be examined and understood more interactively and visually. The problem is that in the absence of a specialised and powerful environment, in the presented experience as teachers it seems difficult to present the graphs of quadratic functions in a clear and understandable way for some students and teachers of mathematics. This can affect the inclusion and deep understanding of the concepts of quadratic functions and their applications.

Research Focus

To solve this problem, “Mathematica Application” as a potential tool to examine and graph quadratic functions was identified. However, there has not yet been a detailed evaluation of the effectiveness and performance of this application in the context of quadratic functions. So, the need to evaluate the “Mathematica Application” in examining and graphing quadratic functions is essential to understand how effective and suitable this computing environment is in fulfilling these goals. The identification and solution of this problem would enable the use of a modern and specialized tool to help in the learning and understanding of quadratic functions, thus improving the performance and experience of students and professors in teaching mathematics.

Research Aim and Research Questions

The purpose of this research was to evaluate the effectiveness of the "Mathematica Application" in examining and graphing quadratic functions. In order to achieve this goal, we aim to analyse students' experience and use of the Mathematica application in examining quadratic functions and their graphical representation. Their comments and ratings to evaluate the level of use, benefits and difficulties they encountered in using this application will be taken into account.

Research questions:

1. How effective is the “Mathematica Application” in examining and presenting quadratic functions?
2. What are the main benefits and difficulties of using Mathematica to graph quadratic functions compared to traditional methods?
3. Has the Mathematica application improved the understanding and learning of quadratic functions among mathematics students?

Research hypothesis:

H₁: “Mathematica application” is an effective tool for examining quadratic functions and their graphical representation.

H₂: The use of Mathematica to graph quadratic functions has obvious benefits and difficulties compared to traditional methods.

H₃: The use of the Mathematica application has a positive impact on the understanding and learning of quadratic functions among students.

Literature Review

Research in this studied field is lacking in our country, so this paper bases on the review of international literature as follows. Mathematica application is a powerful computer algebra system developed by Wolfram Research (Wolfram, 1999), and the lead developer is Stephen Wolfram. It is a very high-level programming language that is suitable for different types of mathematics courses. The Mathematica application is a system for doing mathematics with computers. It includes arbitrary precision and exact numerical calculations, symbolic calculations, graphics, sound, hyperlinks, and documentation in an easy-to-use software package. The computer algebra system Mathematica is an attractive medium for teaching mathematics. Several computer algebra systems exist, such as Mathematica and others, and at this level, it is largely a matter of taste which system one chooses to use. However, looking a little further, it is the opinion of the authors that (Jonassen, 2002). Mathematica is

superior to the others. The Mathematica application works with input-output logic, has a graphical interface, and is easy to use to create graphs (Ardic & Isleyen, 2017). Mathematica's ease of use and animation features provide students with an environment to discover, experiment, identify patterns, generate and test conjectures, and visualize multiple representations of the derivative concept in ways that were impossible using the whiteboard and the pencil (Shatila et al., 2016).

The results of the study by Bataineh et al. (2019) showed that the teaching method using computerised educational materials using the Mathematica application, in the experimental group was more effective in developing students' skills for solving the derivative problem and its applications. This approach provided students with multiple representations of derivative concepts, which were useful when solving different context problems, and also motivated students to think in critical and innovative ways. The author showed how to use Mathematica to quickly perform calculations that would be time-consuming and potentially time-consuming if done by hand (Baumann, 2000). Also, from the study of the author Orhani (2021), the findings reflected the high results of the participants regarding the integration of technology in mathematics lessons. Mathematica can motivate and help students develop the essential mathematical concepts and skills needed in their fields (Sholahudin, 2017). Based on previous research conducted by Musyriifah et al. (2021) in the development of learning modules, the resulting product is valid, useful, attractive, practical, and suitable for use. The Mathematica app would revitalize the learning process and encourage creativity, critical thinking, and innovation. There is a urgent need to make the teaching and learning of science, math, and engineering more hands-on, practical, and fun, says AUC (n.d.). Mathematica software provides easy and effective access to students to many representations of derivative concepts. There are few studies that have been conducted on the use of Mathematica as a tool for first year college students. Mathematica provides a powerful interactive and dynamic working environment, which when integrated in teaching and learning results in a great improvement in the effectiveness of lecturing. Mathematica is one of the most popular CAS which has positive effect on learning theoretical and applicable mathematics. It also improves students' mathematical knowledge as it motivates the student to build their mathematical concepts (Vorob'ev, 2012). Many universities were interested in improving their mathematics students' understanding and performance. Reform movements to the mathematical courses such as calculus suggested that CAS (such as Maple and Mathematica) are used in teaching calculus to increase students' conceptual understanding, improve students' ability in problem solving and develop positive attitudes towards mathematics and technology (Tall et al., 2008). The traditional teaching on mathematics subjects, based on lectures and seminar classes can be integrated with laboratory classes in which the corresponding CAS is used to reinforce the theoretical problems and solving nonstandard and practically oriented problems with tedious computations. (Tersian & Chaparova, 2020). The importance of Mathematica software in teaching Analytical Geometry is undeniable. This was observed on the development of teaching materials of Analytic Geometry using Mathematica software in the development of students' representation, and research on improving the achievement and learning independence of differential calculus students of the mathematics education program of Universitas Negeri Yogyakarta using the software Mathematica (Listyani, 2006). Strogatz (2013) in his book introduces us to quadratic functions and makes it easy to understand how they vary and how they affect graphs. It explains the use of the Mathematica application to visualise these functions and shows how this technology can help solve complex mathematical problems in a fast and accurate way. In the book "Mathematica in Action: Problem Solving Through Visualisation and Computation" by Borwein and Bailey (2009), along with the contributions of other authors, provide an in-depth perspective on the power of Mathematica in solving mathematical problems. Using the Mathematica application before moving on to manual solutions has been shown to be a powerful tool to speed up problem-solving time and better understand mathematical concepts. In addition to solving mathematical problems, they show that the Mathematica application also illustrates use in other sciences, making it attractive to students, professors and researchers of

various fields. *Mathematica in Education* by Dziubak et al. (2014) is an informative and inspiring book for anyone interested in the use of Mathematica in mathematics education and other sciences. The authors provide examples of the successful use of Mathematica in teaching and research, showing how this technology can help improve the teaching and understanding of mathematics and solve complex problems in other fields of knowledge. In the future, this research may pave the way for further development of mathematics teaching and technology integration in a more intentional and conscious way.

Research Methodology

General Background

This research was exploratory and combined, using a mixed methodology that included elements of qualitative and quantitative research. Exploratory research is a type of research that aims exploring and better understanding a certain topic or problem, fulfilling the defined purpose and bringing new knowledge and new perspectives on the research subject (George, 2021). In this case, our research aims to explore the effectiveness of the “Mathematica Application” in examining and graphing quadratic functions.

Mixed Methods Research involved the use of combined methods in a study, including data obtained from qualitative and quantitative research. The combination of these two methods helped in a more complete understanding of the research subject and provides a broad and detailed perspective on the topic of study (George, 2021).

So, our research was of an exploratory type, aiming to understand and discover how the “Mathematica Application” helps in examining and graphing quadratic functions. Also, the research was with combined data, including first the graphical analysis produced by the Mathematica application (quantitative data) and then the data obtained from the interviews (qualitative data). Combining these data allows us to achieve a more detailed understanding and provide affordable and reliable results for evaluating the effectiveness of the Mathematica application.

Sample / Participants / Group

In this research, the main included participants were high school students from the tenth grade with a total of 25 students. The samples were selected purposively, in a specific group of mathematics students since quadratic functions are elaborated in these classes. The selection of the sample was made taking into account the necessary criteria, such as experience in using the “Mathematica Application” and knowledge of quadratic functions. Throughout the selection process, it has been ensured that the subjects are motivated and suitable to give their contribution to the evaluation of the effectiveness of the Mathematica application in the examination and graphical presentation of quadratic functions. In the research, first with all the participating students, the traditional approach was used, and then with all the students, the alternative approach was used using the Mathematica application. The issue of sensitisation was carefully and responsibly handled in order to ensure that all study participants had a clear perception and felt involved and informed about both methods used the traditional one and the alternative one using the Mathematica application.

Instrument and Procedures

Data collection methods included two main aspects: qualitative data collection and quantitative data collection.

Qualitative data were obtained through individual and group interviews with students. These

interviews were used to obtain information about their experience with the Mathematica application, its use for examining quadratic functions, and their assessment of the performance and benefits of this application. The interviews were structured with open and closed questions to ensure a wide range of responses. The purpose of the questions for this research was to explore the effectiveness of Mathematica in examining and graphing quadratic functions, and to evaluate the benefits and difficulties of using Mathematica compared to traditional methods. The questions aimed to reveal users' perceptions, experiences and feelings towards the Mathematica application and its impact on the understanding and learning of quadratic functions. The survey was used to gather student perceptions and measure a subjective assessment of the effectiveness of the Mathematica application. On the other hand, the observation allowed evaluating the practical use and performance of the Mathematica application by students during the presentation of quadratic functions in class.

Quantitative data included the examining and graphing quadratic functions through the Mathematica application. A data set of known quadratic functions and use the Mathematica application to display their graphs was selected. The tools provided by the Mathematica application to determine the significant points of the functions, analyse the shape of the functions, and compare the graphs produced with the appropriate graphs of the functions were used. This data was important to evaluate the level of conformity and the quality of the graphical representation of the Mathematica application.

Data Analysis

The data analysis sub-chapter for this study aimed to explore and find out how "Mathematica Application" helps examining and graphing the quadratic functions. The analysis process was carried out with appropriate methods to handle the data collected from interviews with focus groups and observations in a detailed and systematized manner. After transcribing the focus group interviews and analysing the observations, coding techniques were used to identify the themes covered and group student responses into specific categories. Part of the data analysis was also carried out with quantitative methods, using statistical software to measure the distribution of responses and to calculate the different percentages of students in the codified categories. The results of the analysis are interpreted critically and carefully to arrive at accurate conclusions supported by the collected data.

Methodology validation

To ensure the validity and reliability of the research results, several strategies were implemented. For the validation of qualitative data, the triangulation technique to confirm and verify the results by comparing them with data collected from other entities and alternative sources were used. For quantitative data validation, replication and independent testing techniques to verify the results and ensure the accuracy of our analyses were used. We also ensured that all ethical issues and necessary standards of data protection and confidentiality were respected throughout the research process. Through these research methodology methods and strategies, accurate and reliable results to evaluate the effectiveness of "Mathematica App" in examining and graphing quadratic functions were provided. Since the application was available on the Wolfram Mathematica open-source web page, there was no reason to ask for permission from the author to use the Mathematica application. To check the accuracy of the examination and graphical presentation of the quadratic function, we as mathematics teachers were ready to take care of this process. To achieve the triangulation technique in this study several alternative sources of data were used, such as previous studies on the use of Mathematica in teaching and mathematics, observations and discussions with teachers and students, review of student papers, and interviews with students.

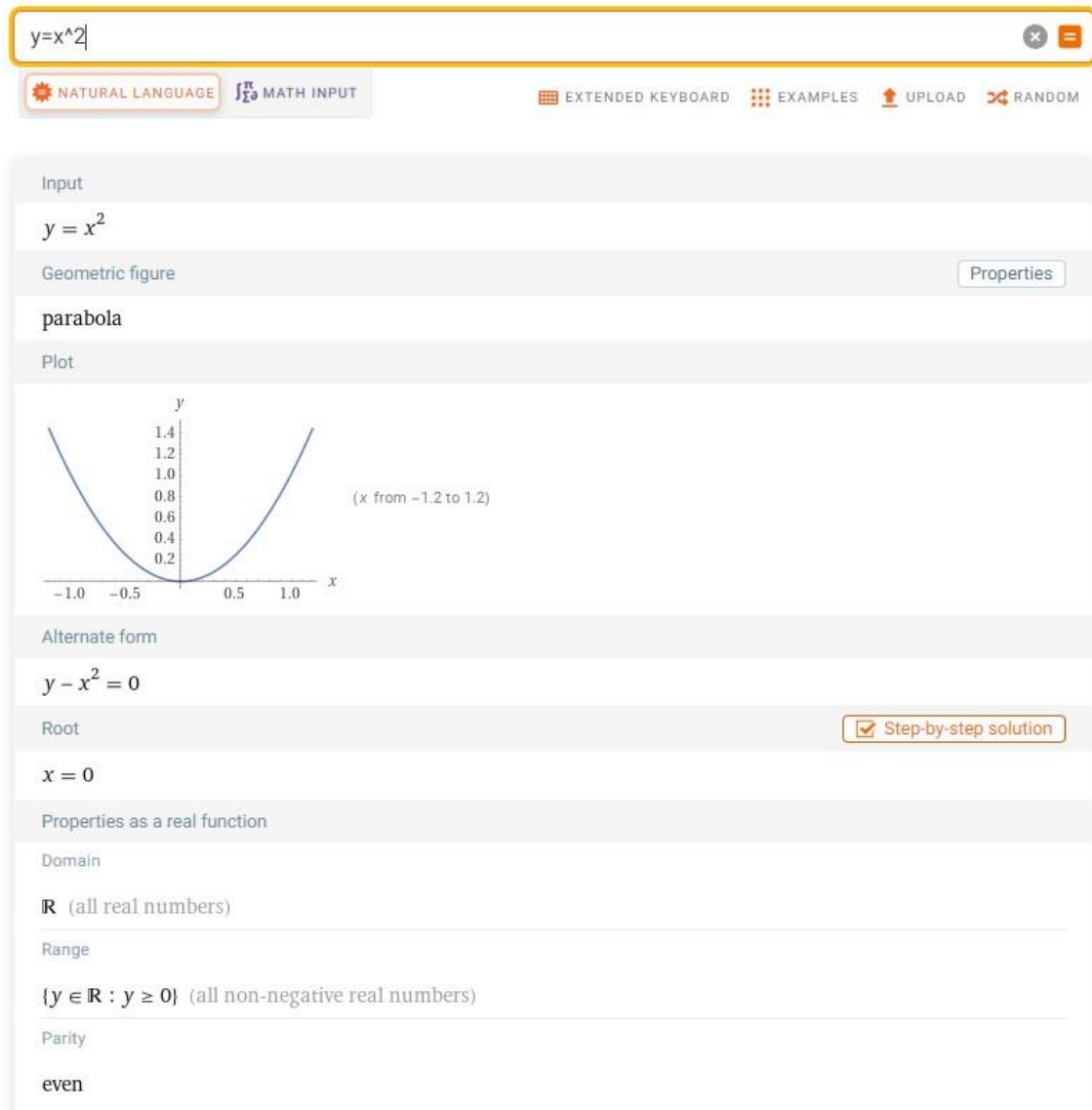
Research Results

In this chapter, the results of the given research on evaluating the effectiveness of the "Mathematica Application" in examining and graphing quadratic functions were presented and analysed. This chapter includes a summary of data collected from qualitative and quantitative research methods, providing a clear and detailed overview of the perceptions and experiences of users of the Mathematica application.

The results collected from the observation of the use of the "Mathematica Application" in the examination and graphical presentation of quadratic functions by the students are as follows. The ease of creating graphs Through the Mathematica application, great ease of creating graphs of quadratic functions was noticed. Students were able to quickly visualise the shape and characteristics of functions. The Mathematica application provided valuable assistance in identifying critical points of quadratic functions, such as extremum points and inflection points. Students used the Mathematica application's available tools to easily find critical point values. Also, the Mathematica application provided a detailed representation of graphs of quadratic functions. Students discovered important points such as zeros of the function, and monotonicity of the function through graphing. An important advantage that was observed in the Mathematica application was the ability to change the parameters of the quadratic functions and display the changes on the graph. Students experimented with coefficient values and assessed their influence on the shape and motion of the function. Also, the Mathematica application provided accurate results in the graphical representation of quadratic functions. The produced graphs are fully adequate and accurate in representing the shape and characteristics of the functions. Therefore, the results of the observation show that the Mathematica application was a powerful and effective tool for examining and graphically presenting quadratic functions. Students benefit from the ease of use, help in identifying critical points, detailed graphing, the ability to change parameters, and accurate graphing results. Below we present a part of the examination and graphical representation of the quadratic function $y = x^2$:

Figure 1

Mathematica Application



The results table shows the percentage of examples that students worked on in class, comparing the traditional method of solving quadratic functions with the use of the Mathematica application to solve them. The percentages shown represent the distribution of responses according to three categories: complete solution, partial solution, and lack of solution.

The analysis of the quantitative results allows us to evaluate the performance of the Mathematica application in presenting complete and partial solutions of quadratic functions, as well as identifying cases when the Mathematica application does not provide solutions. This gives us a clear impression of whether the application is efficient in handling quadratic functions compared to traditional methods. Below we present these results:

Table 1

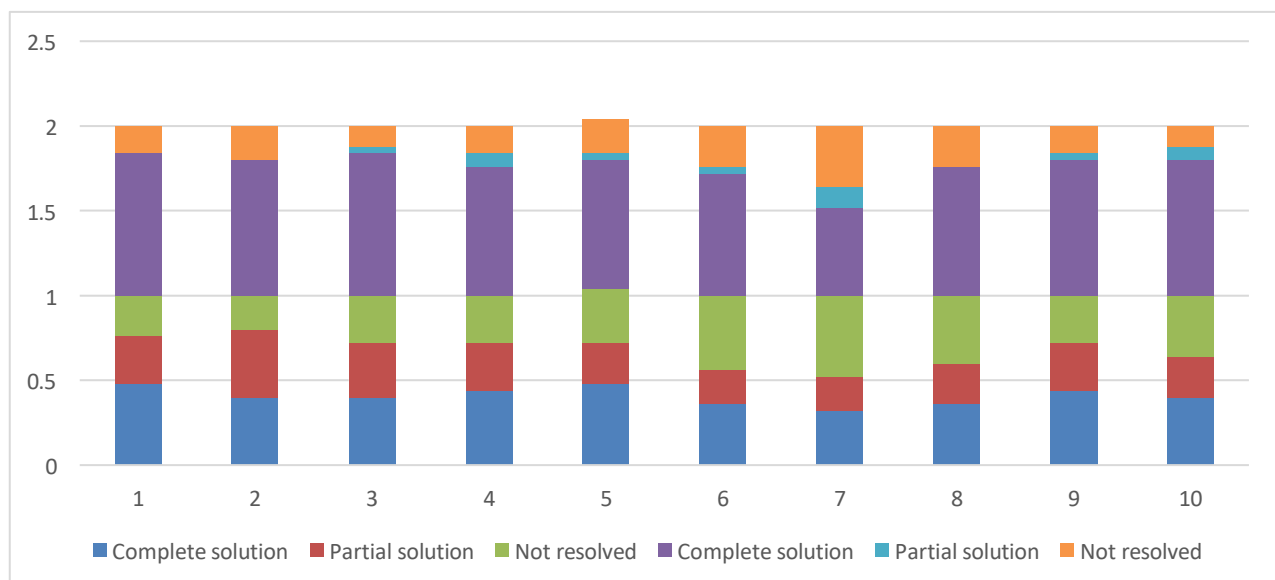
The Results from the Assessment of the Students During the Examination and Graphical Presentation of Quadratic Functions

No.	Quadratic functions	Traditional method (solution in a notebook)			Alternative method (solution with Mathematica application)		
		Complete solution	Partial solution	Not resolved	Complete solution	Partial solution	Not resolved
1	$y = x^2$	48%	28%	24%	84%	0%	16%
2	$y = -x^2$	40%	40%	20%	80%	0%	20%
3	$y = x^2 + 1$	40%	32%	28%	84%	4%	12%
4	$y = x^2 - 2$	44%	28%	28%	76%	8%	16%
5	$y = -x^2 + 3$	48%	24%	32%	76%	4%	20%
6	$y = -x^2 + 2x + 2$	36%	20%	44%	72%	4%	24%
7	$y = (x - 3)^2 - 2$	32%	20%	48%	52%	12%	36%
8	$y = x^2 + 2x - 15$	36%	24%	40%	76%	0%	24%
9	$y = x^2 - 3x - 4$	44%	28%	28%	80%	4%	16%
10	$y = 2x^2 + x + 5$	40%	24%	36%	80%	8%	12%

The diagram below provides a detailed overview of the results of this research and sheds light on the role and benefits of the "Mathematica Application" in examining and graphing quadratic functions. In the following, these results will be discussed and evaluated, linking them to the research hypotheses and the main goals of the study:

Figure 2

The Results from the Assessment of the Students During the Examination and the Graphical Presentation of Quadratic Functions



Through traditional methods (solving in a notebook), the percentage of complete solutions for quadratic functions it ranged from 32% to 48%. The percentage of partial solutions varied from 20% to 40%, while the percentage of cases where the solution of the quadratic function was not achieved it ranges from 24% to 48%.

Through the alternative method (solving with the Mathematica application), the percentage of complete solutions for quadratic functions was higher and ranged from 72% to 84%. The percentage of partial solutions varied from 0% to 8%, while the percentage of cases where the solution of the quadratic function was not reached it ranges from 12% to 36%.

The results showed that the use of the Mathematica application has provided a significant benefit in the complete solution of quadratic functions, achieving high percentages of complete solutions for most of the tested cases. The alternative method has also offered a considerable advantage in the graphical presentation of quadratic functions, offering clear and understandable solutions for most cases.

Data collected from the focus group interviews with students to assess their experience with Mathematica in examining and graphing quadratic functions yield these findings. A student said he used the Mathematica app to examine quadratic functions for a class project. He noted that the Mathematica application made easier the understanding and graph of the quadratic function and to identify critical points such as extremum points and turning points. Another student expressed that the Mathematica application helped visualising quadratic functions interactively. He pointed out that this gives them a deeper understanding of the relationship between the shape of a function and its graph. Likewise, a student expressed that the use of the Mathematica application in the graphical presentation of quadratic functions makes them more attractive and understandable for students. He observed that graphs drawn by the Mathematica application give a better sense of the shape of the function and help in evaluating their trends and characteristics. The results showed that the Mathematica application also provided options to display multiple graphs in one coordinate, making it easier for students to compare quadratic functions and evaluate the differences between them. Some students report that using Mathematica to review quadratic functions helped them solve large problems more easily and complete their math assignments with more confidence. The data collected from focus group interviews provide us with a clear perspective on the user experience with the Mathematica application in examining and graphing quadratic functions. Most users have positively evaluated Mathematica's ability to help understand and present quadratic functions interactively and engagingly.

Discussion

Based on the results of the interviews and observations collected, it can be assessed that the "Mathematica Application" was an effective tool for examining and graphically presenting quadratic functions. Students have positively evaluated the benefits and performance of the Mathematica application in solving quadratic functions and their graphical presentation. The use of the Mathematica application has provided obvious benefits in the context of examining and graphing quadratic functions. Students have identified the ease of creating graphs, the help in identifying critical points, and the detailed presentation of graphs, the possibility of changing parameters, and the correct results of the graph presentation as the main advantages of the Mathematica application. The results of the study by Bataineh et al. (2019) were consistent with the given study showing that the teaching method using the Mathematica application was more effective in developing students' problem-solving skills. The results of the study showed that the use of the Mathematica application has brought about a significant improvement compared to the traditional methods of solving quadratic functions and their graphical representation. The percentage of complete and partial solutions of quadratic functions through the Mathematica application has been much higher than with traditional methods. This suggests that the Mathematica application provided a more efficient and accurate tool for solving quadratic functions and creating graphs. Therefore, it is possible to give answer to the first question of the research that the

"Mathematica Application" is very effective in examining and graphing quadratic functions,

providing a powerful and useful tool for students in understanding and learning these functions. According to our findings and the study of Kinlay (n.d.) it is possible to give answer to the second research question that the benefits of using the Mathematica application were: Ease in creating graphs; Identification of critical points; Detailed presentation of graphics; The possibility of changing the parameters; Motivating students to complete the task, etc. However, the difficulties of using the Mathematica application were: The requirement for technical knowledge; Lack of wide access; its use may be limited due to financial constraints; Difficulty in recognising syntax, etc. The results of the research provided answers to the third research question that students have evaluated the performance of the Mathematica application in creating graphs of quadratic functions. The app has provided an improved and easier experience, helping them better understand quadratic functions and improve their graphing skills. Interactivity, the visualisation of many graphs, and ease of use were important aspects that have contributed to the positive assessment of students on the performance of the Mathematica application. Also, from the findings of this research and from the study of Dziubak et al. (2014), it is also possible to give answer to the last question of the research by saying that the Mathematica application has influenced the improvement of the understanding and learning of quadratic functions among students of mathematics. Improving the understanding of concepts, improving skills in graphic representation, facilitating experimentation, and increasing motivation and engagement are the main factors that have contributed to this positive impact. The Mathematica application has created a suitable and stimulating environment for students to learn and better understand quadratic functions.

On the other hand, according to the given findings, the hypotheses presented for this research can be confirmed. The results of the research and the study by Bataineh et al. (2019) showed to confirm the hypothesis H₁: The use of "Mathematica Application" was evaluated as an effective tool for examining quadratic functions and their graphical representation. Users reported significant benefits in using Mathematica for solving quadratic functions and creating their graphs. The results of the presented research and the study by Shatila et al. (2016) support the hypothesis H₂: The students appreciated that the "Mathematica Application" provides graphical representations of quadratic functions understandably and clearly. The graphs produced by the Mathematica application were evaluated as detailed and perfect in presenting the shape and characteristics of quadratic functions. The results of our research and research by Vorob'ev (2012) supported the hypothesis H₃: The use of the Mathematica application showed obvious benefits compared to traditional methods for the graphical presentation of quadratic functions. The Mathematica app helped students better understanding the concepts of quadratic functions and improving their graphing skills. Also, the use of the Mathematica application increased the motivation and engagement of students in learning this subject. Students rated the performance of the Mathematica application in examining and presenting quadratic functions as satisfactory and adequate. The application provided an improved and easier experience in creating graphs, help in understanding quadratic functions, and the ability to experiment with changing parameters.

One of the main limitations of the research was the sample size used in the survey and observation. The limited sample may not be fully representative of the entire population of interest, thus reducing the generalisability of the results to a wider group. The use of surveys may involve a degree of subjectivity, as students may respond in a manner influenced by their individual perceptions, personal experiences and preferences. This may affect the objectivity of the results. The research is based on the context of a particular school of students and users of the Mathematica application. The results may differ if the research is conducted in a different context or with a different group of participants. The limited time for conducting the research may have affected the detail of the analysis and the collection of more data. In some cases, a longer duration could provide more information and depth to the study.

The research focused on using the Mathematica application before traditional methods, but it is

possible that using another graphics application or other technology tools would provide different results.

Based on the conducted research, there are some suggestions for future research that could expand knowledge and address some of the limitations of the current study. In order to have a wider and more complete representation of the population of interest, it is suggested to choose the sample size. The use of large samples will increase the statistical certainty and reliability of the research results. The current research was conducted in the context of a particular school of mathematics students. Future studies may consider using the Mathematica application in different settings. Additional research could use a control group to compare the effectiveness of the Mathematica application with other methods of representing quadratic functions. Future research could deepen the assessment of students' attitudes and expressions towards the Mathematica application. Future research could also compare the effectiveness of the Mathematica application with other technological tools used for graphing quadratic functions.

Conclusions and Implications

In conclusion, the given research aimed to evaluate the effectiveness of the "Mathematica Application" in examining and graphically presenting quadratic functions. Based on the results of the data analysis and their interpretation, it can be concluded that the "Mathematica Application" was a very effective tool for examining and graphically presenting quadratic functions. Students have appreciated the ease of use of the Mathematica application and the help it provided in solving quadratic functions. The Mathematica application provided graphical representations of quadratic functions understandably and clearly. Using the Mathematica application had obvious benefits compared to traditional methods of solving quadratic functions. The Mathematica application provided more accurate solutions and perfect graphics, bringing a better user experience. However, the use of the Mathematica application had some potential difficulties, such as a lack of technical knowledge and access limitations. Nevertheless, students rated the performance of the Mathematica application as satisfactory and fulfilling. The application has positively influenced the understanding and learning of quadratic functions among students.

Overall, it can be confirmed that the "Mathematica Application" is an effective tool for examining and graphing quadratic functions, providing clear benefits to users. The results of the research showed that the Mathematica application has a positive impact on the understanding and learning of quadratic functions among students. These conclusions can serve as a basis for using Mathematica in the context of quadratic functions and can encourage more research and use of this application in the field of mathematics.

As the landscape of Mathematics education continues to evolve, incorporating the "Mathematica Application" into quadratic function learning offers promising prospects for the future. The results of the research highlighted its effectiveness in enhancing students' understanding and graphical representation of quadratic functions, making it a valuable resource to be integrated into curricula. Embracing the potential of innovative technologies like the "Mathematica Application" will foster a dynamic and engaging mathematics learning environment in the future perspective. Continual research and adaptation, considering the ever-evolving educational landscape, will ensure that quadratic function education remains relevant, effective, and impactful for future generations of learners.

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References

- Ardic, M. A., & Isleyen, T. (2017). Secondary school mathematics teachers' and students' views on computer assisted mathematics Mathematica example. *Malaysian Online Journal of Educational Technology*, 5(1), 46–64. <https://mojet.net/index.php/mojet/article/view/92>
- AUC. (n.d.). *Mathematica software revolutionizes science, engineering education*. Retrieved July 9, 2023, from <https://www.aucegypt.edu/news/stories/mathematica-software-revolutionizes-science-engineering-education>
- Aydin, E. (2005). The use of computers in mathematics education: A paradigm shift from “Computer assisted instruction” towards “Student programming”. *The Turkish Online Journal of Educational Technology*, 4(2), Article 4. <https://files.eric.ed.gov/fulltext/ED502604.pdf>
- Bataineh, H., Zoubi, A., & Khataybeh, A. (2019). Utilizing MATHEMATICA software to improve students' problem solving skills of derivative and its applications. *International Journal of Education and Research*, 7, 57–70. <https://www.ijern.com/journal/2019/November-2019/05.pdf>
- Baumann, G. (2000). *Symmetry analysis of differential equations with Mathematica*. Springer New York. <https://doi.org/10.1007/978-1-4612-2110-4>
- Borwein, J., & Bailey, D. H. (2009). *Mathematica in action: Problem solving through visualization and computation*. Springer New York. <https://doi.org/10.1007/978-0-387-75477-2>
- Dziubak, S., Sobotka, T., & Suchánek, P. (2014). *Mathematica in education*. World Scientific.
- George, T. (2021, December 6). *Exploratory research | Definition, guide, & examples*. Scribbr. <https://www.scribbr.com/methodology/exploratory-research/>
- Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, 3, 275–285. <https://doi.org/10.1016/j.susoc.2022.05.004>
- Jonassen, T. M. (2002). *Mathematica as a teaching tool for a large audience of students* [Conference presentation]. International Arctic Seminar 2002, Murmansk, Russia.
- Kinlay, J. (n.d.). *What are some real-world applications of Mathematica?*. Wolfram Community. Retrieved July 9, 2023, from <https://community.wolfram.com/groups/-/m/t/774416>
- Listyani, E. (2006). *Efforts to increase achievement and independence learning differential calculus with mathematica software on mathematics study program students*. FMIPA UNY.
- Musyrifah, E., Rabbani, H., Sobiruddin, D., & Khairunnisa, K. (2021). Development of wolfram mathematica application-assisted learning module on derivative in high school. *Journal of Physics: Conference Series*, 1836, Article 012076. <https://doi.org/10.1088/1742-6596/1836/1/012076>
- Nielsen, L. E. (2015). *Understanding quadratic functions and solving quadratic equations: An analysis of student thinking and reasoning* [PhD dissertation]. University of Washington. <http://hdl.handle.net/1773/33799>
- Orhani, S. (2021). Integration technology in math lessons. In Yu. B. Melnyk, & L. M. Georgieva (Eds.), *Current issues of education and science. 9th international conference, CIES-2021, Riga, Latvia – Kharkiv, Ukraine, November 10–13, 2021, Conference proceedings* (pp. 25–32). <https://doi.org/10.26697/9786177089147.2021.04>

- Strogatz, S. (2013). *The joy of x: A guided tour of math, from one to infinity*. Mariner Books.
- Shatila, H., Habre, S., & Osta, I. (2016). Effects of technology-aided multiple-representations approach on students' understanding of derivatives. In *Proceedings of 28th International Conference on Technology in Collegiate Mathematics* (pp. 221–225). <https://laur.lau.edu.lb:8443/xmlui/bitstream/handle/10725/8057/Effects.pdf>
- Sholahudin, U. (2017). Pemanfaatan perangkat lunak mathematica dalam perkuliahan kalkulus materi limit fungsi. In *Seminar Nasional Riset Terapan 2017* (pp. 247–250). <https://e-jurnal.lppmunsera.org/index.php/senasset/article/view/456>
- Tall, D., Smith, D., & Piez, C. (2008). Technology and calculus. In M. K. Heid & G. M. Blume (Eds.), *Research on technology and the teaching and learning of mathematics* (volume I: research syntheses, pp. 207–258). Information Age Publishing.
- Tersian, S., & Chaparova, J. (2020). *About using "Mathematica" in teaching of diferential calculus. University of Ruse Angel Kanchev*.
https://www.researchgate.net/publication/228993636_ABOUT_USING_MATHEMATICA_IN_TEACHING_OF_DIFFERENTIAL_CALCULUS
- Velázquez, F. D., & Méndez, G. M. (2021). Application in augmented reality for learning mathematical functions: A study for the development of spatial intelligence in secondary education students. *Mathematics*, 9(4), Article 369. <https://doi.org/10.3390/math9040369>
- Vorob'ev, E. (2012). Online teaching of calculus using webmathematica [Conference presentation]. First International Conference. Globalization: Business, Finance and Education (ITERB-2012), Larnaca, Cyprus.
- Wolfram, S. (1999). *The Mathematica book* (4th ed.). Cambridge University Press.

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Perception of Teachers on Entrepreneurial Education Before and After the Implementation of a Pilot Program

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Abstract: Teachers' commitment to entrepreneurial education determines the effect of an intervention program. The objectives of the study, which was conducted in 2019, were both to explore seventy-five (75) teachers' perceptions on entrepreneurial education and ways of implementing it and record the differences through a questionnaire which was completed before and after the pilot program. According to the results, the teachers revealed higher mean values in the post-test, compared to the pre-test values, in all items of the questionnaire, except from the one that concerned their preparation during the university studies. More specifically, the pilot program seems to have broadened teachers' knowledge on entrepreneurial education and skills. They also recognized its value in learning engagement and commitment and selected teachers in elementary education and mathematicians in secondary education as the most appropriate professionals to teach entrepreneurship in school as part of all subjects through activities and Information and Communication Technologies (ICT). Finally, according to the findings, networking and cooperation with the headmaster, teachers' association members, entrepreneurs and parents' and guardians' association can have a positive impact on entrepreneurial education. This study highlights the necessity not only to enhance teachers' knowledge on entrepreneurial education by including it in their undergraduate studies, their in-service training, and the school curricula but also to foster entrepreneurial education at primary and secondary school level.

Keywords: entrepreneurship, entrepreneurial education, teachers, pilot program.

Introduction

Entrepreneurship education is a form of education for students, which aims at developing ideas and turning them into action as well as acquiring skills and abilities (e.g., creativity, innovation, risk-taking) that facilitate the implementation of these ideas (Lindner, 2019; Secundo et al., 2021). EntreComp, a framework launched by the European Commission in 2016, identifies three essential pillars that describe entrepreneurship: “Ideas and opportunities”, “Resources” and “Into action” (European Commission, 2021). The entrepreneurs of the future are at schools today and entrepreneurship education is pivotal in producing successful entrepreneurs.

Many researchers have investigated the focus that courses and programs on entrepreneurship should have, ranging from start-ups, venture creation and business operation (Kassean et al., 2015; Lackéus et al., 2016) until developing entrepreneurial life skills and abilities (Gibb, 2002; Jones et al., 2018). This range also accounts for the confusion that prevails in the literature regarding the variety and content of the terminology on the introduction of entrepreneurship in education, which includes learning *for* entrepreneurship (i.e., acquiring knowledge and competences to turn ideas into reality), learning *through* entrepreneurship (i.e., applying the methodology of entrepreneurial process to achieve learning goals) and learning *about* entrepreneurship (i.e., learning about theories and empirical findings about entrepreneurship and entrepreneurs) (Gibb, 2005). In this study, the term ‘entrepreneurial education’ suggested by Erkkilä (2000) is adopted, which refers not only to a start-up perspective (narrow view) but also to personal development, mindset, skills, and abilities (broad view).

The functionality of entrepreneurial education is better when it is integrated into schoolwork and daily school routine. Moreover, the importance of Information and Communication Technologies (ICT) in teaching entrepreneurial education and its combination with digital education is often highlighted in the literature (Seikkula-Leino et al., 2019).

Since 2015 all United Nations Member States struggle to achieve the 17 Sustainable Development Goals (SDGs) as described in the 2030 Agenda for Sustainable Development that are urgent for peace and prosperity for people and the planet (United Nations, 2015). In the Agenda, entrepreneurship is described as the driving force that can improve the world and the future and address the challenges of our time (Apostolopoulos et al., 2018). Especially, in the post- COVID-19 era all citizens should be equipped with entrepreneurial skills that foster creativity and innovation in problem-solving.

Research Problem

According to research (European Commission, 2021; Seikkula-Leino et al., 2019), teachers seem to lack the appropriate knowledge on entrepreneurial education and how it can be taught. Additionally, most teachers in the European Union lack entrepreneurial education competence due to lack of good-quality teacher training and support, that would develop their entrepreneurial skills and equip them with modern teaching methods and techniques (Hameed & Irfan, 2019). Even though research and literature review emphasize the importance of entrepreneurial education, teachers still miss information on the requirements and other context elements at the micro-level (e.g., pedagogy, didactics, assessment, students, educators, stakeholders and network, online setting, learning space, content) (Thomassen et al., 2020; Tsoli & Babalis, 2021a).

Moreover, according to the systematic review conducted by Jardim et al. (2021), most of the educational programs that study and practice entrepreneurship are implemented in universities, less in middle and high-schools, and even fewer in elementary schools and kindergartens. The research conducted in universities explore mainly social entrepreneurship competency (García-González & Ramírez-Montoya, 2023), the determinant factors of entrepreneurial intention (Fragoso et al., 2020),

challenges and opportunities due to the COVID-19 pandemic (Liguori & Winker, 2020), the impact of programs on entrepreneurial activity (Eesley & Lee, 2020).

Even though research highlights the role of entrepreneurial education in students' development, there is a gap in the context of primary and secondary education on teachers' knowledge, understanding, competencies and skills as well as their adequate preparation and training to apply entrepreneurial education (Colombelli et al., 2022). This study intends to investigate the knowledge and perceptions of teachers in three European countries (Greece, Spain, Portugal) based on 'teachers' voice' and focuses on factors that lead to a successful implementation of an entrepreneurial education.

Research Focus

Based on the above, the present study focuses on the differences between teachers' perceptions regarding entrepreneurial education before and after implementing the pilot program in Greece, Spain, and Portugal. It also examines the extent of teachers' knowledge of the content of entrepreneurial education and the factors that influence its implementation at macro (e.g., government policy, technological development), meso (e.g., discipline, digital tools, university) and micro level (e.g., educators, network, content). It also focuses on the possible enhancement of their knowledge after participating in an ERASMUS+ program, in the context of which a 6-month pilot program, entitled ETHICSBOARD, was designed, implemented, and evaluated in 2019, with the aim to teach entrepreneurship and its' relation to ethics to students between 10 and 15 years old in three European countries, i.e., Greece, Portugal and Spain. Therefore, the main variables of the study are entrepreneurial education and factors concerning its implementation and teachers' perceptions. The current study is of scientific interest, because: a) it suggests ways to implement entrepreneurial education at schools based on 'teachers' voice', b) it provides data that can be taken into account by educational policy and legislation, and c) it may increase awareness of universities to offer compulsory courses focusing on developing students' entrepreneurial competence.

Research Aim and Research Questions

In this quantitative study, pre-test and post-test perception surveys were administered to a group of 75 teachers of primary and secondary education in Greece, Spain, and Portugal to determine the effect of a pilot educational program, called ETHICSBOARD, on teachers' perceptions regarding teaching entrepreneurship in education. The aim of the research was to investigate the impact of the pilot program on teachers' knowledge and perceptions regarding entrepreneurial education (e.g., meaning, entrepreneurship skills, importance, requirements, ways of teaching) and record the differences in two times, before and after the intervention program. The research questions were:

- Which are teachers' knowledge and perceptions on entrepreneurial education with regards to

- 1) the meaning, 2) the entrepreneurial skills, 3) the importance, 4) the requirements, 5) the ways of teaching and 6) the specialties that should be teaching entrepreneurship in education before the implementation of the pilot course (pre-measure)?

- Which are teachers' knowledge and perceptions on entrepreneurial education with regards to

- 1) the meaning, 2) the entrepreneurial skills, 3) the importance, 4) the requirements, 5) the ways of teaching and 6) the specialties that should be teaching entrepreneurship in education after the implementation of the pilot course (post-measure)?

- Are there any differences among pre-measure and post-measure in all the above variables?

Research Methodology

General Background

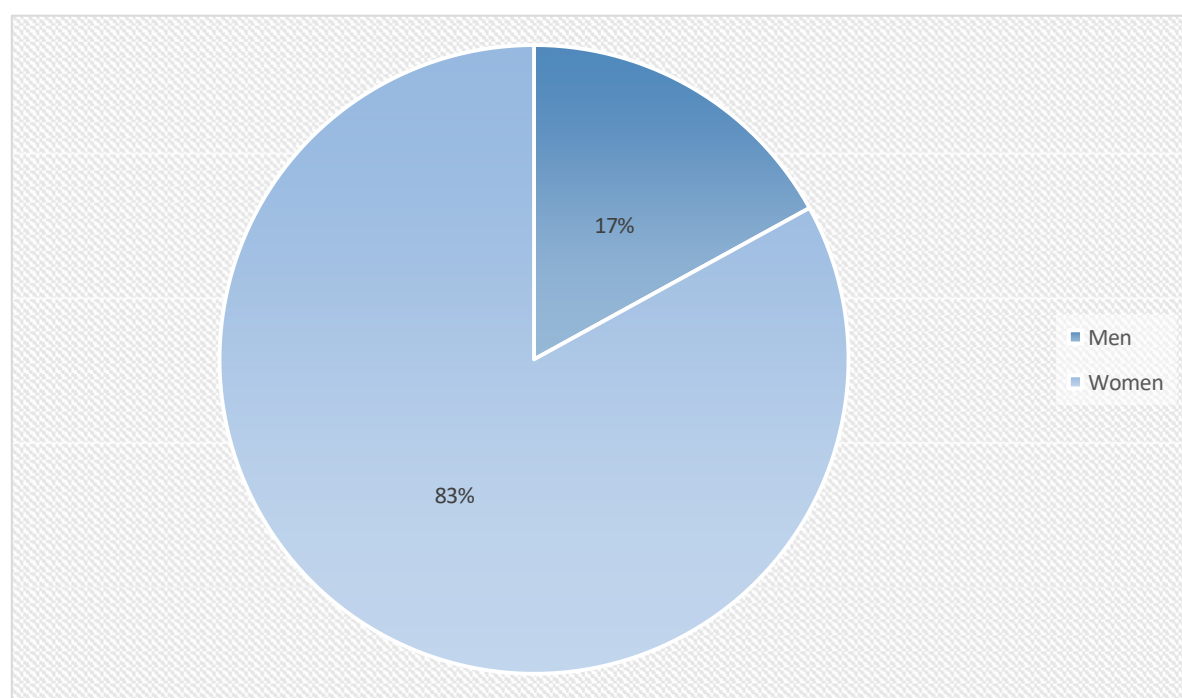
The aim of the present study was to investigate the impact of a pilot program on teachers' perceptions of the importance, the requirements, the appropriate ways to teach entrepreneurship in school and other context elements at the micro-level. A training curriculum on entrepreneurship was developed for primary and secondary school education based on modern and experiential pedagogical approaches, tools, and gamification practices. Moreover, ETHICSBOARD program envisaged two portfolios (teaching and learning), an eLearning platform accessible to students with special educational needs and/or disabilities, a good practice handbook and policy recommendations on teaching ethics and entrepreneurship in school education. Teachers from Greece, Spain and Portugal attended the 'Train-the-Trainer' event in Athens before implementing the pilot program, which gave them the opportunity to discuss and become familiar with the pilot program they eventually applied (Babalís & Tsoli, 2021). Pre-testing and post-testing data was collected after asking participants to complete a questionnaire, which was developed based on the state-of-the-art report, the user needs analysis and general literature review on ethics and entrepreneurship.

Sample / Participants / Group

Seventy-five (75) teachers who implemented the pilot program to school students aged 10 – 15 years old participated in the study.

Figure 1

Teachers' Percentage Based on Their Gender

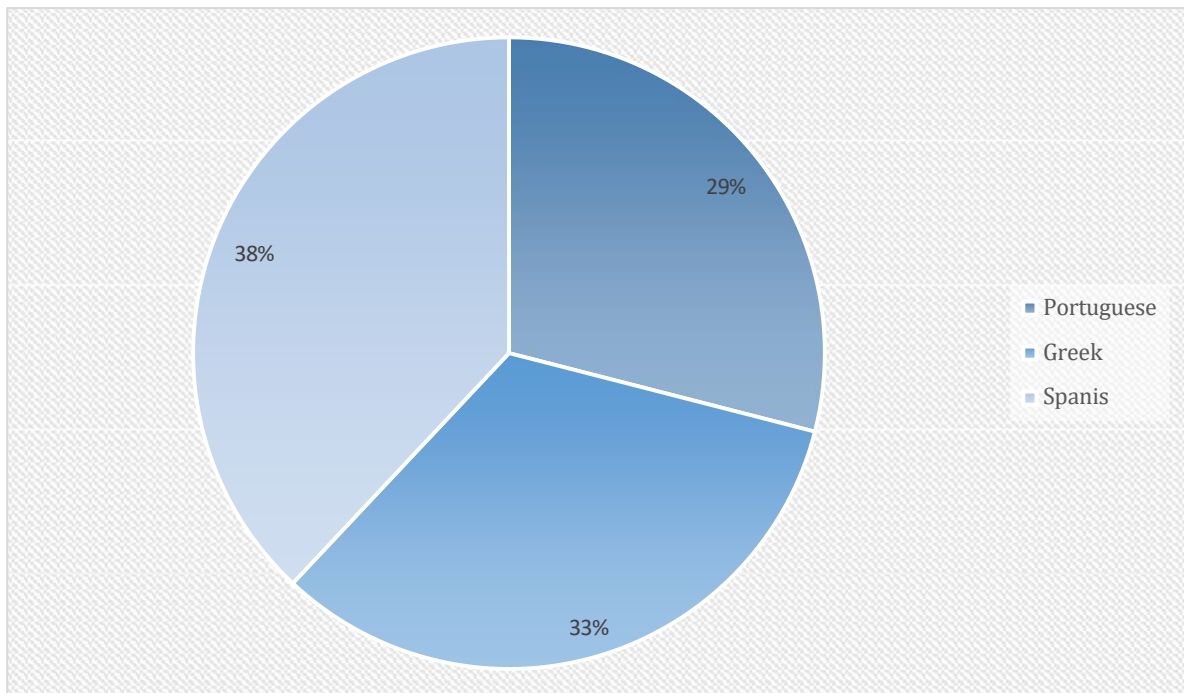


Source: author own development.

Most of the participants were women, i.e., sixty-two (62, 82.7%) and thirteen (13, 17.3%) were men (Figure 1).

Figure 2

Teachers' Percentage Based on Their Nationality

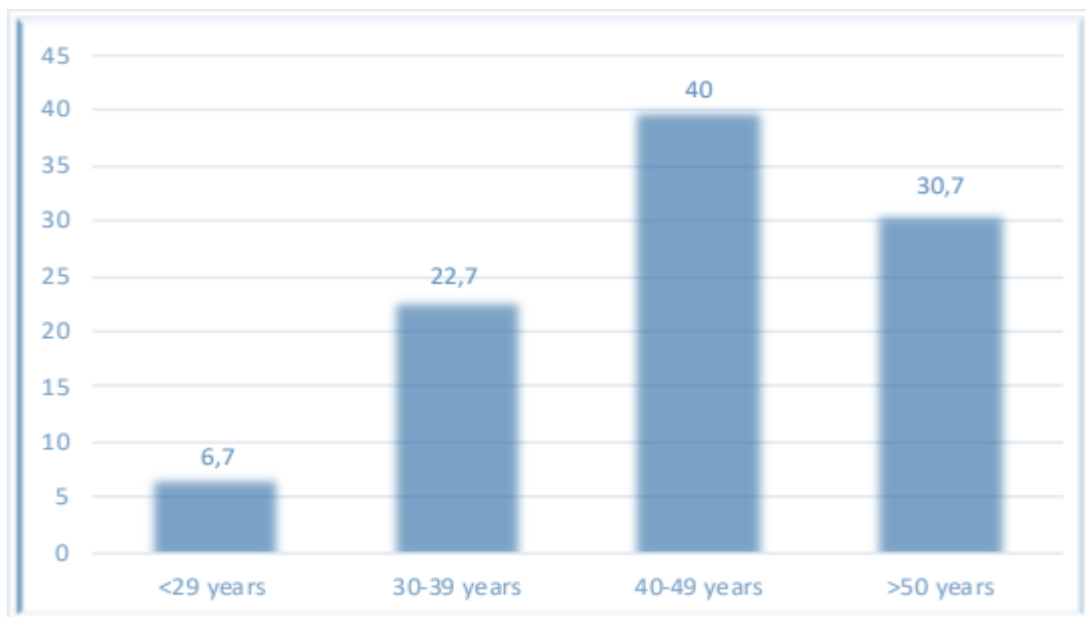


Source: author own development.

From the total sample, twenty-five (25, 33.3%) were from Greece, twenty-eight (28, 37.3%) were from Spain, and twenty-two (22, 29.3%) were coming from Portugal (Figure 2).

Figure 3

Teachers' Percentage Based on Their Age



Source: author own development.

Regarding teachers' age, five (5, 6.7%) were between 20 to 29 years old, seventeen (17, 22.7%) teachers were thirty (30) to thirty-nine (39) years old, thirty (30, 40.0%) teachers were forty (40) to forty-nine (49) years old, and finally twenty-three (23, 30.7%) teachers were above fifty (50) years old (Figure 3).

Instrument and Procedures

Teachers' perceptions were measured via a questionnaire, which was constructed based on the certain theoretical concepts and the empirical results from previous research (Babalís & Tsoli, 2021; Jardim et al., 2021; Kassean et al., 2015; Seikkula-Leino et al., 2019).

Three curricula designed for teachers, students and parents, a teaching and learning portfolio and an eLearning course on ethics and entrepreneurship were developed and implemented by the teachers in the three above-mentioned countries in the academic year 2019. The duration of the pilot testing of pilot program via face-to-face and virtual learning was six months, from February to July 2019. After completing the user needs' analysis, whose purpose was to identify the needs of teachers, parents and entrepreneurs using mixed methods, as well as gathering the expertise already practiced at the partner schools and surveying the state-of-the-art in this area, a questionnaire was constructed as part of the evaluation activity to identify any changes in teachers' perceptions and competencies in engaging with entrepreneurship. The questionnaire consisted of two parts; the first part was concerned with the demographical questions (e.g., gender, nationality, age, total teaching experience, etc.) and the second part was filled with a 10-items-set self-report scale answered through a 4-point Likert scale format ranging from "strongly agree" to "strongly disagree". Each items-set provided 5 to 7 answers that could correspond to teachers' perceptions. Examples of the items were: *Entrepreneurial skills in education are...*, *Education for Entrepreneurship is appropriate to be taught by ...*, etc. The questionnaire was translated into Greek, Spanish and Portuguese, and was distributed to teachers both electronically and printed to complete it in approximately thirty (30) minutes. All ethical principles in research were followed.

Data Analysis

The factor structure and reliability of the questionnaire was acceptable, according to the exploratory factor analysis. The examination of the significant differences between pre-test and post-test was conducted using univariate and multivariate statistical analyses (Wilks' Lambda, F -values, p -values, partial η^2). Follow-up ANOVAs were performed on the subscales where there were significant MANOVA effects (Tukey test). Bonferroni adjustment was applied to control for the inflation of Type I error (Tabachnick & Fidell, 2006). The means (M) and standard deviations (SD) were also examined.

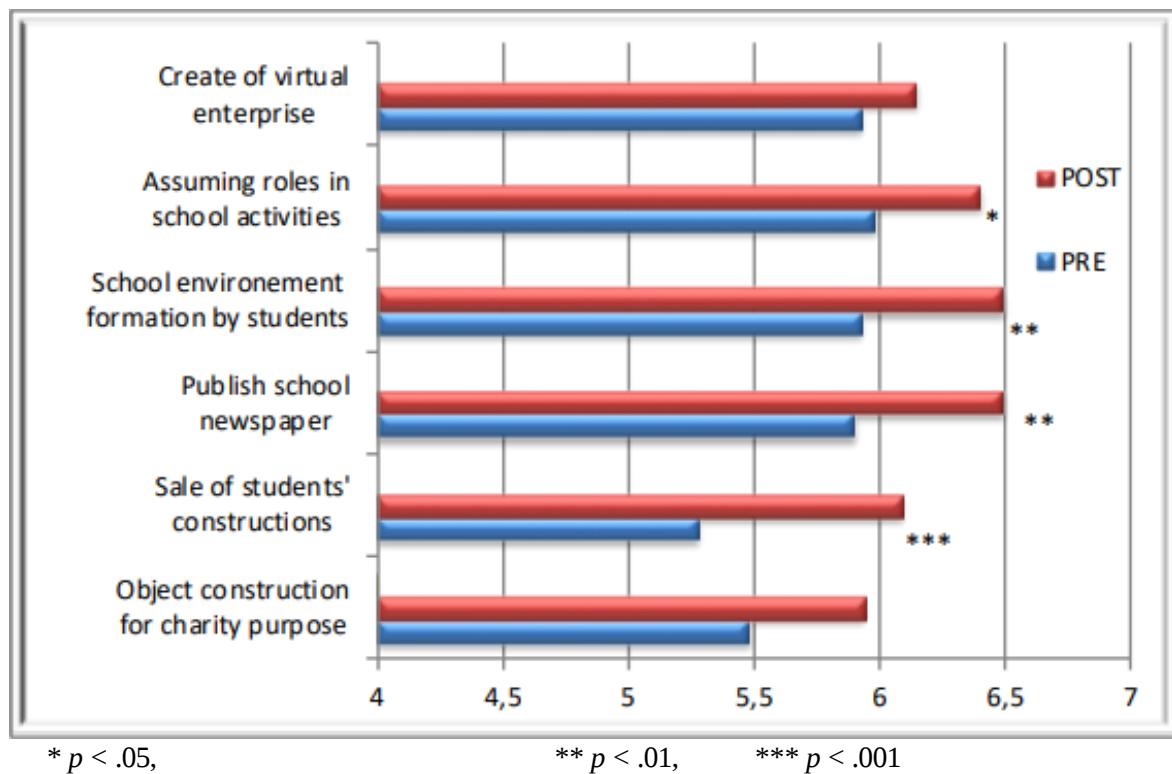
Research Results

Figures 4 to 10 present the differences in the two measures, i.e., before and after the implementation of the pilot program.

In particular, figure 4 presents the means (M), the standard deviations (SD) and the differences (F -values) among pre-measure (before the pilot program) and post-measure (after the pilot program) regarding the meaning of entrepreneurial education. Based on the teachers' responses, the results indicate that after the pilot program the teachers in total showed higher mean values in four (4) statements: 1) assuming roles in school activities, 2) school environment formation by students, 3) publish school newspaper, and 4) sale of students' constructions.

Figure 4

Means (M), Standard Deviations (SD) and Differences (F-values) Among Pre-measure and Post-measure in Teachers Regarding the Meaning of Entrepreneurial Education

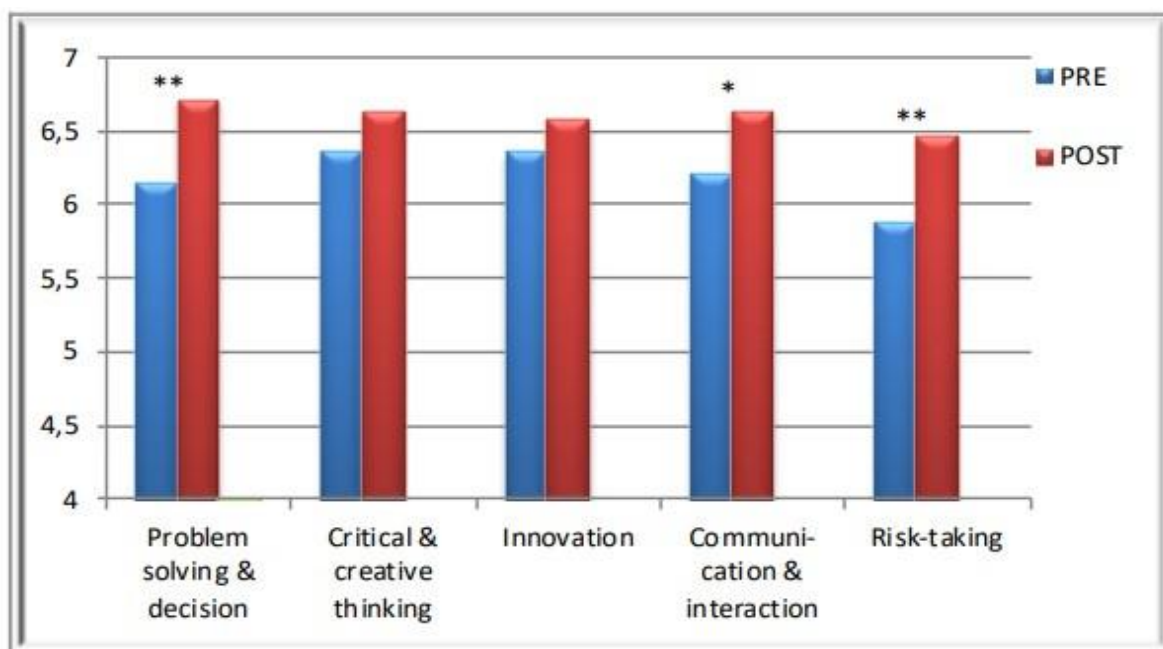


Source: author own development.

Figure 5 presents teachers' perceptions on the entrepreneurial skills in education among pre-measure and post-measure. In more detail, when comparing the post-measure to the pre-measures, it seems that teachers show higher mean values in the following three (3) skills: 1) problem solving and responsible decision making, 2) communication and interaction and 3) risk-taking.

Figure 5

Means (M), Standard Deviations (SD) and Differences (F-values) Among Pre-measure and Post-measure in Teachers Regarding the Entrepreneurial Skills in Education



* $p < .05$,

** $p < .01$,

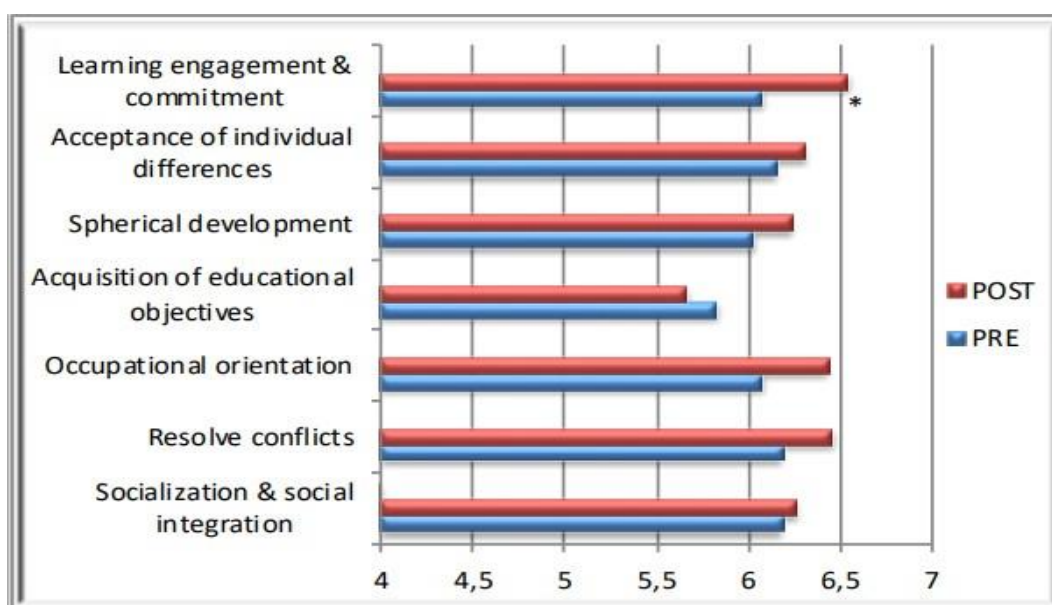
*** $p < .001$

Source: author's own development.

Figure 6 presents teachers' perceptions in Time 1 & 2 regarding the importance of entrepreneurial education. Results among the two measures (before and after the pilot program) showed statistically significant differences in students' learning engagement and commitment in the measure after the pilot program compared to the pre-measure. Nevertheless, all dimensions showed higher mean values as far as the importance of entrepreneurial education is concerned, even though not statistically significant different.

Figure 6

Means (M), Standard Deviations (SD) and Differences (F-values) Among Pre-measure and Post-measure in Teachers Regarding the Importance of Entrepreneurial Education



* $p < .05$,

** $p < .01$,

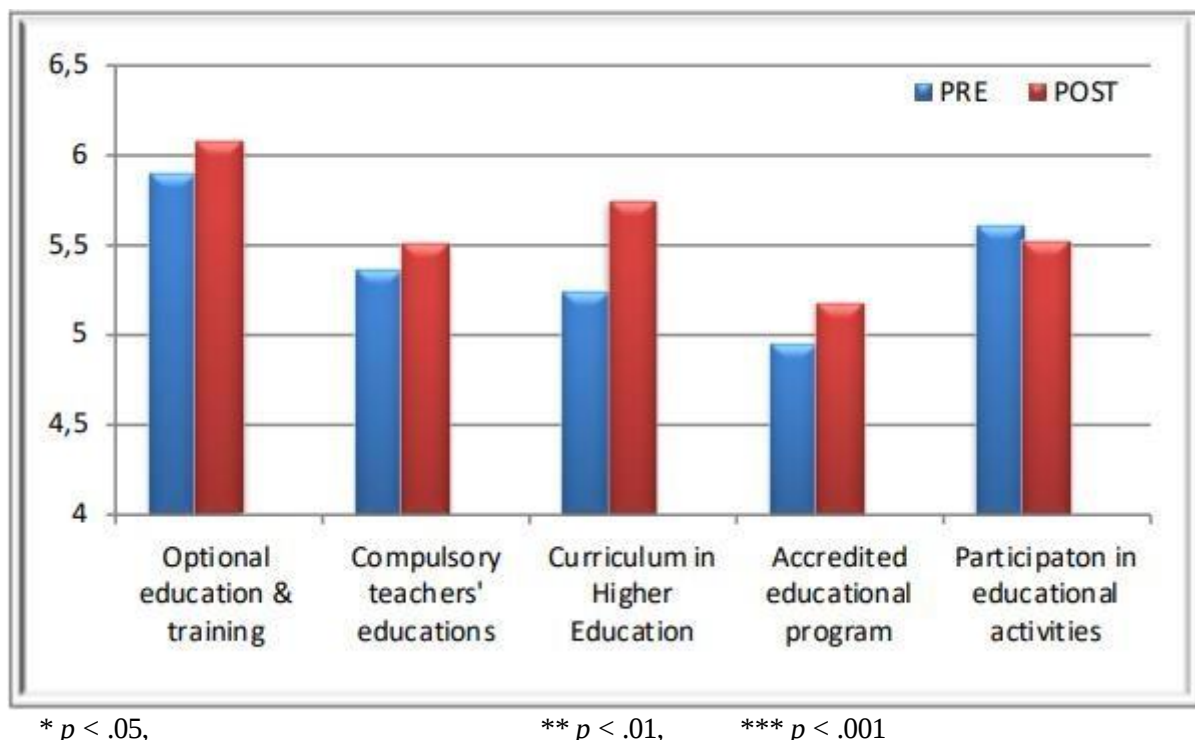
*** $p < .001$

Source: author's own development.

In Figure 7 teachers provided their perceptions with regard to the requirements of the entrepreneurial education. Findings didn't show any statistically significant differences among teachers' responses between pre-measure that took place before the pilot program and after that, in the post-measure.

Figure 7

Means (M), Standard Deviations (SD) and Differences (F-values) Among Pre-measure and Post-measure in Teachers Regarding the Requirements of the Entrepreneurial Education

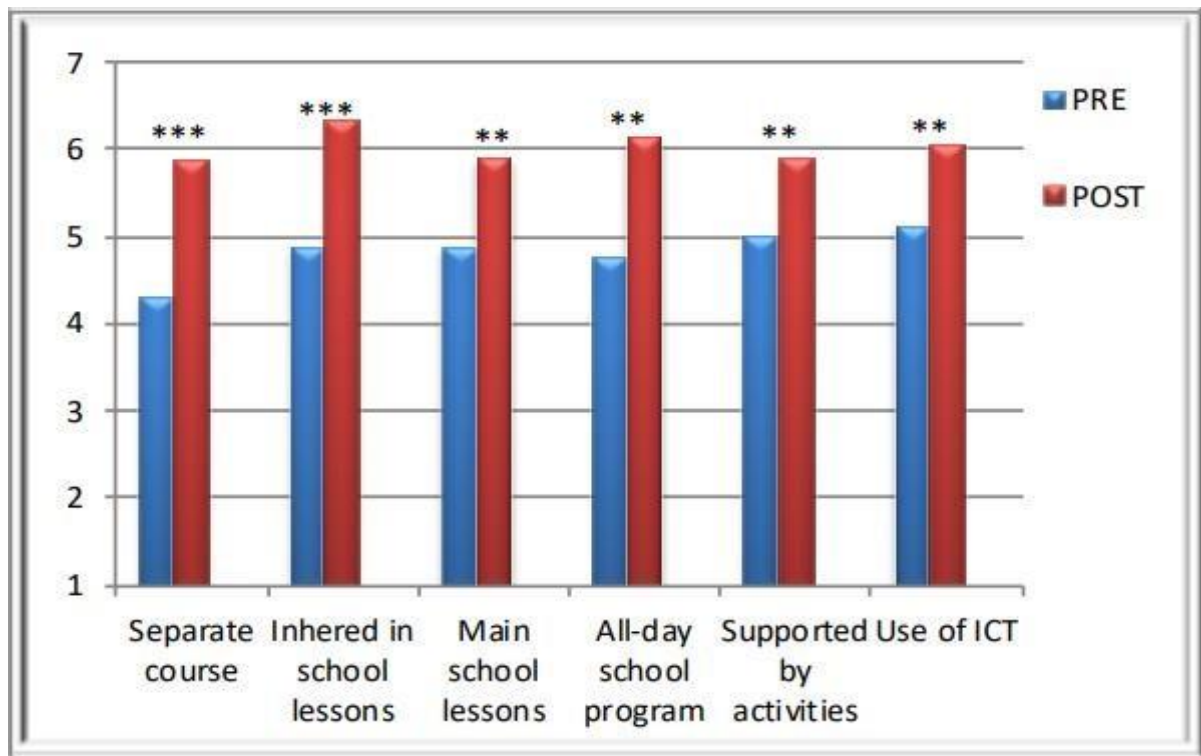


Source: author own development.

Figure 8 presents the differences between pre-measure and post-measure concerning the appropriate way to teach entrepreneurship. The results showed statistically significant differences between the two measures in all items, i.e., 1) teach entrepreneurship as a separate course, 2) inhere entrepreneurship in school lessons, 3) entrepreneurship as a main school lesson, 4) teach entrepreneurship in all-day school program, 5) entrepreneurship supported by activities, and 6) teach entrepreneurship with the use of Information and Communication Technology (ICT).

Figure 8

Means (M), Standard Deviations (SD) and Differences (F-values) Among Pre-measure and Post-measure in Teachers Regarding the Appropriate Way to Teach Entrepreneurship in School



* $p < .05$,

** $p < .01$,

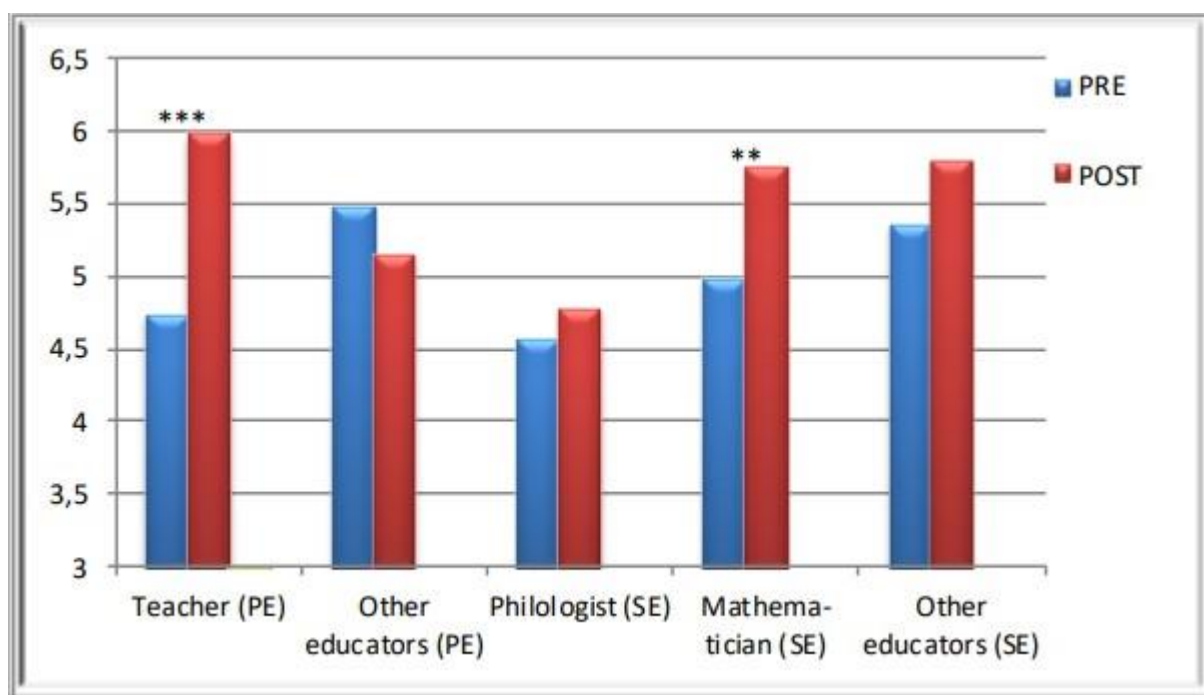
*** $p < .001$

Source: author's own development.

Another important issue regarding entrepreneurial education concerns who is the most appropriate professional to educate students. Figure 9 presents the results, where it seems that in the post measure compared to the pre-measure teachers choose teachers as appropriate to teach entrepreneurial education in primary education, and mathematicians in secondary education.

Figure 9

Means (M), Standard Deviations (SD) and Differences (F-values) Among Pre-measure and Post-measure in Teachers Regarding Who Should Teach Entrepreneurship in School



* $p < .05$,

** $p < .01$,

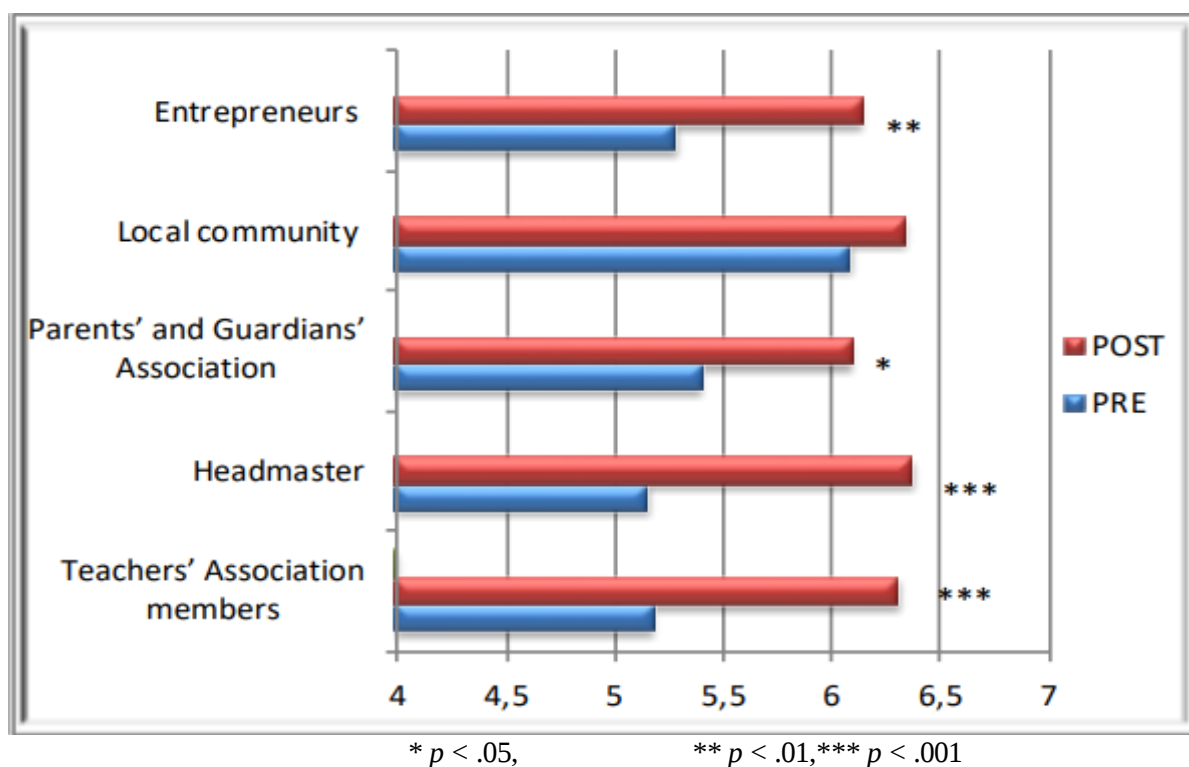
*** $p < .001$

Source: author own development.

Figure 10 presents teachers' perceptions on how to achieve entrepreneurial education improvement. The results showed significant differences between teacher responses before and after the pilot program. In more detail, all items except from local community showed statistically significant differences, indicating that teachers' collaboration with 1) entrepreneurs (e.g., site and school visits), 2) Parents' and Guardians' Association, 3) the Headmaster, and 4) the Teachers' Association members contributes to a quality application.

Figure 10

Means (M), Standard Deviations (SD) and Differences (F-values) Among Pre-measure and Post-measure in Teachers Regarding the Best Ways to Improve Entrepreneurial Education



Source: author own development.

Discussion

This study resulted in statistical significant differences among pre-measure and post-measure with respect to teachers' knowledge and perceptions on 1) the meaning, 2) the entrepreneurial skills,

3) the importance, 4) the requirements, 5) the ways of teaching, 6) the professionals that should be teaching entrepreneurship in schools and 7) the best ways to improve entrepreneurial education. Generally, in the post-measure teachers revealed higher mean values, compared to the pre-test values. More specifically:

It seems that teachers in our sample were not familiar with the width of the content and the range of activities entrepreneurial education may include. Indeed, according to Maritz and Brown (2013), the definitions of entrepreneurial education is not consistent and spans from venture creation to entrepreneurial behaviour. This finding applies for teachers across many other European countries, apart from Greece, Portugal and Spain (Tsoli & Babalis, 2021a). For example, teachers' understanding of entrepreneurial education in UK and Finland was found to be limited to enterprising behavior and did not include the entrepreneurial skills (Seikkula-Leino et al., 2019). Generally, the lack of experienced and qualified teachers who are not really aware of the content of entrepreneurial education is stated in the literature (Akpan, 2021; Garavan et al., 2010; Miço & Cungu, 2023). However, after the intervention program teachers expanded their view on entrepreneurial education and recognized activities, such as publication of a school newspaper or sale of students' construction, as part of this type of education.

Moreover, teachers' responses at post-test showed that they enhanced the list of entrepreneurial skills, including risk-taking, problem-solving, decision-making, communication, and interaction. In their pilot study, which was addressed to 60 students from 5 European countries, who had been attending entrepreneurial education courses, Luppi et al. (2019) also found that their research raised the awareness on communication and teamwork among both students and teachers.

Furthermore, in the post-measure compared to the pre-measure, teachers correlated entrepreneurial education with learning engagement and commitment. Shittu et al. (2021) in their research found that student engagement in entrepreneurial education programs has an effect on entrepreneurial skills growth.

Nevertheless, the pilot-program did not have an effect on teachers' perceptions on the requirements of entrepreneurial education (e.g., compulsory, or optional course in teacher education, design and implementation of a curriculum in higher education).

Moreover, according always to teachers' perceptions, the most appropriate way to teach entrepreneurship is not as a separate course but infused in school lessons as well as in the all-day school program, supported by activities and the use of Information and Communication Technologies (ICT). Other research points out the importance of considering entrepreneurial education as part of all subjects and not as a separated concept (Lindner, 2019). According to qualitative and quantitative data, ETHICSBOARD broadened teachers' knowledge and views, because they could select the appropriate didactic approach to develop students' entrepreneurial skills (Tsoli & Babalis, 2021b; Tsoli et al., 2021).

Teachers believe that the most appropriate professional to teach entrepreneurship is the teacher in primary education and the mathematician in secondary education. This finding reveals teachers' narrow view on entrepreneurship, since a mathematician could develop a good business plan and support the math behind the business (e.g., determine the cost, calculate break even and projected sales, develop pricing strategies, etc.).

Finally, teachers after the pilot program recognized that entrepreneurial education benefits from engaging the headmaster, teachers' association members, entrepreneurs and parents' and guardians' association. Students, teachers, social network and other external stakeholders (i.e., entrepreneurs) exert a strong influence on entrepreneurial education (Neumeyer & McKenna, 2016).

This study implies a need for further research. A more in-depth analysis on the infusion of entrepreneurial education could have value. Additionally, a meta-analysis selecting the studies about how entrepreneurial education is implemented in the educational systems worldwide could be of great importance. Sharing the lessons learned and best practices from these approaches would be valuable.

Conclusions and Implications

This study attempted to identify the differences on what teachers know and how they consider entrepreneurial education before and after implementing a relevant pilot-program in Europe (i.e., Greece, Spain, and Portugal). After conducting pre- and post-tests, the results yielded some interesting findings. Overall, the program had a positive effect on all examined variables. The teachers that formed our sample were not educated enough or at all in entrepreneurial education during their undergraduate studies or as part of their ongoing training. Nevertheless, through the implementation of the pilot-program, it seems that teachers acquired a broader view on the meaning and content of entrepreneurial education, which does not only refer to an enterprise or charity activities, but also to school activities in which students can participate (e.g., publication of a school newspaper, shaping the classroom and school space and physical environment, participating in musical and cultural activities, selling crafts and using the money for excursions, seminars, etc.). Moreover, the pilot program enhanced teachers' perceptions on life skills that are related to entrepreneurship, such as risk-taking, problem-solving, decision-making, communication, and interaction. An important result is that teachers associated entrepreneurial education to learning engagement and commitment. They also identified teachers at primary school level and the mathematicians at secondary school level as the most appropriate professionals to teach entrepreneurship, which should be infused in all school lessons, and not be taught

as a separate course, with the support of the new technologies.

Teacher training, both initial teacher education and continuous professional development, in entrepreneurial education is important, since it can help them better understand its importance, requirements and other practical issues concerning its implementation (Miço & Cungu, 2023; Penaluna et al., 2020).

This study has some limitations. The data was collected from a few schools in Greece, Spain, and Portugal and the number of participants is small; therefore, the results do not necessarily represent the situation and by no means can they be generalized. The questionnaire was self-report and could lead to some bias with teachers, either overestimating or underestimating themselves. Results based on gender, nationality, and age differences was not included in the objectives of this study.

Finally, based on the present study, we could introduce some other recommendations:

- Entrepreneurial education in Greece needs support and promotion by policy makers. It needs to be integrated in the curriculum of all levels of education (primary, secondary, tertiary).
- Students intended for practicing the teaching profession should learn about entrepreneurial education in the context of both teacher initial and continuing training.
- It is important for students, while being trained at entrepreneurial education, to interact with the material, their classmates and their teachers. A variety of methods and techniques are available to teachers to apply, such as experiments, case studies, games, projects, simulations, internships with start-ups, etc.

Suggestions for Future Research

The work reported in this paper provides a good starting point for discussion and opens new future research possibilities that could be beneficial to the field. As confirmed in this study, teachers were not familiar with entrepreneurial education, because either they had not received entrepreneurial education as students, nor had they been prepared during their studies to teach it. Therefore, policy makers should support efforts to increase entrepreneurial education in Greece. Further research on the number of schools and the level of education that entrepreneurial education is being applied, as well as the reasons why teachers promote it or not could help address the obstacles they encounter. Such research will shed light to the role of education in promoting entrepreneurial spirit.

Moreover, this study, as many empirical studies, showed that entrepreneurship can be taught, and relevant educational programs have the potential to develop knowledge, skills and abilities to students as well shift teachers' mindset. However, there is little discussion concerning the reasons why there is still such a residual implementation of entrepreneurial education in compulsory schooling, despite the fact that it is considered as a fundamental competence. In addition, studies investigating the requirements and other general information concerning 'what, who, when, why and how' should teach entrepreneurship are missing and such topics are still not clear to schools and universities. Such studies will help provide further details on questions such as:

- What is entrepreneurship, and what are its effects on personal growth?
- Who should teach it, according to the level of education and the specialty of the teacher?
- When is the most appropriate time for entrepreneurial education to start?
- How can it be integrated (e.g., deeply embedded into the curriculum or as a

stand-alone course)?

Another finding of this study was that the pilot program enhanced teachers' perceptions on life skills that are related to entrepreneurship. Intercorrelations between entrepreneurship and specific life skills (e.g., self-knowledge, empathy, emotion regulation, decision-making, problem-solving, critical and creative thinking) is a suggestion for further research. In this context, research identifying the common personality traits of a successful entrepreneur could enhance the list that has already been derived by the literature.

An important result of this study was that teachers associated entrepreneurial education to learning engagement and commitment. Future research, both quantitative and qualitative, with different or more robust methodology might address this topic more effectively.

Finally, other recommendations for future research, on the occasion of this research but also beyond and above it, could include:

- New Technologies and their implications for entrepreneurship.
- Good practices of entrepreneurial education in different countries.
- Support of entrepreneurial education by agencies and organizations, local or international, public, or private.
- Entrepreneurial education and its contribution to phenomena, such as bullying, violence, social exclusion.

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References

- Akpan, O. E. (2021). Entrepreneurship studies education in tertiary institutions in Nigeria: theories and practices. *International Journal of Vocational and Technical Education Research*, 7(1), 35–42. <https://www.eajournals.org/wp-content/uploads/Entrepreneurship-Studies-Education-in-Tertiary-Institutions-in-Nigeria.pdf>
- Apostolopoulos, N., Al-Dajani, H., Holt, D., Jones, P., & Newbery, R. (2018). Entrepreneurship and the sustainable development goals. In N. Apostolopoulos, H. Al-Dajani, D. Holt, P. Jones, & R. Newbery (Eds.), *Entrepreneurship and the sustainable development goals* (Contemporary Issues in Entrepreneurship Research, vol. 8, pp. 1–7). Emerald Publishing. <https://books.emeraldinsight.com/resources/pdfs/chapters/9781787563766-TYPE23-NR2.pdf>
- Babalís, T., & Tsoli, K. (2021). Teaching ethics and entrepreneurship at school and at their related communities. In M. Pavlakis & E. Chelioti (Eds.), *Entrepreneurship Education: applications & good practices at School & University* (pp. 82–101). JA Greece.
- Colombelli, A., Loccisano, S., Panelli, A., Pennisi, O. A. M., & Serraino, F. (2022). Entrepreneurship education: The effects of challenge-based learning on the entrepreneurial mindset of university students. *Administrative Sciences*, 12(1), Article 10. <https://doi.org/10.3390/admsci12010010>

- Eesley, C. E., & Lee, Y. S. (2020). Do university entrepreneurship programs promote entrepreneurship?. *Strategic Management*, 42(4), 833–861. <https://doi.org/10.1002/smj.3246>
- Erkkilä, K. (2000). *Entrepreneurial education: Mapping the debates in the United States, the United Kingdom and Finland*. Garland Publishing Inc.
<https://books.google.com.ua/books?id=OKPVtIgN0tcC&printsec=frontcover&hl=ru#v=onepage&q&f=false>
- European Commission (2021). *A guide to fostering entrepreneurship education. Five key actions towards a digital, green and resilient Europe*. <https://eisma.ec.europa.eu/system/files/2022-01/A%20guide%20for%20fostering%20entrepreneurship%20education.pdf>
- Fragoso, R., Rocha-Junior, W., & Xavier, A. (2020). Determinant factors of entrepreneurial intention among university students in Brazil and Portugal. *Journal of Small Business & Entrepreneurship*, 32(1), 33–57. <https://doi.org/10.1080/08276331.2018.1551459>
- Garavan, T., Birdthistle, N., Ó Cinnéide, B., & Collet, C. (2010). Entrepreneurship education in the Republic of Ireland: context, opportunities and challenges. In Fayolle, A. (Ed.), *Handbook of Research in Entrepreneurship Education* (vol. 3, pp. 225–247). Edward Elgar Publishing. <https://doi.org/10.4337/9781849806688.00024>
- García-González, A., & Ramírez-Montoya, M. S. (2023). Social entrepreneurship competency in higher education: An analysis using mixed methods. *Journal of Social Entrepreneurship*, 14(1), 91–109. <https://doi.org/10.1080/19420676.2020.1823872>
- Gibb, A. A. (2002). In pursuit of a new ‘enterprise’ and ‘entrepreneurship’ paradigm for learning: Creative destruction, new values, new ways of doing things and new combinations of knowledge. *International Journal of Management Reviews*, 4(3), 233–269. <https://doi.org/10.1111/1468-2370.00086>
- Gibb, A. A. (2005). The Future of entrepreneurship education—determining the basis for coherent policy and practice? In P. Kyro, & C. Carrier (Eds.), *The dynamics of learning entrepreneurship in a cross-cultural university context* (pp. 44–67). University of Tampere, Research Centre for Vocational and Professional Education.
- Jardim, J., Bártolo, A., & Pinho, A. (2021). Towards a global entrepreneurial culture: a systematic review of the effectiveness of entrepreneurship education programs. *Education Sciences*, 11(8), Article 398. <https://doi.org/10.3390/educsci11080398>
- Jones, C., Penaluna, K., Penaluna, A., & Matlay, H. (2018). The changing nature of enterprise: addressing the challenge of Vesper and Gartner. *Industry & Higher Education*, 32(6), 430–437. <https://doi.org/10.1177/0950422218804075>
- Hameed, I., & Irfan, Z. (2019). Entrepreneurship education: A review of challenges, characteristics and opportunities. *Entrepreneurship Education*, 2, 135–148. <https://doi.org/10.1007/s41959-019-00018-z>
- Kassean, H., Vanevenhoven, J., Liguori, E., & Winkel, D.E. (2015). Entrepreneurship education: a need for reflection, real-world experience and action. *International Journal of Entrepreneurial Behavior & Research*, 21(5), 690–708. <https://doi.org/10.1108/IJEBr-07-2014-0123>
- Lackéus, M., Lundqvist, M., & Middleton, K.W. (2016). Bridging the traditional-progressive education rift

- through entrepreneurship. *International Journal of Entrepreneurial Behavior & Research*, 22(6), 777–803. <http://dx.doi.org/10.1108/IJEBr-03-2016-0072>
- Liguori, E., & Winker, C. (2020). From offline to online: challenges and opportunities for entrepreneurship education following the COVID-19 pandemic. *Entrepreneurship Education and Pedagogy*, 3(4), 346–351. <https://doi.org/10.1177/2515127420916>
- Lindner, J. (2019). Entrepreneurial spirit for the whole school-Ways to become an e.e.si.-entrepreneurship school. *Discourse and Communication for Sustainable Education*, 10(2), 5–12. <https://doi.org/10.2478/dcse-2019-0013>
- Luppi, E., Bolzani, D., & Terzieva, L. (2019). Assessment of transversal competencies in entrepreneurial education: A literature review and a pilot study. *Form@re – Open Journal Per La Formazione in Rete*, 19(1), 251–268. <http://dx.doi.org/10.13128/formare-25114>
- Maritz, A., & Brown, C. R. (2013). Illuminating the black box of entrepreneurship education programs. *Education and Training*, 55(3), 234–252. <https://doi.org/10.1108/00400911311309305>
- Miço, H., & Cungu, J. (2023). Entrepreneurship education, a challenging learning process towards entrepreneurial competence in education. *Administrative Sciences*, 13(1), Article 22. <https://doi.org/10.3390/admsci13010022>
- Neumeyer, X., & McKenna, A. (2016). Entrepreneurial thinking in interdisciplinary student teams. *Advances in Engineering Education*, 5(1), 1-20. <https://files.eric.ed.gov/fulltext/EJ1090585.pdf>
- Penaluna, A., Penaluna, K., & Polenakovikj, R. (2020). Developing entrepreneurial education in national school curricula: Lessons from North Macedonia and Wales. *Entrepreneurship Education*, 3, 245–263. <https://doi.org/10.1007/s41959-020-00038-0>
- Secundo, G., Mele, G., Del Vecchio, P., Elia, G., Margherita, A., & Ndou, V. (2021). Threat or opportunity? A case study of digital-enabled redesign of entrepreneurship education in the COVID-19 emergency. *Technological Forecasting and Social Change*, 166, Article 120565. <https://doi.org/10.1016/j.techfore.2020.120565>
- Seikkula-Leino, J., Ruskovaara, E., Pihkala, T., Rodríguez, I. D., & Delfino, J. (2019). Developing entrepreneurship education in Europe: Teachers' commitment to entrepreneurship education in the UK, Finland and Spain. In A. Fayolle, D. Kariv, L. Lezion, & H. Matlay (Eds.), *The role and impact of entrepreneurship education methods, teachers and innovative programmes* (pp. 130–145). Edward Elgar Publishing. <https://doi.org/10.4337/9781786438232.00014>
- Shittu, A. I., Amao-Taiwo, B., & Ekpe-Iko, G. (2021). Student engagement in entrepreneurship education programs: Implications for entrepreneurial skills development in universities. *Journal of African Employment, Entrepreneurship, and Skills Development (JAEESD)*, (Special issue), 83–98.
- Tabachnick, B. G., & Fidell, L. S. (2006). *Using multivariate statistics* (5th ed.). Allyn and Bacon.
- Thomassen, M. L., Williams Middleton, K., Ramsgaard, M. B., Neergaard, H., & Warren, L. (2020). Conceptualizing context in entrepreneurship education: A literature review. *International Journal of Entrepreneurial Behavior & Research*, 26(5), 863–886. <https://doi.org/10.1108/IJEBr-04-2018-0258>
- Tsoli, K., & Babalis, T. (2021a). A comparative study on teachers' views on entrepreneurial education. In

L. Gómez Chova, A. López Martínez, & I. Candel Torres (Eds.), *INTED2021 Proceedings 15th International Technology, Education and Development Conference* (pp. 7598–7605). IATED Academy. <https://doi.org/10.21125/inted.2021.1530>

Tsoli, K., & Babalis, T. (2021b). Innovation, entrepreneurial skills and ethics: The impact of a pilot program on students in European Union aged 13–15. *Psychology*, 12(9), 1364–1378. <https://doi.org/10.4236/psych.2021.129085>

Tsoli, K., Babalis, T., & Giouli, E. (2021). Developing entrepreneurial skills in primary and secondary school students in Europe: The views and role of teachers. In V. Papavassiliou, G. Xanthakou, N. Andreadakis, E. Nikolaou, & M. Kaila (Eds.), *Bio-diversity, social and cultural diversity* (pp. 387–405). Diadrassi.

United Nations (2015). Transforming our world: The 2030 Agenda for sustainable development. <https://sustainabledevelopment.un.org/post2015/transformingourworld/publication>

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Censorship in Teacher Training: The Case of the Lending Library of the Pedagogical Academy of Heraklion, Crete, Greece

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Abstract: This paper examines censorship forms implemented in the pedagogical training received by the students (teacher candidates) of the Pedagogical Academy of Heraklion (Crete, Greece) during the period of the April dictatorship (1967-1974). First, a bibliographical overview of the main term of the paper, namely the censorship, is attempted, and then the historical context of the censorship actions undertaken by the dictators is analysed. The research was based on the archival material of the Academy, specifically the documents relating to its lending library. The historical interpretive methodology of 'history from below' was followed. The aim of the research was to highlight the correlation between the examined documents, which seemingly did not relate to the concept of censorship, and the conceptual and historical context set. The results of the research revealed many acts of censorship, overt or latent, concerning the formation of the institution's lending library. The above results constituted important findings, as they contributed to the scientific methodology of 'history from below', as the research object was not associated with a person or a group of people, as is common practice. Instead, the focus of the research was placed on an institution of pedagogical training that has been in the margins in terms of research, and there were no papers in the relevant scientific discourse that base their research on such a research unit. Finally, this research attempted to highlight important findings that sometimes confirm and sometimes contradict the hitherto known literature on the implementation of censorship in the period under review. More specifically, the findings were consistent with the general idea of the intense censorship activity of the dictators in the period 1967-1972, but it also highlights similar results for the period 1972-1974, for which relevant research had shown that the phenomenon of censorship was clearly less visible.

Keywords: censorship, Pedagogical Academy, teacher training, lending library

Introduction

Literature review

Conceptual definition of the term. The attempt to define the censorship conceptually runs up against its extremely diverse nature and requires a broader definition than one might expect. The foreign-language literature presents three main characteristics in comparison with the Greek literature. First, it has examined more areas based on the intention or action of censorship. Subsequently, these studies have been implemented earlier than the Greek example and also focus on this concept in more detail. In the following text an attempt to focus on some very specific elements of this Greek and foreign-language literature was made.

The conceptual definition of the term under consideration varies according to the space and time around which it is considered and thus it is not possible to define common accepted characteristics for all time periods (Curry, 1997). The basic conceptual features of an initial assessment around censorship converge on the notions of "*suppressing, repressing or restricting the circulation*" of certain intellectual property (Reichman, 2001, p. 2), because it is considered objectionable according to the censor's criteria. The censorship is, in essence, an interference in the field of information and the free movement of ideas, imposed by a public authority or a political power (Ziogas, 2008). Examples that one can relate to this definition from the Greek political scene abound, especially (but not only) in the periods of Greek dictatorial - totalitarian regimes (Leonidas, 1974). In modern Greek history these regimes operated in the following periods: 1925-1926, 1936-1940 and 1967-1974. This view, however, is considered quite simplistic and partially examines the censor's power.

The term has been distinguished into three sub-forms. There is the *preventive* type of censorship which imposes a permanent control on what is going to be published. It is a method that has been applied since the Middle Ages, with regard to the bibliographic production of the period, and over time its application has been extended to the artistic, scientific and news domains (Minnich, 2010; Charnow & Charnow, 2005). In the relevant Greek literature, the issue of preventive censorship has been prominently studied in relation to its implementation in the Greek newsroom during the period under review in this research (1967-1974) and the high degree of implementation of the method has been noted in newspapers that opposed the dictatorial regime (Stratos, 1995), and even in news publications that operated illegally (Raitsinis, 2016).

The *repressive* form of censorship, which refers to the restriction of the circulation of an already published intellectual property is also distinguished. This type of censorship procedures may involve confiscation of the intellectual work or even punishment of the author. In some cases, in fact, when this type of censorship is not exercised in a direct way, indirect ways, related to economic issues, are imposed and work in this direction. The characteristics of this form of censorship is different from the first type mentioned above, as here the circulation of the intellectual good is initially allowed, but then it is considered that the same good may cause more moral damage compared to the general act of censorship that was not initially imposed (Heins, 2007). The preventive and repressive forms are institutionalised by the political authority and seem as regulatory actions.

There is, however, a third perspective on the issue, which refers to the case of self-censorship, according to which the author implicitly censors himself, thus, this type constitutes a non-institutionalised type of censorship (Petsini & Christopoulos, 2016, pp. 12-13). This is a type of

censorship that has been studied to a small extent in the Greek-language literature, which has identified relevant implementation of this type in the newspaper Hellenic Chronicle, which was published during the period 1824-1826 (Dimitropoulos, 2018). Significant reference to self-censorship, however, is located in the field of the historical study of literary genres. Particularly, the work of the neo-Hellenist, Byzantinologist and literary scholar Nikolaos Mavrogordatos (1882-1971) seems to have been of considerable interest in the literature (Bouchard, 2018 ; Pehlivanos, 2018). More theoretical documentation of this term, however, is found in related studies concerning not the historical study of literary genres, but their reception based on literary theory (Zervou, 1992).

The foreign-language literature has further advanced the theoretical exploration of the term and highlights the fact that it is a productive form of censorship, as individuals are unconsciously forced to constrain their preferences according to heterodoxy, and ultimately not only accept them, but continue to produce cultural products based on these norms (Bunn, 2015, p. 26; Cook, & Heilmann, 2013). A very useful point that has also been highlighted is the role of libraries in the process of self-censorship. It is worth noting that many books are censored by library workers, and in this case it is often not a matter of censorship, but of redefining the content. In essence, libraries themselves tend to self-censor their content and the criteria by which they do so are not yet clear. However, in some cases they are related to exogenous (in relation to libraries) actors and factors or even inaccuracies and misinterpretations in administrative tasks and ultimately either overt or latent censorship processes emerge (Whelan, 2009; Moellendick, 2009, pp. 71-72; Moody, 2004, 2005).

The above distinction does not penetrate in depth and thus more theoretical tools are needed in order to explore these categories to the extent that they should be explored rather than examined superficially. Therefore, censorious actions were examined both in the form of arbitrary practices and in the capacity of a covert action that takes into account all socially determined prohibitions arising from political, economic, religious or other systems of power (Jansen, 1988, p. 221). In order to fully understand the previous statement the views of M. Foucault about the formation and management of power structures should be taken into account.

Without intending to analyse the French philosopher's work, it is considered useful to make a very brief reference to his views that influence the subject of the proposed research. This reflection arises from his research on power relations and, above all, we can condense some of his thoughts as they emerge from his works *Surveillance and Punishment* and *The History of Sexuality*.

The first book briefly discusses the characteristics of the disciplinary means applied in prisons during the Enlightenment period. It follows from his thought that the authority that applies punitive practices '*must remain aloof from the punishment it imposes*' (Foucault, 1976, p. 76). For this reason, a whole mechanism is set up by the agents of power, whereby a state of risk is established, through which the ideal way of exercising disciplinary power is formed. Thus the subjects accept these actions. Moreover, the act of enforcing detention moves from the group view of punishment to an individual action, where each prisoner is placed individually in cells which have the characteristic of visibility, the "panopticon". The prisoners are now visible and thus become participants in the process of detention and repression (Foucault, 1976, pp. 226-231). Thus they limit and censor themselves, maintaining the state of confinement.

The second mentioned book, examines the limitation of discourse around sex. Foucault (1982, p. 47) uses the term '*mass culture*' which is associate with a process of '*regulated impulse*' and refers to the whole network of relations and mechanisms activated to impose restriction as something normal. Example of such mechanisms are the sciences (such as medical ones) that were activated to establish repression practices as something normal and moral, by introducing new concepts that justify

prohibition.

After reading the two books, a relational understanding of censorship emerged, as the power relation is not only generated within the state apparatus, but also between citizens. Therefore, the formation of our self, our "subjectivity", is directly related to the networks of power relations. That which limits the expression of our subjectivity and censors it must be considered in relation to these networks of power in which we ourselves participate. This leads us to the conclusion that censorship is also influenced by the subjects themselves. They self-censor and thus contribute to the perpetuation of a restrictive and limited situation.

The above productive aspect of censorship has been supported by many modern supporters. One of these is J. Butler who points out that there are strong censorship examples that have not resulted from explicit state policies of restriction (Butler, 1998, pp. 249–251). Moreover, the author agrees with Foucault's view of the productive aspect of censorship and extends it in relation to its repressive form, considering that it fails to form a regime of complete prohibition, because it fails to form the conditions of subjectification through legitimate means and to describe the social space it wants to impose.

The French sociologist P. Bourdieu has also dealt with the issue of censorship by examining it from a different point of view, language and symbolic power. Censorship is established as a structural necessity within the field of language, which is directly linked to the social position of the individual and the social conditions under which it is created. These seem to influence what Bourdieu calls the '*expressive interest*', which is linked to the form and power of censorship and is satisfied within the restrictive frameworks set for it. Censorship, then, becomes a result of a project of '*euphemism*', which can go as far as silence. The analysis, however, goes deeper and demonstrates that the mechanisms of censorship need not take the form of an explicit prohibition by an institution, as the best kind of censorship is one in which subjects do not understand that they are being censored. This requires a process of internalisation of the dominant discourse. Anyone who does not participate in this process is excluded from the social groups themselves. Therefore, the more effective the repression is, the less the concept of censorship is revealed, as it becomes something normal in the mind of the reader (Bourdieu, 1991, pp. 137–139).

Extending the above, it has been pointed out (Athanasίου, 2008, p. 159) that the concept of habitus also plays a decisive role in the issue of censorship. This follows if taking into consideration that the subjects' prepositions are also located in the culturally acceptable objects or goods. That is, something appears as normality in relation to the cultural criteria that we have and have been shaped within society, either by the primary habitus (the family) or by the secondary habitus (school). Therefore, the notion of rivalry in one's speech - a basic criterion for applying some kind of censorship - is linked to the habitus from which the characterisation of it as rivalry arises. This converses with Foucault's view of subjectivity, mentioned above, as the formation of the acceptable subject is influenced by the dominant habitus and is ultimately embodied in a process of explicit or implicit restriction.

The censorship during the period of April dictatorship (1967-1974) in Greece. The above theoretical remarks will help in a deeper examination of the phenomenon of the censorship about the chosen period. However, before describing the archival documents that will be interpreted in light of these considerations, it seems appropriate to explain the route of censorship during the April dictatorship years.

¹ These newspapers were censored because they expressed mainly left-wing political ideology. These are two specific cases and, as mentioned in the following section of the investigation, there were other newspapers and magazines that were censored precisely because they expressed left-wing political ideology.

On the basis of the theoretical framework that has preceded it, it is obvious that examples of repressive censorship were abundant during the April dictatorship. Main victims of this phenomenon were the field of letters, arts and the press. Common to all censored works was their left-wing - and not completely communist - ideological orientation. Some well-known examples were: a) the immediate closure of newspapers such as *Avgi* and *Democratic Change*¹, b) the censorship of the poems of Varnalis and Ritsos, c) the banning of the film *The Battleship Potemkin* and d) the censorship of several songs by the composers songs by M. Theodorakis. D. Savvopoulos and G. Markopoulos, who also expressed anti-dictatorial ideas.

This was a form of the repression that was imposed, but in fact the impact of the preventive form of censorship was stronger. According to this, a whole mechanism was set up for the a priori control of every intellectual good that was to be released. Through this process they managed not only to restrict but also to control the general circulation of ideas.

The truth is that dictators found a very well-established legal basis from the past to implement this plan and all it took was a "legislative" misdirection to bring it back. In fact, earlier provisions from Forced Laws and Legislative Decrees, stemming from the dictatorship of 4 August 1936 and from the subsequent occupation governments of 1941-1944, which established strict state control over all kinds of printed matter, books, newspapers, theatre, singing as an artistic creation and cinema, came into force in 1967 (Andritsos, 2016). More specifically, since the period of a previous established dictatorship in Greece (1936-1941), the regime of preventive censorship was institutionalised with the relevant provisions establishing the *Ministry of Press and Tourism*. The dictators of that time took advantage of the argument of economic and tourism progress and created directorates for the control of the press, both domestic and foreign, as well as a directorate on tourism propaganda. The aim was to completely control the circulation of ideas, but also to project an idealised image abroad, a typical feature of totalitarian regimes. In particular, the Forced law 45 /1936 states that this ministry aims at «*enlightening public opinion, namely the issues related to the Greek and foreign daily and periodical press, all kinds of conferences and exhibitions, theatre, cinema, gramophone records, advertising of all kinds, lectures, publications and, in general, all forms of printed matter, live and mechanical events, so that they are within the framework of national traditions and ideals, including the control of radio broadcasting*».

This was a complete and comprehensive preventive act of censorship on almost everything that is circulated, which is reinforced by a series of legal texts that clarify the framework of repression, such as, for example, the Forced Law 437/1937, according to which non-compliance with the instructions of the Ministry of State brings about «*imposition of disciplinary control and penalties*». There were also several other laws that explicitly formulated the implementation of preventive censorship in the field of letters, arts and the press, preventing anything that opposes the Christian religion, offends public morals, propagates anarchic and subversive ideas, according to the judgment of the *Ministry of State*. In relation to the subject of this paper, Article 20 of Royal decree 108/1942² is of particular importance, which states that «*For the publication of any book in Greece, permission is required from the Directorate of Popular Education of the General Directorate of Press and Radio Broadcasting*». The same logic seems to have prevailed in the field of the press, for which Article 8 of the Forced Law 1092/1938 states: «*All issues concerning the circulation and sale of newspapers and magazines and the persons and organizations involved in them are regulated by the Deputy Ministry of Press and Tourism*».

The characteristics of the above-mentioned legal texts are akin to a regime of restriction of freedom in circulation of ideas and cultural goods. Therefore, they constitute an excellent about the necessity of censorial intervention.

² It was a law decided by the occupation government of Greece, which continued in a way with this legal provision the censorship actions of the preceding dictatorial period (1936-1941).

The *General Directorate of Press and Information* of the *Presidency of the Government* is now in charge of coordinating the censorship. It was headed by Colonel Vryonis. As it turned out, the task of repression was strengthened, especially in the early years of the regime's rule, where the most intense incidents occurred. Axelos (1984, p. 42) mentions that «*for two years formal and effective censorship was imposed on every published publication*». This situation is related to the anxiety of the rulers to ensure the proper conditions for the implementation of power. The censorship as a form of intellectual violence was accompanied in this period by the prohibition of legitimate political activity, the exile of left-wing ideological supporters and many preventive checks on the 'legitimacy' of public officials. Therefore, in the early years of the dictators' rule, violent repression, physical or otherwise, emerged as the dominant characteristic of its ideology and mode of governance.

Considering the years 1967-1969 we should also take into account another political-economic factor that had a direct impact on the area we are examining. This was the freezing of the agreement on the association of our country with the E.U., which brought a considerable political and economic burden. Censorship in this case functioned as a key tool to control the existing criticism on this issue and, consequently, as an auxiliary tool to promote a misleading appearance to the public opinion, according to which Greece relations with E.U. had not been disturbed (Peshmazoglou, 1999, p. 100).

Over time, however, the dictatorship regime came under strong pressure to shift towards the implementation of liberal policies. The pressure came mainly from Greek business leaders, which throughout the seven years seem to have been favoured. It is in this context that the attempt for a new constitution should be considered. The result, however, was not as expected, because internal contradictions and ideological rigidities could not be overcome. This is also reflected in the legislation being promoted, which in essence was incapable of overcoming the notion of repression.

A characteristic example, which also concerns our research, is Law 346/1969, according to which the abolition of preventive censorship is prescribed. It is clearly stated in Article 11 that «*The press is free and carries out a public mission, which entails rights and duties as well as responsibility for the accuracy of its publications*». At first sight, this action enables the regime to propagandize in part a return to democratic normality. However, a closer study leads to the conclusion that censorship remains, as the number of punishable offenses, which are consistent with the non-liberal 'ideological' framework of the dictatorship's principles, increases. More specifically, there are plenty of articles in this law that define the prohibited publications, which include «*insulting the king*», «*sedition publications*»,

«*publications stirring up political passions*», «*obscene publications*», «*publications on suicides*» and, most importantly, «*publications against the national economy*». Finally, throughout the law, there is an apparently deliberate ambiguity concerning the definition of what is objectionable, in order to reinforce the feeling of self-censorship on the part of the publishers themselves.

Thus, the censorship is becoming dominant, even after the law, which prescribes its relaxation/abolition. Moreover, it is obvious that it supports dictatorship regime propaganda and operates in a productive context, in the sense that it creates those conditions whereby citizens or publishers contribute to the perpetuation of a dominant situation.

The second period of this research (1972-1974) has completely different political and cultural characteristics, which will be interpreted in relation to changes in the lending library. On a political level, the late phase of the dictatorship (1972-1974) is characterised by a fake political attempt of 'liberalisation'. In this context, various changes were promoted, such as the alleged abolition of preventive censorship, which were discussed above, the new (and more 'liberal' constitution), but also additional changes concerning education in general. In the field that concerns the paper, it is worth keeping in mind the change in the Analytical and Timetable Programme of the Pedagogical Academies,

which theoretically promote liberal characteristics, something which, of course, does not emerge from the study of these programmes³. In cultural terms, this period is characterised by the cessation of the silence of artistic creators, especially G. Seferis with the first official statement of disapproval of censorship, which contributed to the lifting of preventive censorship.

In general, the silence of the first two years (1967-1969) was succeeded by an intense intellectual movement with new publications with liberal ideology. So, dictators showed some tolerance at that time. It is also worth mentioning the emergence of several new artists in the fields of literature, visual arts, theatre and cinema. All this should be seen as a movement to produce a different cultural version against the dominant culture promoted by the dictators, who based their national narrative on the type of 'mass culture', i.e. putting forward government propaganda through radio and television, with the aim of disorienting people from the deep cultural deadlocks and projecting another model (Papanikolaou, 2017, pp. 201-209). This kind of mass production of cultural products de facto concerns the censorious actions that are examined in this article, as it constitutes self-censorship. Inviting citizens to participate in cultural products and unconsciously adopting them pushes individuals to limit their choices in the space of the culturally acceptable good, in line with the characteristics of dictators.

In this direction, sports (football) but also various celebrations (religious or not), were utilised, aiming at keeping the people hypnotic and, above all, to transmit to them a different type of culture, which would not threaten the presence of the dictators in power. In the same logic of propaganda, television broadcasts also worked, something unprecedented for Greece at that time. It is worth noting that the content of the few television programs at that time was determined by the dictatorial regime (Zacharopoulos & Paraschos, 1993, p. 42; Dampasis, 2002, p. 26; Klapsis, 2019, p. 90). Another means of propaganda for the dominant political and cultural situation were the Cinematographic Newsreels, which were short films shown in cinemas and presented events in the world, but differentiated according to the intentions of the dictators (Lambrinos, 2013, p. 230). Finally, during the period under review (1967-1974), a number of films were state-financed, which dealt with war issues, such as the resistance against the Germans, as well as the revolution against the Turks, in order to strengthen the national spirit of the citizens and consequently to reinforce the ideological background of the dictators (Koulouri, 2020, p. 411; Papadimitriou & Kulentianou, 2009, p. 225; Lemonidou, 2017, p. 190).

Research Problem

The issue of the censorship is an extremely diverse concept. However, its study in the Greek literature has been quite limited and mainly focused on specific aspects, overlooking other essential characteristics. The essential features studied in the Greek literature most often focus on the violent suppression of freedom of expression through bans on books, newspapers, magazines and artistic material. All these cases were linked to politically turbulent periods and some took place during the rule of totalitarian regimes (1936-1941 and 1967-1974). But is this enough and, more importantly, does it constitute the main mechanism of censorship? Apparently, the relevant literature has not managed to highlight in the field of modern Greek historiography of education other aspects of the application of censorial actions, which are related to non-obvious processes.

Research Focus

This paper focused on exploring forms of censorship in teacher education during the period of the April dictatorship (1967-1974) in Greece. More specifically, through the above mentioned findings of the literature dealing with the issue of censorship, an attempt was made to show at least two aspects of

³ For more details on this topic see Kounalakis, M. (2020). *The historical library of the Pedagogical Academy of Heraklion (1933 - 1985) and its role in teacher education* (pp. 256-280) [Unpublished doctoral dissertation]. University of Crete.

censorship, one overt and one latent, which seem to have directly influenced the pedagogical training of the future teachers, students of Pedagogical Academy of Heraklion (Hereafter P.A.H.) of this period. All theoretical remarks on this subject were correlated with specific archival documents from the Pedagogical Academy of Heraklion.

Research Aim and Research Questions

The main objective was to highlight those features of the pedagogical training offered by the P.A.H., which were related to the enforcement of censorious actions. This process emerged through the study of the lending library of P.A.H. The main research question was to assess whether there were features of the pedagogical training offered by the P.A.H. in the period under review that were conducive to the development of censorship. The individual research questions concerned the specific actions of this censorship strategy.

Research Methodology

General Background

The theoretical remarks that precede this paper, as well as the brief historical review of censorship implementation during the period of the April dictatorship (1967- 1974) in Greece, served as basic tools of interpretation for the presence of censorship in teacher education within the specific example presented in this paper. More specifically, selected archival documents of the P.A.H. deposited at the KE.M.E.I.E.D.E.⁴ were utilised regarding the training of future teachers in Crete during the period of the seven-year April dictatorship. We will attempt to describe the books that were banned by a document sent to the Pedagogical Academies, as well as the route of this act. Subsequently, we are going to focus on a catalogue containing the books in the lending library of the P.A.H. in order to highlight interesting facts about the circulation of selected categories. In addition, a series of non-obvious actions related to book enrichment in the lending library in the hope that sufficient information will emerge to link these actions to an inverse notion of censorship, which is linked to its productive notion, as discussed in the theoretical part of the article was examined. The methodology was the historical interpretive method of 'history from below' whereby the focus was on individuals and situations that were marginalised by historians and the aim of this methodology is to bring out the real voice of the objects of research, which official history often silences by focusing on 'big' events (Hourdakis, 2006).

Sample of the research: Description of the archival documents relating to censorship in the field of education of teacher candidates in Crete

Library folder with recommendations for book purchase. In a folder entitled *Library folder with recommendations for books to be purchased*, which belongs to P.A.H. archives, a series of mails were found, according to which a number of books should be completely banned. Apart from the content of this list, it is considered appropriate to study the route of the documents leading to the ban. The key document states that

«We temporarily prohibit the circulation, marketing, retail or wholesale sale, clandestine or through agents (placemen) of all the books, writings and reprints listed in the attached list'. It goes on to specify that 'Publishers, booksellers, travelling salesmen and any private individual who associates with them for the purpose of buying or selling the items in the above list' will be punished 'in accordance with the provisions of Article 9 of Law No 9 of 1912, in combination with the provisions of the Criminal Code».

⁴ Centre for the Study and Research of the History of Education and the Teaching Profession of the University of Crete, Greece.

The 'legal' penalty is mentioned in the law entitled '*On the state of siege*' as amended by Laws in 1962, 1941 and 1922.

The previous legislation proves the declaration of Greece in a state of siege, which also marks the abolition of freedom of circulation of intellectual property in the country. The order is notified to the gendarmerie and the *Athens City Police Directorate*, so that they can take the necessary measures and carry out the required checks.

The next action of this prohibition is a very important piece of information according to which *«in addition to the list of banned books transmitted, a second list has been drawn up, which will be sent and a third list will probably be drawn up»*. The same document also mentions that

«it would be advisable for to consider the possibility of an investigation by the competent persons locally into the possibility of the existence in school libraries of books of communist or corrupting content in addition to those contained in the daily catalogues».

The last document in the archives referring to the ban is addressed mainly to the Inspectors of Primary Education in the district and asks for a preventive check of school books. The inspectors are obliged to inform the principals of the schools under their jurisdiction in case

«where books are sent to the Schools by the publishers for purchase, they have to make a preventive inspection of them and, if in their objective and impartial judgment the books sent are objectionable either in content or form, they are obliged to be returned immediately to the senders».

Library archive. From the file entitled *Library Archive*, found in the archive, details about the origin of books of P.A.H. lending library were detected. More specifically, there were numerous documents referring to the decisions to purchase or donate books to the lending library during the late period of the April dictatorship, which covered the period of 1972-1974.

Donations consisted the main reason for the enrichment and also the formation of this lending library, according to this document. The books were divided into 24 taxonomic - cognitive categories, based also on the taxonomic distribution prevailing in the aggregated book catalogues of the library of the P.A.H.

Research Results

List of banned books

In the above mentioned list there were a total of 759 titles of banned books, magazines and newspapers, divided into 14 categories. As regards the content of this list, it should be commented that the five most numerous categories were, in order, the following: Literary, Historical, Books published in the Iron Curtain and imported into Greece, Newspapers and Marxist. The table below shows in detail the most numerous categories of banned books, as well as the number of book titles corresponding to each of them:

Table 1

Number of Books, Newspapers or Magazines Banned by the April 21 Regime, Sorted in Descending Order

Category name	Number on books
Literary	184
Historical	114

Books published in the Iron Curtain and imported into Greece	72
Newspapers	63
Marxist	62

Based on the above mentioned list, it follows a very brief presentation of the content of some categories, not only the five most numerous. In the category of Marxist books we detect book titles which refer to the functioning of the Soviet Union and its ideological principles. The list with the most recorded authors, included some of the greatest ideological leaders of the left-wing ideological and political conviction, such as Lenin (20 books), Marx (5 books), Trotsky (4 books) and Mao Tse-tung (3 books).

In the category of Historical books there are book titles about Byzantium, ancient Greece, Chinese history, Russian history, modern Greek history, prehistoric Greece, World War II, history of modern and ancient Greek literature and history of the Greek language. The books are written mainly by Greek authors, but there are also books in foreign languages in translation. Dimitrios Fotiadis with 14 titles is the most recorded author in this category, followed by Yannis Kordatos with 9 books and Tasos Vournas with 5 titles. All of these authors also embrace left-wing ideological and political convictions.

In the most numerous category, i.e. Literary, there are books titles on prose and poetry, but also scientific treatises on literary issues. Mainly identified books by some of the most well - known authors with left-wing ideological and political convictions were found in this category. More specifically, the most recorded authors are: Yannis Ritsos (26 books), Menelaos Loudemis (18 books), Kostas Varnalis (16 books), Tasos Livaditis (3 books) and Kostas Birkas (3 books).

In the category of Partisan books there are mainly titles dealing with internal issues of the left-wing political party in Greece. In the category of Political books were detected scholarly analyses of the international political situation from the perspective of the left-wing ideology. Among the most recorded authors, were found some who played an important role in the Greek the left-wing ideology, such as: Elias Iliou, Miltos Kyrkos and Yannis Voultesis.

In the category of Philosophical books were detected very important books about the communist ideology. For example, we found 5 books by Mao Tse-Tung, but also books by Hegel, Plekhanov, Lenin and Stalin. Finally, in the categories of Newspapers and Magazines all the titles come from left-wing ideological organisations in Greece and abroad. Interestingly, there are newspapers from Germany, Australia, London and the USA.

Library archive

According to the second series of documents the research resulted in 1.189 donations of books within a period of 2 years. This number should be considered extremely high compared to the total number of copies/books in the library during this period.

The categories of books that are donated the most concern ancient and modern Greek literature. These are followed by books on psychology, sociological-political books on issues of left-wing political ideology, history and pedagogical books. Table 2 shows in descending order the number of donations by taxonomic category:

Table 2

Number of Donations by Taxonomic Category of Books in the Lending Library of the P.A.H. During the Period 1972–1974

Category names	Number of books
Psychology	367
Ancient greek literature	232
Modern greek literature	177
Sociology-politics	77
History	70
Pedagogy	64
Philosophics	60
Science-agronomy	30
Declamations	21
Physical education-scouting-sanitation	21
Didactics	20
Without information	15
Theological	11
Foreign literature-foreign languages	6
Magazines	8
Art and aesthetics	4
Dictionaries-encyclopedias	1
Literature	1
Home economics	2
Legislation	2

A very important feature of these donations is that they come from a very small number of donors, despite their large number. It should be said that two are the main donors to the library in the period 1972-1974, the *Student Welfare Service* (865 donations) and the *General Secretariat for Press and Information* (259 donations). The *General Secretariat of Press and Information* offers a large number of books on modern Greek literature and a relatively high number of sociological-political books on issues of left-wing political ideology. On the other hand, the *Student Welfare Office* donates mainly books on psychology, but also many books on ancient Greek literature. The dominant taxonomic categories

mentioned above are broken down by donor according to what is shown in Tables 3 and 4:

Table 3

Number of Donations from the General Secretariat of Press and Information by Taxonomic Category of Books in the Lending library of the P.A.H. During the Period 1972–1974

Donor name	Number of books
Psychology	0
Ancient Greek literature	0
Modern Greek literature	144
Sociological-political	50
Pedagogy	0
History	26

Table 4

Number of Donations from the Student Welfare Service by Book Category of the Lending Library of the P.A.H. During the Period 1972–1974

Donor name	Number of books
Psychology	362
Ancient Greek literature	230
Modern Greek literature	44
Sociological-political	21
Pedagogy	57
History	14

Discussion

The results of the research should be related to the theoretical remarks on the definition of the concept of censorship, as well as to the brief references that preceded it concerning the legislative actions of the dictatorship regime in this field. At this point, there is a need to clarify that this effort involved a high degree of novelty, as there were no relevant studies in the international and Greek-language literature on the subject of this paper in the field of the historiography of Modern Greek education and for this reason it is difficult to make any correlations or comparisons of the findings of this research with others. Therefore, the main aim of this article was to add to the relevant scholarly discourse a still unappreciated aspect of the application of censorial actions in periods of dictatorial regimes and, particularly, regarding the issue of the education of future teachers.

The purpose of this research was to assess whether there were features of the pedagogical training offered by the P.A.H. in the period under review that were conducive to the development of censorship. According to the findings of the research, there were a number of intense censorial actions concerning the content of the permissible knowledge that the institution's lending library could contain, which attempted to delimit culturally acceptable debate. The administration of the P.A.H. could not fail to comply with this order, as it was interested in its survival in the newly formed political and ideological context. The process of removing books from the lending library corpus constitutes a *de jure* act of degradation of the pedagogical training offered by the P.A.H., but also a *de facto* confession of its complicity with the ideological principles of the dictatorship regime. What can be effortlessly deduced from the research of the archive is the policing and repressive character of the educational institutions at that time. It is no coincidence that all mails that were studied, originating from the Ministry of the Presidency of the Government and the General Secretariat for Press and Information, was transferred to the structures of the Ministry of Education and Religious Affairs, which then pass these orders on to the directors and inspectors of primary education, who are required to cooperate with the police. The ban therefore originates from non-educational institutions and permeates all educational institutions. Therefore, the lending library itself functions as a 'micro-unit' of research and is clearly part of the pedagogical training provided. In this sense, the main objective of the research has been achieved.

The individual research questions concerned the specific actions of this censorship strategy. From the findings of the research it became clear that censorship in the period under consideration with regard to the pedagogical training of P.A.H. was not limited to the violent prohibition of knowledge, but also extended to a non-obvious process of determining permissible knowledge. This took place through specific donations, mainly from state institutions, which influenced the ideological stance of the library and in an implicit way ideologically and pedagogically directed the Academy's students. The origin of the books is a very useful element in interpreting this research and was shown in Tables 3 and 4. What can be concluded is that the main organisation for implementing and coordinating the censorship (the General Secretariat for Press and Information) intervened in the enrichment of the lending library with a donation of many books from the second group, aiming at its ideological reorientation. On the other hand, State Service for Student Welfare was taking the same action, except that it is also donating a large number of books from the first group. If one considers that the largest number of donations came from a department of the ministry which was concerned with the concept of welfare, then the donations took on a different meaning. More specifically, the dictatorial regime intervenes in the library and influences its ideological orientation in an invisible way through the concept of welfare, which has been associated in the past with situations of dealing with morbid situations, but at the same time has also functioned as a means for social reforms and shaping the concept of socially acceptable (Karakatsani & Theodorou, 2010). Therefore, this intention of healing the body is now transferred in the intellectual level and it seems to be more effective in this way. This is an experiment of 'inoculating' the spirit of the students' minds with the aim of their ideological 'purification', according to dictators' standards.

The above description can be explained in terms of productive censorship. Dictators created the substitute of the cultural tradition that violently overthrew by them and incorporated people into it, as part of it and a structural component of its continuation. The same seems to have been attempted in the lending library under consideration. A large set of books were offered that served the hyper-nationalist approach as a characteristic element of dictators' ideology. Therefore, the individual research questions are answered and highlighted a strong presence of hidden censorship in the provided pedagogical training.

Conclusions and Implications

In conclusion, it could be argued that the main objective of the present research, namely the

emergence of characteristics in the pedagogical training offered by the P.A.H. in the period 1967-1974, has been achieved. Through the presentation of the preceding research findings, the violent intervention of the dictators during their first period of rule (1967-1972) and the continuation of this effort in a clandestine manner in their second period of rule (1972-1974) became apparent. Through all this preceding research it became clear that the P.A.H. lending library, as a micro-unit of research, is capable of revealing to a certain extent a 'bottom-up' censorship. As it was mentioned in the conceptual definition of the censorship, its repressive form does not produce strong effects. Dictators could not shape the conditions of subjectification of citizens according to its own criteria through legal means. It tried in the early phase of its government, but the result of this effort had the opposite effect in the field of culture.

In conclusion, it could be argued that the 'other academy' - the lending library - reveals overt and latent aspects of censorship in the pedagogical training of students of P.A.H. during 1967-1974. The dictators initially intervened in an overt way by removing 'corrupt' books and completed the procedure of repression by contributing (through the donations mentioned above) to the formation of a dominant knowledge group which could more effectively and unobtrusively control the formation of the scientific and not only scientific personality of future teachers.

It is worth noting at this point that the current research, as it is part of an archival material study, pertains exclusively to the institution from which the archival material originates, namely, the P.A.H. Therefore, in accordance with the ethics of the historical interpretative methodology "from below", it is difficult to generalise the conclusions of this research to other institutions providing pedagogical training in Greece in the period 1964-1974. In any case, the aim of the followed methodology was to correlate and compare the findings from the micro-units of research (in this case the library of the P.A.H.) with the literature and more generally with research that examined "from above" the historical reality. By definition, such an effort aspires to highlight a specific case of historical reality, with the aim not to influence the general picture the researcher has of a historical period, but to reflect on the particular characteristics of the specific case under study.

Suggestions for Future Research

This research could be further developed at a future level. In continuation of the proposed study, it would be of great historical interest to attempt a correlation and subsequent comparison of the institution of censorship in education (as there are no relevant studies on this issue in teacher education) in the period 1967-1974 with the findings of the present research. In this way, the researcher would have the opportunity to reflect on the presence of other unseen forms of censorship, which they may have overlooked in his/her research. Therefore, this research can be an occasion for broader work on the institution of censorship and offer an additional methodological - interpretative tool. However, the topic of this article can be explored more comprehensively and especially in greater depth if other documents are included, which will accompany the documents studied in this paper. More specifically, it would be of great research interest to study the book loans of the lending library under consideration. In this way, it would be possible to understand whether the censorship intention studied in this article was implemented in practice by the students themselves - future teachers. In this way, the productive form of censorship, which was discussed in the theoretical part of this paper, could be more fully highlighted. It would also be useful to study the documents concerning the student projects created by the borrowed books. It would also be important to study documents concerning the teaching of the courses at the P.A.H. during that period, so that any convergences or divergences with the censorship intention described above can be seen.

References

- Andritsos, G. (2016). Censorship in Greek cinema: Protectors of the nation and youth. *Journal of the Editors*.
- Athanasidou, A. (2008). Censorship and performativity: Regulating the limits of legal discourse. In G. Ziogas (Ed.), *Aspects of censorship in Greece* (pp. 158–166). Nefeli.
- Axelos, L. (1984). *Editorial activity and the movement of ideas in Greece*. Stochastis.
- Bouchard, J. (2018). Nikolaos Mavrokordatos and self-censorship. In I. Hadjipanagioti-Sangmeister (Ed.), *Control of ideas and censorship from the beginnings of Greek printing until the Constitution of 1844* (pp. 163–172). Athens.
- Bourdieu, P. (1991). *Language and symbolic power*. Polity Press.
- Bunn, M. (2015). Reimagining repression: New censorship theory and after. *History and Theory*, 54(1), 25–44. <https://www.jstor.org/stable/24543076>
- Butler, J. (1998). Ruled out: Vocabularies of the censor. In R. Post (eds.), *Censorship and silencing*. (pp. 247–260). Getty Research Institute for the History of Art and the Humanities.
- Charnow, S. D. (2005). The Politics of preventive censorship. In *Theatre, politics, and markets in Fin-de-Siècle Paris* (pp. 53–84). Palgrave Macmillan New York. https://doi.org/10.1007/978-1-137-05458-6_3
- Cook, P., & Heilmann, C. (2013). Two types of self-censorship: Public and private. *Political Studies*, 61(1), 178–196. <https://doi.org/10.1111/j.1467-9248.2012.00957.x>
- Curry, A. (1997). *The limits of tolerance: Censorship and intellectual freedom in public libraries*. Scarecrow Press.
- Dimitropoulos, D. (2018). Between censorship and self-censorship. The attitude of the Hellenic Chronicles. In I. Hadjipanagioti-Sangmeister (Ed.), *Control of ideas and censorship from the beginnings of Greek printing until the Constitution of 1844* (pp. 351–372). Athens.
- Forced law 1092/1938, About the press. (1938). *Official Government Gazette*, 68, Vol. A, 02/22/1938.
- Forced law 437/1937. About Supplementing Law No. 45 of the Forced Law "About the establishment of the State Ministry of Press and Tourism. (1937). *Official Government Gazette*, 22, Vol. A, 25-1-1937
- Forced law 45/1936, About the establishment of the Ministry of Press and Tourism. (1936). *Official Government Gazette*, 379, Vol. A, 31-8-1936.
- Foucault, M. (1976). *Supervision and punishment*. Rappas.
- Foucault, M. (1982). *History of sexuality. 1 The thirst for knowledge*. Rappas.
- Heins, M. (2007). *Not in front of the children: 'Indecency', censorship, and the innocence of youth*. Rutgers University Press. <https://www.jstor.org/stable/j.ctt5hj1m3>
- Hourdakis, A. (2006). "Little secrets": The small scale and the concept of "microtext" in the history of education on the basis of a children's scrapbook. In H. Tzikas (Ed.), *Issues of history and historiography of education* (pp. 71–104). Epikentro.

- Jansen, S. C. (1991). *Censorship: The knot that binds power and knowledge*. Oxford University Press.
- Karakatsani, D., & Theodorou, V. (2010). 'Hygiene orders': Medical supervision and social welfare for the child in the first decades of the 20th century. *Dionikos*.
- Klapisis, H. (2019). The propaganda of dictatorship. In D. Kairidis, A. Klapisis, & S. Vlachopoulos (Eds.), *Dictatorship of the Colonels: A seven year period anatomy* (pp. 90–108). Patakis.
- Koulouri, X. (2020). *Fustanelles and Chlamydes, historical memory and national identity 1821-1930*. Alexandria. Lambrinos, F. (2013). *It is Junta. Will it pass?*. Kastaniotis.
- Law 346/1969, About the press. (1969). *Official Government Gazette*, 232, Vol. A, 11/15/1969.
- Lemonidou, E. (2017). *History on the Big Screen. History, cinema and national identities*. Taxideftis.
- Leonidas, N. (1974). The rodent of truth: Censorship and the rodents that served it during the seven years. *Anti*, (1).
- Meynand, J. (2002). *The political forces in Greece. Volume 2: Royal abortion and military dictatorship*. Savvalas.
- Minnich, N. H. (2010). The fifth Lateran council and preventive censorship of printed books. *Annali Della Scuola Normale Superiore Di Pisa. Classe Di Lettere e Filosofia*, 2(1), 67–104. <http://www.jstor.org/stable/24308618>
- Moellendick, C. M. (2009). Libraries, censors, and self-censorship. *PNLA Quarterly*, 73(4), 68–76. <https://pnla.org/wp-content/uploads/2018/03/volume-73-4-summer-2009.pdf>
- Moody, K. (2004). Opinions and experiences of Queensland-based public librarians with regard to censorship of materials in public library collections: An exploratory analysis. In *Proceedings of the ALIA 2004 Biennial Conference: Challenging Ideas*. https://eprints.qut.edu.au/479/1/ALIA_Paper_eprints.pdf
- Moody, K. (2005). Covert censorship in libraries: A discussion paper. *The Australian Library Journal*, 54(2), 138–147. <https://doi.org/10.1080/00049670.2005.10721741>
- Papadimitriou, L., & Kulentianou, M. (2009). *The Greek musical. Critical-cultural view*. Papazisis.
- Papanikolaou, D. (2017). Making some paradoxical moves: Culture in the years of dictatorship. In Karamanolakis (Ed.), *The military dictatorship*. Ta Nea.
- Pehlivanos, M. (2018). On the self-censorship of a ruler: Nicholas Mavrokordatos and the Philotheos Parerga. In I. Hadjipanagioti-Sangmeister (Ed.), *Control of ideas and censorship from the beginnings of Greek printing until the Constitution of 1844* (pp. 173–192). Athens.
- Peshmazoglou, V. (1999). Greek dictatorship (1967–1974) and the EU: Economy, politics, ideology. In G. Athanasatou (Ed.), *The dictatorship 1967–1974* (pp. 92–114). Kastaniotis.
- Petsini, P., & Christopoulos, D. (2016). Why censorship. In P. Petsini & D. Christopoulos (Eds.), *Censorship in Greece 1967-1974*. (pp. 10–16). Rosa Luxemburg Foundation.
- Raitsinis, C. (2016). *Illegal press, censorship and propaganda during the dictatorship of the colonels 1967-1974* [Unpublished doctoral dissertation]. Aristotle University of Thessaloniki, School of Economics and Political Sciences.
- Reichman, H. (2001). *Censorship and selection: Issues and answers for schools* (3rd. ed.). American Library

Association.

Royal decree 108/1942, About the amendment, supplementation and codification of the provisions on the control of theatrical works, cinematographic films, gramophone records and books. (1942). *Official Government Gazette*, 48, Vol. A, 03/06/1942.

Stratos, K. (1995). *Opposition and dissent the position of the newspapers in the 1967-1974 dictatorship*. Kastaniotis.

Whelan, D. (2009, February 02). *A dirty little secret: Self-censorship*. School Library Journal. <https://www.slj.com/story/a-dirty-little-secret-self-censorship>

Zacharopoulos, T., & Paraschos, M. (1993). *Mass media in Greece: Power, politics and privatization*. Praeger.

Zervou, A. (1992). *Censorship and resistance in the texts of our childhood: 'Robinson', 'Alice' and 'The fairy tale with no name': an adult's reading*. Odysseus.

Ziogas, G. (2008). *Aspects of censorship in Greece*. In G. Ziogas (Ed.), *Aspects of censorship in Greece* (pp. 2–10). Nefeli.

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Parental Support for Rural Female Students' Progression in Advanced Level Sciences in one Province of Zimbabwe

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Abstract: In general, the patriarchal society indoctrinates rural females into accepting subservient positions in numerous domains (i.e., education). It is against this background that this study was geared towards establishing the extent to which parent support the rural female students' progression in education, with specific reference to Advanced Level sciences. Therefore, the study was driven towards comprehending what motivates and influences rural female students to progress in Advanced Level science subjects. Data analysis and interpretation were grounded in pragmatist paradigm and mixed method approach, with personal interviews and semi-structured questionnaires as instruments. The

sample for this study was comprised of 130 Advanced Level rural female students who were progressing in science subjects chosen using stratified random sampling. The quantitative data being scrutinised through the use of frequencies and percentages, and non-numerical data was analysed in accordance with the derived themes. The results acknowledged that female students in the targeted rural school encountered various gender-based challenges (i.e., labelling of science as 'masculine') in Advanced Level science teaching-learning. It was further noted that there existed limited encouragement from their parents when it comes to them venturing into Advanced Level sciences. This study concluded that from the rural female students' viewpoint their parents to a larger extent are seen as not valuing their progression in Advanced Level sciences. In this context, parents are recommended to be sensitised on the relevance of promoting rural female students' progression in Advanced Level sciences. From the results, it is advanced that work on how to transform societal views towards rural female students' progression in Advanced Level sciences.

Keywords: Advanced Level sciences, parental support, progression, rural female student

Introduction

The education curriculum is one experience that most children undergo as they are prepared for future societal functions (Olibie, 2014). Thus, its goal is to create a positive transformation in students' competencies. However, this is expected to occur in a society where the trend of rural females playing subservient roles in the patriarchal society has been seen perpetuated by certain behaviors (Uwizeyimana & Mathevula, 2014). According to Muzvidziwa (2013) social traditions can negatively influence female in coming up with a decision or participate in activities with males of their age. Thus, this environment creates an obstacle that robs females of their human identity and rights (Amin et al., 2018). In this case, females' lives, and roles they perform in society tend to be controlled by cultural barriers (Amadi et al., 2013). For example, the limited females' progression in Advanced Level sciences (i.e., Biology, Chemistry, Physics, Pure Mathematics, Statistics, and Computer Science) (Klugman et al., 2014; Mudau & Ncube, 2017). The male students who progress in these science subjects, are alleged to be born with natural capacities different from those of females (Chikuvadze, 2020). Thus, females acknowledge themselves as being lower to males and have assumed adverse opinions about their potential or capabilities (Zikhali & Perumal, 2016).

This scenario forces the underprivileged female students to the peril of being deserted in their progression in science subjects (Kane & Mertz, 2012). Hereafter, if the existing patriarchal system falls short in addressing female students' needs. These settings advance a narrative that females are at times victims to stereotypic intimidations (Tolbert, 2020). Thus, rural female students have to overcome social obstacles that question their potential to progress in Advanced Level sciences (Zikhali & Perumal, 2016). Rural females have internalised these misconceptions about their potential in education (i.e., science subjects). This is so that despite the increased attention on engaging parents to enhance their children to participation in education, inequitable representation in science pathways remains a challenge (Tolbert, 2020).

In the targeted province, several of rural female students progressing in Ordinary Level sciences (i.e., Biology, Chemistry, Computer Science, Mathematics, Physics, etc.) in rural secondary schools has significantly increased as compared to Advanced Level (Chikuvadze, 2020). Despite, the limited rural female students' progression in Advanced Level sciences, researchers (Chikuvadze, 2022; Mawere et al., 2011) interrogated this issue from other people's perspective (cultural beliefs, teachers, parents, and policymakers) from either urban or peri-urban settlements. Hence, the voices of rural female students were silent on the issue of their progression in Advanced Level sciences. It is against this background

that this study sought to interrogate rural female students' opinions concerning parental support towards their progression in Advanced Level sciences.

Research Problem

The Government of Zimbabwe introduced statutes to promote females' progression in numerous spheres of life (i.e., economy, education, politics, etc.) (Chikuvadze & Chidarikire, 2023). This intends to create an environment that empowers females in the economy, education, etc. However, the sum of rural female students progressing in Advanced Level sciences is significant. This existing gender gap in science subjects has been interrogated by various scholars (e.g., Chikuvadze & Chidarikire, 2023; Chikuvadze, 2022; van Houtte 2023) at different levels focusing on the secondary school or societal levels. Hence the need for this study to interrogate this issue from the rural female students' opinions.

Research Focus

To contribute to the empirical evidence this study intended to gain insight into this identified from the rural female students' standpoint guided by the following research objective: to establish the extent to which parents support rural females' progression in Advanced Level sciences.

Research Aim

A glance at the gender related documentation shows how various governments and non-governmental organisations are advocating for the progression of the rural females in education. Thus, rural female empowerment is increasingly gaining much attention from various stakeholders in education. Therefore, this study was aimed at understanding what motivates rural female students to progress in Advanced Level sciences, source of influence for their progression in Advanced Level science subjects, and issues discouraging them from progressing in Advanced Level sciences.

Theoretical framework

The interrogation of rural female students' opinions towards parental support in their progression in Advanced Level sciences was guided by a theoretical lens made up of functionalism, socialism, and feminism theories. This lens distilled the selected respondents' insights about gender issues in science education and to consider some challenges encountered by rural female students in their progression in Advanced Level sciences. Thus, the framework articulates an intersection between these theories, and rural secondary school contexts in a bid to shed light on rural female students' underrepresentation in Advanced Level science subjects. These theories are taken to be appropriate for this study because when the potentials of rural female students are harnessed through equality and equity (Unterhalter, 2023). Through this framework, this discussion is expected to interrogate various hidden forms of oppression of rural female students in their progression in Advanced Level sciences. This was done through listening to rural female students' understandings and compensable consideration to societal values and practices (Lappalainen et al., 2023).

According to feminists, historically males had more power than females in the patriarchal society (Sen, 2023). Thus, the gender conflict has been seen as the foundation of the society. It is in this context that feminists advocate for the empowerment of the historically disadvantaged rural female students in their progression in Advanced Level science subjects (Shukla & Mishra, 2020). This creates a scenario where rural female students to acquire relevant knowledge, skills and attitudes in different spheres of life (Griffiths & Millei, 2013). In this case education needs to create an environment that brings out the best out of both the females and males (Kalita, 2017). According to Newchurch (2017) functionalists consider education as a crucial social tool that can be used to maintain stability in society through the creation of the sense of empowerment through instilling values and roles. Thus, education is considered

as one of the ways that can be used to break through the cultural conservatism. The next section interrogates relevant sources that cover issues related to parental support and its impact on rural female students' progression in education.

Mahuro and Hungi (2016) considers the family as the fundamental unit in nurturing a child. Hence, the parental support is necessary as an individual traverses through different stages of growth (i.e., from infancy to adolescence). In this context, parental support refers to all forms of nurturing that are given to school-age child (i.e., either a female or male) by parents, and guardians in order to ensure the accomplishment of societal expectations (Waters et al., 2014). In support, Gonzalez-Mena (2011) postulated that parental support was a blend of obligation and dynamic involvement on the part of the parents to the child's progression in sciences. This takes diverse forms at home, for example the provision of basic necessities, instilling expected social values, moulding of positive behaviour, and, enhancing educational aspirations (Rafiq et al., 2013).

According to Anyikwa and Obidike (2012), the parental support is expected to influence how the child makes decisions in life (i.e., career choices). Thus, this is expected to create a platform that promotes effective learning both at home and school. In these circumstances parents are seen as active collaborators in their child's growth and development. Therefore, parents should be well informed about the secondary school operates and their child's progress in learning activities (Olibie, 2014). In this regard parents should be part of their child's educational success through the provision of psychological and academic needs, school-to-home communications, etc. (Lawrence & Fakaude, 2021). However, the parental support during the child's growth and development varies within societies and cultures (Amin et al., 2018). It is in this context that this discussion formed the lens through which the issue under investigation were interrogated with the view to add on empirical evidence on going discourse around rural female students' progression in Advanced Level sciences.

Research Methodology

General Background

This study was grounded in a pragmatist paradigm and mixed-method approach in data collection, analysis, and interpretation (Gobo, 2023). This methodological design was an expedient, and compatibilist lens for selecting the research design that cut across the quantitative and qualitative gulfs (Foster, 2023). Hence, it assisted the researchers to collect, analyse and interpret the current issue with the purpose of engaging the data to articulate the issue under investigation (Luu et al., 2023).

Sample/Participants

From the purposively 10 selected secondary schools in one province, one thousand rural female students studying Advanced Level sciences as potential respondents were identified. A stratified random sampling was used to selected respondents (Ansary et al., 2023), from the 1 300 Advanced Level students according to their rural secondary schools. The potential respondents were put into stratum according to their schools. The random selection was conducted in each of the strata to come up with a representative sample comprising 130 Advanced Level rural female students.

Instrument and Procedures

The study was conducted in phases among them literature method used to identify the gaps to be filled by this study; personal interviews; and a semi-structured questionnaire with open and close-ended indicators focusing on source of motivation to progress in Advanced Level sciences, sources of influence in rural female students' selection of Advanced Level sciences, and issues discouraging rural female students from progressing in Advanced Level sciences was applied to the selected 130

respondents. The objective of this semi-structured questionnaire was to collect data in dependable and effective manner (Taherdoost, 2016). Thus, the precision and constancy formed a significant aspect of the data collection process. The semi-structured questionnaire had a measurement scale that included the following: strongly agree, agree, strongly disagree, and agree. In order for the researchers to triangulate data collected through the earlier on mentioned instruments, personal interviews were conducted. 20 respondents for interviews were purposively selected, the inclusion criterion was that they should have been involved in the completion of semi-structured questionnaire. Both numerical and non-numerical data solicited through these instruments were in the context of the issue under investigation.

Data Analysis

The numerical and non-numerical data were analysed through descriptive statistics and thematic analysis respectively. Ethical considerations were at the centre of data collection, analysis, and discussion. Respondents' contributions are presented in the following sections below.

Research Results

The respondents were asked to share experiences concerning parental support on rural female students' progression in Advance Level sciences. Apart from the fact that the selected respondents were adolescents under the guidance of their parents, there was a probability that their interests and intellectual acumen may prompt their progression in Advanced Level sciences, among other issues. Their motivation to progress in Advanced Level science subjects is discussed below.

Rural female students' motivation to progress in Advanced Level sciences

This section interrogates respondents' views on what motivates rural female students to progress in Advanced Level sciences.

Table 1

The Analysis of the Source of Motivation to Progress in Advanced Level Sciences (Based on the Closed Questionnaire)

Indicator(s)	Strongly Agree	Agree	Strongly Disagree	Disagree
Encouragement from parents	2.3	5	67.7	25
Other females studying engineering in tertiary institutions	50	31	11.5	7.5
Pressure from peers	35.5	53	7.7	3.8

From the table above it can be noted that a few respondents (2.3%) strongly agree and (5%) agree with the notion that encouragement from parents was a source of motivation for rural female students to progress in Advanced Level sciences. On the other hand, most of the respondents (67.7%) strongly disagree with the opinion that encouragement from parents was a source of motivation for their progression in Advanced Level sciences. However, most respondents (50%) strongly acknowledged that other females progressing in engineering in tertiary institutions were a source of motivation for them to progress in Advanced Level sciences. In this regard, one of the respondents noted that:

Upon expressing my wish to pursue pure mathematics or statistics at Advanced Level my parents (dad) became uncompromising. He questioned where as a woman would I apply the mathematical principles in the local community to earn a decent living. I was instructed to go for commercials, such that I can venture into projects like gardening and later sale the products (Respondent 1)

In support, another respondent highlighted that:

At home, my siblings [females] are pursuing either arts or commercials in local polytechnics and universities. Hence, we spend most of our spare time chatting about careers in these fields. On rare occasions we talk about sciences they will be talking about the challenges associated with females' progression in these areas (Respondent 15)

From the above presentation it can be revealed that though the respondents had different sources of motivation when it comes to progression in Advanced Level sciences, the respondents acknowledged that their parents were the least source of motivation. This situation is heightened by patriarchal norms, which give priority to most social issues to males, with females playing subservient roles. The next section on sources of influence for rural female students' career selection is presented and analysed.

Table 2

The Analysis of Sources of Influence in Rural Female Students' Selection of Advanced Level Sciences (Based on the Closed Questionnaire)

Indicator(s)	Strongly Agree	Agree	Strongly Disagree	Disagree
Parents	11.5	19.2	62.4	6.9
Teachers	53.8	30.8	11.5	3.9
Friends	57.7	26.9	9.2	6.2

From the statistics presented in Table 2, it's interesting to note that (11.5%) of the respondents strongly agree with the notion that parents were a source of influence in rural female students' selection of sciences. In addition, (19.2%) of the respondents agreed that parents were a source of influence in rural female students' selection of sciences. From another angle, it was noted that most of the respondents (62.4%) strongly disagreed with the notion that parents were a source of influence in rural female students' selection of sciences. In other words, rural female students' progression in Advanced Level sciences tends to hit a brick due to parents' limited influence in their selection of science-related career paths. As a result, rural female students select careers or subjects that satisfy their parents' demands and expectations. It was also, revealed that teachers and friends were some of the key sources of influence in the rural female students' selection of Advanced Level sciences. In this context, a respondent acknowledged that:

When fetching firewood with other young women during the school holidays programmes that one can do after completing Advanced Level. Some of these girls are pursuing different programmes in polytechnics and universities, majoring in commercials and social sciences (Respondent 13)

Thus, another respondent revealed that:

On fewer occasions I interact with girls pursuing science-related programmes either in polytechnics or universities, they share with us their nasty experiences. In some instances, they highlight that they are taken as being outsiders in the so-called 'masculine' programmes (Respondent 1)

Further to this one of the respondents noted that:

Yes, I am pursuing science subjects at Advanced Level, though with limited encouragement from my parents. Our discussions most of the time centred on issues, which have nothing to do with career selection or what I intend to do after Advanced Level.

However, my Advanced Level Pure Mathematics encourages me to do well in my studies such that I can pursue the so-called 'masculine' programmes at university (Respondent 20)

These results brought to light the point that some parents discourage rural female students from progressing in Advanced level sciences. Thus, traditionally prearranged gender roles have a great influence on rural female students' science-related career path interests (Omar, 2011). However, the female students' interests, and abilities are not taken into account when some of the decisions are made. In the next section issues discouraging rural female students from progressing in Advanced Level sciences.

Table 3

The Analysis of Issues Discouraging Rural Female Students from Progressing in Advanced Level Sciences (Based on the Closed Questionnaire)

Indicator(s)	Strongly Agree	Agree	Strongly Disagree	Disagree
Rural parents inspire their sons to get married women who participated in sciences at Advanced Level and beyond	8.5	10	46.9	34.6
Rural parents were of the opinion that women with science-related professions do not respect husbands with non-science-related professions	43.8	31.5	11.5	13.2
Rural parents discourage women from taking up science-related professions	42.3	32.3	19.2	6.2
Advanced Level sciences are coined 'masculine' subjects	66.9	20.8	4.6	7.7

The above results revealed that most of the respondents (46.9%) strongly disagree with the opinion that rural parents inspire their sons to get married women who participated in sciences at Advanced Level and beyond. In addition, some respondents (43.8%), strongly agree with the view that rural parents were of the opinion that women with science-related professions do not respect husbands with non-science-related professions. From another angle, some respondents (42.3%) and (32.3%) strongly agree and agree respectively to the notion that rural parents discourage females from taking up sciences at Advanced Level. In the same vein, most of the respondents (66.9%) strongly agree with the opinion that science subjects are coined 'masculine.' In this context, rural female students might become reluctant to progress in Advanced Level sciences and beyond. This tends to leave them in a tight corner when it comes to whether to progress or not to progress in Advanced Level sciences. Those who opt to progress in Advanced Level sciences might considered as outcasts in the patriarchal rural society. In this context, one of the respondents noted that:

During discussions with my parents, I am always reminded of a certain village woman who is in her late 30s but still single. A lot of stories a being peddled about why she is unmarried, one of which is that males are afraid to approach her due to her professional qualifications (Respondent 15)

The above results concur with Amadi et al. (2013) who highlighted parents' fear of cultural belief

systems instills odd defiance, and ideals, which makes parents believe that rural female students upon progressing in sciences will become non-compliant to cultural expectations. In this case, cultural expectations favor rural male students to progress in Advanced Level sciences as opposed to rural female students. This is a clear indication that sex-role type of subject selection and gender difference in the patriarchal culture has some objectionable influence on rural female students' progression in Advanced Level sciences. This was supported by a respondent who postulated that:

At our school female students pursuing Advanced Level science subjects on most occasions are seen moving around with boys. They don't interact with fellow female students pursuing other subjects at Advanced Level. Thus, they are seeing themselves as if they are 'boys' (Respondent 11)

This brings to light the point that sciences were stereotyped, thereby making it difficult for rural female students to progress in these subjects at Advanced Level. From another angle, one of the respondents revealed that:

Just before sitting for my [Advanced Level] examinations, mom promised to mobilise resources such that I can attend some [science subjects] extra lessons. This was a welcome move since I wanted to pass with flying colours. At the bottom of my mind, I having a thought that I should be the first engineer in our family (Respondent 4)

This is an unquestionable circumstance that in the absence of constructive backing, any determination to advance rural female students' progression in Advanced Level sciences was greatly hampered (Ajaja, 2012). Thus, if parents value their children's education irrespective of their sex, they tend to inspire them to select the career path of their choice (Dube, 2020). However, another respondent from a different viewpoint highlighted that:

At our school in the [Advanced Level] Physics group, am the only female student. However, the going is not all that rosy. I am finding the going a bit tough since A[dvanced] Level Physics involves a lot of challenging calculations. Provided with another chance I would opt for the arts combination and join other rural female students (Respondent 12)

In this context, Advanced Level sciences (Biology, Chemistry, Computer Science, Mathematics and Physics) were seen as having a 'masculine' image. Thus, this inclines towards sex stereotyping, and relates negatively to rural female students' progression in Advanced Level sciences. Under such a scenario rural female students tend to develop beliefs that they cannot progress in Advanced Level sciences, which are perceived as being inappropriate to their gender. The above contribution concurs with Mapfumo et al. (2002) who postulated that from patriarchal standpoint males are thought to be born with talents different from those of rural female students. This gives credence to the notion that rural female students do not progress in Advanced Level sciences due to their parents' attitudes towards them. In support one of the respondents highlighted that:

Parents were stopping rural female students from progressing in science-related professions. For instance, one Form Four female student was dispirited from progressing in science subjects, though she was brilliant in these subjects. [...] not much was expected from us as rural girls (Respondent 9)

The results showed that social beliefs excluded rural female students from progressing in scientific and technological developmental processes. Thus, rural female students were expected to have their major roles around the home, marriage and motherhood. This was seen as having a negative effect on rural female students' progression in Advanced Level sciences. Thus, rural female students nurtured to admit the gender prejudice, which if not reversed, in the long term will continue to create a situation in which rural female students are underprivileged in science-related careers or professions. Thus, parents

are persuasive in the gender inclined societal activities; this buttress gender-stereotypical expectations in rural female students' progression in Advanced Level sciences.

Discussion

In this paper, respondents were questioned in terms of the opinions on parents support towards rural female students' progression in Advanced Level sciences by conducting interviews, and applying semi-structured questionnaires. It was found that though the government proclaimed policy guidelines to advance the progression of students in education, there is still a huge gap in rural female students' representation in Advanced Level sciences. Thus, this has created the platform for the authors to look at how other factors (i.e., parental support, etc.) influence rural female students' progression in Advanced Level sciences (Mead, 2023; Mowen, 2015). From this study, it can be noted that from the respondents' viewpoint parents' motivation or influence on rural female students' progression in Advanced Level sciences was limited. In addition, parents were seen as discouraging rural female students' progression in Advanced Level sciences. Thus, patriarchal prospects around roles and activities that are assigned according to gender tend to influence parents' opinions towards rural female students' progression in Advanced Level sciences (Cho, 2015; Guillaume et al., 2014).

The results showed that though rural female students were ambitious to progress in Advanced Level sciences, they are finding it problematic to break glass ceiling due to limited influence from their parents. This concurs with Kwaw et al. (2022) who postulated that in rural areas, there is a viewpoint that female students were a liability, and are only meant to carry out household chores. This discourages parents who grew up in a patriarchal society to support rural female students' progression in Advanced Level sciences. In other words, cultural gender expectations tend to stress, other ambitions for rural female students (i.e., motherhood or marriage) over progression in Advanced Level science subjects (Okeke, 2004). The opinion that in a patriarchal society by means of rigid domestic relations female students cannot match the demands of the Advanced Level sciences (Kiamba, 2008; Moyo & Perumal, 2020). Therefore, this creates an environment that discourages rural female students from progressing in Advanced Level sciences. This has an unfavourable effect upon rural female students' mindset, as they usually ridiculed and laughed at.

In other words, rural female students' limited progression in Advanced Level sciences raises tough questions within education sector concerning their continued marginalization the so coined 'masculine' subjects (Chikuvadze, 2020). This concurs with Lips (2013) and Tharenou (2013) who postulated that rural females were likely to come across gender inequality in their schools. Thus, rural female students' involvement in some arrangement that portrays gender inequality through their interactions with parents, regardless of potential to progress in Advanced Level sciences. This is grounded in the patriarchal ideas, customs, and norms that contribute to the 'masculinization' of Advanced Level sciences (Ntekane, 2018; Wilder, 2014). Thus, patriarchal structures can subsidise to the decrease in the sum of rural female students progressing in Advanced Level sciences (Herrero et al., 2017; Joensen & Nielsen, 2013).

It's against this backdrop that academic gender studies (Cech & Blair-Loy, 2019; Sang, 2018), are portraying diverse viewpoints, which incorporate gender balance in terms of the students (both females and males), irrespective of their difference in societal roles. This might also result in a remarkable upsurge in the figure of those rural female students progressing in science, technology, engineering, and mathematics (Hyde & Mertz, 2009). Thus, cultural beliefs like the diverse roles females and males participate in society and in conclusion, customs, which make available prospects for both sexes (Abusalha, 2023). In addition, parents tend to masculinize Advanced Level sciences learning environment by portraying rural female students as not being fit to progress in it (David, 2016; Legewie

& DiPrete, 2012). Rural female students under such limited motivation and inspiration from their parents find themselves in a situation where they are restricted to progress in Advanced Level sciences. Hence, the gender-role culture prevailing in the society, might impact rural female students' progression in Advanced Level sciences (van Houtte, 2023). Consequently, these respondents concur with Kirmak (2017); Mahuro and Hungi (2016) who postulated that rural female students need to interact with others (parents, siblings) such that they can raise the social awareness on the need for their progression in Advanced Level sciences.

Conclusions and Implications

The results exposed that rural female students encountered various gender-based obstacles when progressing in Advanced Level sciences, such as coining these subjects as 'masculine' and stereotype-related to the capabilities of females. It was further revealed that there was limited praise from parents as rural female students to undertake Advanced Level sciences. Thus, respondents advanced the opinion that rural female students' progression in Advanced Level sciences was chiefly influenced by traditional beliefs. These beliefs tended to place rural female students in subservient spot in their progression in Advanced Level sciences. These gendered opinions tend to regulate rural female students' progression in Advanced Level sciences. Thus, the respondents viewed parents as not being supportive of the underprivileged rural female students' progression in Advanced Level sciences. In other words, the lack of parental support was a major flaw in rural female students' progression in Advanced Level sciences. Hence, need to re-socialize parents in rural communities into a new direction where gender equality and equity are the custom. Therefore, this inadequate parental support at grassroots level discourages rural female students from progressing in Advanced Level sciences. Hence, the need to invite parental support in rural female students' progression in Advanced Level sciences learning activities. This creates the platform for the parents to transform their mindsets such that they can meet the interests of the underprivileged rural female students. In addition, there is need to sensitise parents on the importance of rural female students' progression in Advanced Level sciences and the provision of adequate moral support is recommended. In addition, we recommended that community build effective partnerships with rural secondary schools to continually develop, implement, evaluate, and improve rural secondary school-based parental involvement plans. Thus, these plans should support practices, which push for the school, family and community to be involved in rural female students' progression in Advanced Level sciences in diversified ways.

Suggestions for Future Research

Future research is expected to focus on a detailed qualitative analysis of rural female students' understandings of barriers to their progression in Advanced Level sciences. This provides an in-depth understanding of their experiences with the view to contribute towards the creation of an inclusive environment for their progression in Advanced Level sciences. A comparable inquiry indulging the same methods including parents, policymakers and teachers should be carried out with the view to provide an all round comprehension of parents' support in rural female students' progression in Advanced Level sciences. In addition, a mixed-methods approach can be used in advancing an in-depth conception of parental support in rural female students' progression in Advanced Level sciences.

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References

- Abusalha, S. (2023). Towards gender equality in Hungarian universities. *Periodica Polytechnica Social & Management Sciences*. <https://doi.org/10.3311/PPso.20754>
- Ajaja, P. O. (2012). School dropout pattern among senior secondary schools in Delta State, Nigeria. *International Educational Studies*, 5(2), 145–154. <https://doi.org/10.5539/ies.v5n2p145>
- Amadi, M. A., Role, E., & Makewa, L. D. (2013). Girl child dropout: Experiential teacher and student perceptions. *International Journal of Human & Social Science*, 3(5), 124–131. https://www.ijhssnet.com/journals/Vol_3_No_5_March_2013/13.pdf
- Amin, M., Tatlah, I. A., & Afghani, A. (2018). Problems of females' progression in higher education: Perceptions of female university students. *Pakistan Journal of Gender Studies*, 16(1), 71–88. <https://doi.org/10.46568/pjgs.v16i1.116>
- Ansary, K., Gorain, S. C., & Saha, B. (2023). Attitude towards value-oriented education among undergraduate students. *International Journal of Advanced Education & Research*, 8(1), 17–19. <https://www.multidisciplinaryjournals.net/assets/archives/2023/vol8issue1/8006-901.pdf>
- Anyikwa, N., & Obidike, N. (2012). Mothers' constructions of their roles in the literacy education of their children. *Africa Development*, 37(3), 57–67. <https://www.jstor.org/stable/afrdevafrdev.37.3.57>
- Cech, E. A., & Blair-Loy, M. (2019). The changing career trajectories of new parents in STEM. *Proceedings of the National Academy of Sciences (PNAS)*, 116(10), 4182–4187. <https://doi.org/10.1073/pnas.1810862116>
- Chikuvadze, P., & Chidarikire, M. (2023). Influence of Zimbabwean policies on rural female learners' progression in advanced level science subjects. In C. Ndlovu (Ed.), *Quality education in rural learning ecologies in Zimbabwe: Obstacles and opportunities* (pp. 155–183). Peter Lang. <https://doi.org/10.3726/b19865>
- Chikuvadze, P. (2022). Transforming rural female learners' under-representation in Advanced Level science subjects in Zimbabwe. *Asian Journal of Education & Social Studies*, 35(3), 1–11. <https://doi.org/10.9734/AJESS/2022/v35i3756>
- Chikuvadze, P. (2020). *Female pupils' perspective on societal factors influencing their progression in Advanced Level science subjects in Zimbabwe* [Unpublished doctoral dissertation]. University of the Free State.
- Cho, S. (2015). Modeling for determinants of human trafficking: An empirical analysis. *Social Inclusion*, 3(1), 2–21. <https://doi.org/10.17645/si.v3i1.125>
- David, M. E. (2016). *Feminism, gender, and universities: Politics, passion and pedagogies*. Routledge. <https://doi.org/10.4324/9781315582177>
- Dube, B. (2020). Rural online learning in the context of COVID 19 in South Africa: evoking an inclusive education approach. *Multidisciplinary Journal of Educational Research*, 10(2), 135–157. <https://doi.org/10.17583/remie.2020.5607>
- Foster, C. (2023). Methodological pragmatism in educational research: From qualitative-quantitative to exploratory-confirmatory distinctions. *International Journal of Research & Method in Education*. <https://doi.org/10.1080/1743727X.2023.2210063>

- Gobo, G. (2023). Mixed methods and their pragmatic approach: Is there a risk of being entangled in a positivist epistemology and methodology? Limits, pitfalls and consequences of a bricolage methodology. *Forum: Qualitative Social Research*, 24(1). <https://doi.org/10.17169/fqs-24.1.4005>
- Gonzalez-Mena, J. (2011). *Foundations of early childhood education: Teaching children in a diverse setting* (5th ed.). McGraw-Hill Learning Solutions.
- Griffiths, T. G. & Millei, Z. (2013). *Education in/for socialism: Historical, current and future perspectives*. Routledge.
- Guillaume, Y. R. F., Dawson, J. F., Priola, V., Sacramento, C. A., Woods, S. A., Higson, H. E. ... West, M. A. (2014). Managing diversity in organizations: An integrative model and agenda for future research. *European Journal of Work and Organizational Psychology*, 23(5), 783–802. <https://doi.org/10.1080/1359432X.2013.805485>
- Herrero, J., Torres, A., Rodríguez, F. J., & Juarros-Basterretxea, J. (2017). Intimate partner violence against women in the European Union: The influence of male partners' traditional gender roles and general violence. *Psychology of Violence*, 7(3), 385–394. <http://doi.org/10.1037/vio0000099>
- Hyde, J. S., & Mertz, J. E. (2009). Gender, culture, and mathematics performance. *Proceedings of the National Academy of Sciences (PNAS)*, 106(22), 8801–8807. <https://doi.org/10.1073/pnas.0901265106>
- Joensen, J. S., & Nielsen, H. S. (2013). *Math and gender: Is math a route to a high-powered career?* [Discussion Paper No. 7164]. Institute of Labor Economics (IZA). <https://docs.iza.org/dp7164.pdf>
- Kalita, S. (2017). M. K. Gandhi's philosophy of education in the context of present education system of India. *IOSR Journal of Humanities & Social Science*, 22(11), 11–13.
- Kane, J. M. & Mertz, J. E. (2012). Debunking myths about gender and mathematics performance. *Notices of the American Mathematical Society*, 59(1), 10–21. <https://www.ams.org/staff/jackson/fea-mertz.pdf>
- Kiamba, J. M. (2008). Women and leadership position: Social and cultural barriers to success. *Wagadu: A Journal of Transnational Women & Gender Studies*, 6, 7–26.
- Kirmak, K. (2017). *Breaking the glass ceiling*. KPMG. <https://assets.kpmg.com/content/dam/kpmg/tr/pdf/2017/08/kilidi-kirmak-eng.pdf>
- Klugman, J., Kolb, H., & Morton, M. (2014). Persistent gender inequality in the world of work. *The Fletcher Forum of World Affairs*, 38(2), 133–152. <http://www.jstor.org/stable/45289748>
- Kwaw, R., Mfum-Appiah, J., Larbi-Appiah, N. K., & Bintu, I. (2022). An assessment into parental factors that motivate female students to complete formal education. *Open Journal of Educational Research*, 2(6), 274–282. <https://www.scipublications.com/journal/index.php/ojer/article/view/471>
- Lappalainen, S., Hakala, K., Lahelma, E., Mietola, R., Niemi, A. M., Salo, U. M., & Tolonen, T. (2023). Feminist ethnography as 'troublemaker' in educational research: Analysing barriers of social justice. *Ethnography & Education*, 18(1), 38–56. <https://doi.org/10.1080/17457823.2022.2122855>
- Lawrence, K. C., & Fakaude, O. V. (2021) Parental involvement, learning participation and online learning

- commitment of adolescent learners during the COVID-19 lockdown. *Research in Learning Technology*, 29. <https://doi.org/10.25304/rlt.v29.2544>
- Legewie, J., & DiPrete, T. A. (2012). School context and the gender gap in educational achievement. *American Sociological Review*, 77(3), 463–485. <https://doi.org/10.1177/0003122412440802>
- Lips, H. M. (2013). Acknowledging discrimination as a key to the gender pay gap. *Sex Roles*, 68(3), 223–230. <https://doi.org/10.1007/s11199-012-0245-0>
- Luu, T. Q. H., Sit, H. H. W., & Chen, S. (2023). Mixed methods and research design. In *Cultural interactions of English-medium instruction at Vietnamese Universities: The western proposition by the eastern implementation* (pp. 53–69). Springer Singapore.
- Mahuro, G. M., & Hungi, N. (2016). Parental participation improves student academic achievement: A case of Iganga and Mayuge districts in Uganda. *Cogent Education*, 3(1), Article 1264170. <http://dx.doi.org/10.1080/2331186X.2016.1264170>
- Mapfumo, J., Chireshe, R., & Peresuh, M. (2002). Career perceptions and visions of boys and girls in secondary schools in Zimbabwe: Some implications for teachers and parents. *Zambezia*, 29, <https://doi.org/10.4314/zjh.v29i2.6727>
- Mawere, D., Chauraya, E., Matsa, W., Matope, N., Mugodzwa, T., Maruzani, N., & Mukoni, M. (2011). *Introduction to gender studies: A student guide*. Booklove Publishers.
- Mead, D. (2023). The gender gap in university enrolment: Evidence from subjective expectations. *Education Economics*, 31(1), 54–76. <https://doi.org/10.1080/09645292.2022.2027877>
- Moyo, Z., & Perumal, J. (2020). A systematic review of research on women leading and managing education in Zimbabwe. *Gender & Behaviour*, 18(2), 15688–15697.
- Mowen, T. J. (2015). Parental involvement in school and the role of school security measures. *Education & Urban Society*, 47(7) 830–848. <https://doi.org/10.1177/0013124513508581>
- Mudau, T. J., & Ncube, D. (2017). Leadership qualities of women in educational management positions: Stakeholders' perceptions of selected schools in Matabeleland South region in Zimbabwe. *Gender & Behaviour*, 15(4), 10595–10608.
- Muzvidziwa, I. (2013). Gender, culture and exclusion of women in educational leadership. *Alternation*, 20(2), 236–256.
- Newchurch, A. (2017). *The impact of parental involvement on student success: School and family partnership from the perspective of parents and teachers* (Publication No. 21) [Doctoral dissertation, Kennesaw State University]. https://digitalcommons.kennesaw.edu/teachleaddoc_etd/21
- Ntekane, A. (2018). *Parental involvement in education*. <https://doi.org/10.13140/RG.2.2.36330.21440>
- Okeke, P. E. (2004). Higher education for Africa's women: Partners with or cheerleaders for men?. In P. T. Zeleza & A. Olukoshi (Eds.), *African universities in the twenty-first century: Knowledge and society* (pp. 480–492). CODRESIA.
- Olibie, E. I. (2014). Parental involvement in curriculum implementation as perceived by Nigeria secondary school principals. *Journal of Education & Learning*, 3(1), 40–51.

<http://dx.doi.org/10.5539/jel.v3n1p40>

- Omar, N. (2011). *The impact of culture on girls' access to science and technology of education*. UN International Association of Schools of Social Work.
- Rafiq, H. M. W., Fatima, T., Sohail, M. M., Saleem, M., & Khan, M. A. (2013). Parental involvement and academic achievement; A study on secondary school students of Lahore, Pakistan. *International Journal of Humanities & Social Science*, 3(8), 209-223. https://www.ijhssnet.com/journals/Vol_3_No_8_Special_Issue_April_2013/22.pdf
- Sang, K. J. C. (2018). Gender, ethnicity and feminism: an intersectional analysis of the lived experiences feminist academic women in UK higher education. *Journal of Gender Studies*, 27(2), 192-206. <https://doi.org/10.1080/09589236.2016.1199380>
- Sen, S. (2023). Functionalism, socialism and feminism in education. *EPRA International Journal of Multidisciplinary Research*, 9(4), 115-117.
- Shukla, A., & Mishra, M. S. (2020). Feminism and education. *UGC Care Journal*, 43(4), 56-59.
- Taherdoost, H. (2016). Validity and reliability of the research instrument: How to test the validation of a questionnaire/survey in research. *International Journal of Academic Research in Management*, 5(3), 28-36. <https://doi.org/10.2139/ssrn.3205040>
- Tharenou, P. (2013). The work of feminists is not yet done: The gender pay gap – a stubborn anachronism. *Sex Roles*, 68(3), 198-206. <https://doi.org/10.1007/s11199-012-0221-8>
- Tolbert, D. (2020). Girls can do STEAM too – investigating the influence of a STEAM career awareness workshop on Tanzanian and Zimbabwean secondary school girls' perception of careers in STEAM. *Global Journal of Engineering Education*, 22(2), 76-84. <http://www.wiete.com.au/journals/GJEE/Publish/vol22no2/01-Tolbert-D.pdf>
- Unterhalter, E. (2023) An answer to everything? Four framings of girls' schooling and gender equality in education. *Comparative Education*, 59(2), 145-168. <https://doi.org/10.1080/03050068.2023.2202374>
- Uwizeyimana, D. E., & Mathevula, N. S. (2014). Promotion of female educators into school management positions: a gendered perspective. *Mediterranean Journal of Social Sciences*, 5(20), Article 1203. <https://doi.org/10.5901/mjss.2014.v5n20p1203>
- van Houtte, M. (2023). Understanding the gender gap in school (dis)engagement from three gender dimensions: The individual, the interactional and the institutional. *Educational Studies*, 49(2), 260-278. <https://doi.org/10.1080/03055698.2020.1842722>
- Waters, L. H., Menchaca, M. P., & Borup, J. (2014). Parental involvement in K-12 online and blended learning. In K. Kennedy & R. E. Ferdig (Eds.), *Handbook of research on K-12 online and blended learning* (2nd ed., pp. 403-422). <https://ndownloader.figshare.com/files/12212651>
- Wilder, S. (2014). Effects of parental involvement on academic achievement: A meta-synthesis. *Educational Review*, 66(3), 377-397. <https://doi.org/10.1080/00131911.2013.780009>
- Zikhali, J., & Perumal, J. (2016). Leading in disadvantaged Zimbabwean school contexts: Female school heads' experiences of emotional labour. *Educational Management Administration & Leadership*, 44(3), 347-362. <https://doi.org/10.1177/1741143214558572>

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Final Year Mathematics Students Perception of e-Learning and Instruction During the Covid-19 Era

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Abstract: The current trend of most tertiary teaching to reach out students in different modes such as distance, weekends and sandwich resorts largely to online system. The Covid-19 pandemic brought up various lock-down strategies in most countries. This allowed most universities such as Valley View University (a Premier Private University in Ghana, West Africa) to start with online lesson delivery modes to help maintain their academic calendar. The aim of this study was to investigate into the perception final year students and lecturers in the Mathematics Education department had on the Online Learning System during the Covid-19 pandemic lockdown era. The study adopted an explanatory investigation design through a sample size of 378 respondents comprising 36 lecturers and 342 students. Students' and lecturers' response to questionnaires put in a Likert Scale were investigated in

numerous descriptive and inferential statistics. The results revealed that lecturers registered a higher positive perception of online learning than students. This variation was however not significant. Specifically, lecturers perceived an increased flexibility in online learning, with learners utilizing a wide range of learning sources. Student interest however decreased in terms of the absence of in person meetings, promotion of students learning, ensuring autonomous learning environment, the absentness of cooperative learning strategies and among others. It was recommended that universities who resort to online means of teaching and learning should resource teachers and learners with the necessary accoutrements to help sustain their interest and minimize stress of teaching and learning. Researchers are however encouraged to further investigate into other factors necessary to sustain learners' and teachers' interest in coping with online (e-learning) modes.

Keywords: educational technology, e-learning, ICT, information technology, lecturers' perception, online learning, online teaching, students' perception, technology in the classroom.

Introduction

Online Teaching strategy has been one of the key modes some educational institutions resort to facilitate students learning beyond face-to-face interaction. Such choice of mode of teaching could be influenced by several factors. Among such need for this strategy was the Covid-19 pandemic which hit the world hard to hide people to their most closet shields. Most institutions resorted to distant teaching in order to enhance and continue teaching and learning. The Covid-19 (coronavirus case), which first appeared in 2019, has since spread globally (Li et al., 2021). Since the coronavirus has spread so far, policies requiring social or physical segregation have been put in place to reduce Covid-19's footprint. The beginning of the pandemic has a significant effect on many spheres of life, particularly schooling. Most institutions switched to online-learning pedagogies as a result of the epidemic. Academic institutions face a difficulty, according to Eromafuru (2020), in adapting to current needs of instructional mode while retaining the effectiveness of session delivery. According to Sharma (2020), the pandemic is enabling an instructional transitional teaching using technologies.

Higher education institutions in Ghana were abruptly shut down by the government as a result of the coronavirus epidemic, and students were instructed to leave campuses as one of the precautions against additional infections (Li et al., 2021). Universities embraced the online educational system as a way to make up for time gaps and maintain ongoing education. The continuous face-to-face class programs at the various educational institutions were severely warped by this influence. According to Coman et al. (2020), academic institutions across the continent are establishing institution-wide task committees to lessen the pandemic's effects and maintain the provision of education. In an effort to maintain students' interest in their specific courses and programs of study, many institutions in wealthy countries have quickly transitioned to online-learning (Olayemi et al., 2021).

Rahayu and Wirza (2020) asserted that using technology to access learning experiences is known as "online learning". According to Marfo and Okine (2016), a type of remote education called online learning constantly concentrated on providing opportunities to a learning environment, as it is effective in terms of time and location than campus-based education. Online learning is described in the media as studying and teaching using technology from home rather than attending a traditional classroom. On gadgets like tablets, computers, cell phones, and iPads, the technology can be used. There are numerous online learning platforms available that can be connected to technology, including Whatsapp, Google Classroom, Ruang Guru, Quipper, Zoom meetings, Moodle, and many others.

Online learning is inexpensive and easy for students to access anywhere, anytime, according to Me

and Fu (2020). Students have the possibility to learn individually through online activities (Anwar & Wahid, 2021). Additionally, it offers current information and can be used with other components to strengthen students' understanding, including audio and video explanation, group chats, forums, discussion boards, and quizzes. Giving Baticulon et al. (2020), distance learning exposes students to cultural diversity and globalization in education by removing time and space restrictions and provides a novel learning experience for students through its variety of contacts with the education community.

Online instruction has some drawbacks. According to Landrum et al. (2020), these drawbacks may include the learners' increased reflection, remoteness, and lack of engagement. Additionally, it is hard to check-out abnormal behaviors involving plagiarism and piracy, being misled into these behaviors, devaluing the role of the instructor, and the inability of purely scientific fields to be properly studied through e-learning. Additionally, using some websites excessively results in unanticipated time and financial costs. The pandemic hasn't yet subsided, therefore the system is here to stay. Additionally, it is unlikely that schools would completely return to the traditional system, which is why it is important to look into and comprehend the perspectives and worries of the teachers and students. This is significant because lecturers and students are used to traditional in person instruction, so the fast shift to remote instruction brought on by the pandemic is probably going to have an effect on both instruction and knowledge. Therefore, the aim of this investigation was to ascertain in what way lecturers and apprentices at Valley View University in Ghana felt about online learning with respect to their perceptions of it.

Online Learning

Online form of instruction is considered as providing instructional strategies in contexts using technological devices (such as mobile phones, laptops, etc.) with an Internet connection (Dhawan, 2020, p. 18). Over the past ten years, there has been a notable increase in the use of e-learning in education, which provides a lot of benefits (Allen & Seaman, 2017, p. 23). Education professionals were forced to design online courses that would improve both teaching (lecturing for higher institutions) and learning efficacy because a large number of students are taking their courses online (Evans, 2014). Numerous studies have demonstrated that distant education increases student engagement, improves the quality of conversations, and fosters online relationships. The debate board can help scholars and advance learning by finding solutions to challenging problems. It may be straightforward to access an online learning platform with mobile technologies like applications and PCs, which could improve the effectiveness of mobile learning (Panigrahi et al., 2018).

In the framework of e-learning (on-line instruction), collaboration and virtual communities could be developed. Online learning has been increasingly adopted and employed in higher educational institutions with the help of information technology including computers, tablets, iPads, and mobile phones (Yu, 2021). Online learning could benefit students in a variety of ways, such as by directing their focus toward crucial information and allowing them to participate in collective educational doings (Alwi et al., 2015). Peer discussions and engagement levels were highly and favorably connected with collaborative learning. The development of virtual communities may enhance the effectiveness of distant education (Panigrahi et al., 2018).

Perceptions of Lectures on Online Learning

Giovannella et al. (2020) study comprehended how teachers view and interact with elearning two months after the Covid-19 outbreak began. It was found that teachers valued the use of technology. This is agreed upon and supported by Klapproth et al. (2020), who suggests that teachers improve their digital literacy. Schools should therefore equip them with the technology and software they require in order for them to be willing to use online teaching tools. A scientific works examination by Frazer et al.

(2017) institute that resultative distance learning techniques recognized a number of periodic themes on collective educational doings. However, the authors suggested that there can be a discrepancy between the use of these tactics and teacher perceptions of what matters most for student achievement. According to Frazer et al. (2017), lecturers believed that modifications based on feedback from students to the instructor were a crucial component of successful distance learning to improve student results.

According to a study from 2021 by Butnaru et al. (2021), lecturers think that the more adaptable and flexible nature of online education has produced some advantages, such as easy access to subject matter experts, exposure to learning environments, a variety of course types, and participation in student communities. Staff in the field of content delivery experience problems with material delivery and decreasing student interest because there aren't enough face-to-face meetings, there isn't enough control over student groups, and there is a barrier to resolving these problems. The teaching team's virtual teaching strategies are unaffected by the increased demands created by the background of the coronavirus pandemic. The ability of the teaching staff to adapt to the new criteria, however, is significantly impacted by how they were developed. The teaching staff with access to online courses and digital resources is less likely to struggle with the difficulties presented by online courses and is more assured to continue teaching in the new environment (Butnaru et al., 2021). Teaching via video, either live or digitally broadcast, is the simplest solution for the academic staff in the Covid-19 pandemic setting.

Students' Opinions of Online Learning's Effectiveness

According to Kituyi and Tusubira's (2013) research, the majority of students do not regard online learning to be very beneficial. According to Armstrong (2011), ICT tool availability is important in terms of students' learning support system. Despite the fact that Olayemi et al. (2021) claimed that elective courses had higher quality than required ones. Scholars assumed the high caliber learner of distance classes (Gómez-Rey et al., 2018). Contrarily, Armstrong (2011) explained that students thought in-person training was more challenging intellectually than online instruction. Similar to Bali and Liu's (2018) findings that students believe face-to-face learning to be superior, Matsunaga (2016) discovered that students selected e-learning mode to in-person other instructional modes. Students believe that an effective online teacher is the person who (a) is able to support the learning, (b) tries to become coupled with scholars in the teaching space, (c) parts the experience, (d) is amicable, (e) forms common well-being, and (f) is attentive to students' requirements, giving the investigation by Frazer et al. (2017). Apprentices reported that effective online teaching techniques reduced their stress levels, improved their work, helped them think critically, and made them more receptive to criticism.

With reference to Almahasees et al. (2021) findings, e-learning education is helpful hard time situations. The lecturers and the students both came to this conclusion. Even yet, technology is not as effective as in-person instruction and learning. The faculty and students have acknowledged a lot of tasks related to online learning, together with their adjustment, chiefly for people with hearing disorders, a lack of motivation as well as contact, ICT issues, worries about information confidentiality, and security. They also agreed that online education has advantages. The main benefits included self-learning, affordable rates, ease, and flexibility. Research on faculty members' perceptions and attitudes toward online learning brought to light the significance of instructors in encouraging communication and collaboration with students. The primary success elements, according to the instructors, were instructional design and subject-matter experience.

Therefore, the design, delivery, and completion rates of the curriculum are crucial for success in both online and in-person learning (Nemetz et al., 2017). The COVID-19 outbreak switches in-person instruction to online courses while the school is on lockdown. Thanks to this improvement, educators

are better able to instruct students using cutting-edge technical skills (Isaeva et al., 2020). Students' and faculty members' opinions were disregarded differently when delivering laboratory courses online (Beck & Blumer, 2016). According to a study conducted at a medium-sized public university, Hidayat (2020) discovered that students see online and distance learning technologies as having some advantages, even though these advantages aren't always knowledge-related. Butnaru et al. (2021) report that students who value involvement in conventional classroom courses think it's critical to engage with academia for a clearer understanding.

Research Problem

Despite the fact that technological advancements have created a variety of opportunities for lecturers in education, the change of the comfortable usual in person education location carriages limits to both the tutor and the apprentice due to the complex nature of technological system (Landrum et al., 2020). According to research (Chandran et al., 2020; Pérez-Pérez et al., 2020; Suryawanshi & Venugopal, 2020), online learning environments fall short of improving learners' generic competencies. Additionally, if comparing with in person locations, learners interact as well as engage in virtual education environments differently, which changes the consequences of their learning. The problem is made more difficult by instructors' decreased connection with students and by the absence of prompt feedback and responses (Littlefield, 2018). Studies have stressed that compared to regular classrooms, online learning demands a different methodology and set of abilities (Boling et al., 2012).

Teachers in underdeveloped nations like Ghana are required to switch to online instruction with little to no training. Ghana's situation is particularly challenging because of the country's enormous student population and weak technical and communication infrastructure. For instance, the Valley View University-Techiman Campus is located in a region where most of scholars live in country areas with potential net problems. Additionally, the majority of these children may lack the tools needed to continually be online and access educational content. This is probably going to have a bad impact on how university education is provided for and accessed. Existing literature explains various tactics, tools, structures and importance of online learning systems with little focus of how teachers and learners perceive it. This study adopted an investigation into finding out how mathematics final year students and lecturers perceived the online (e-learning) means of instructing, learning and assessments.

The benefits of distance classes over traditional classroom instruction, according to Li and Lalani (2020), also include the possibility for students to study individually, return to use documented trainings, and read from electronic resources. However, other researchers assert that because of the digital divide, poor internet connectivity, and limited access to digital resources like computers, online learning is not as effective as classroom instruction (Goldstein et al., 2020; Lau et al., 2020; Govindarajan & Srivastava, 2020). Similar to this, according to Goldstein et al. (2020), a reduced number of students in the COVID-19 era are enrolled in online courses because of persistent absenteeism and poor performance on assignments. Govindarajan and Srivastava (2020) found that as of 2018, just 21.3 percent of pupils have PC or tablets in their classrooms. Lau et al. (2020) contend that a tangible academia location is unique and the crucial to in-depth comprehension. Despite this, there are few studies that examine lecturer-student views on distance education. In order to further the body of knowledge, this research aims to find out how instructors and students at Valley View University evaluate its online learning system.

Research Focus

Valley View University usually embark on regular, weekends, distance and sandwich modes of teaching using face-to-face interaction. The Covid-19 pandemic era demanded a full transition of instructional strategies called *e-Learning*. Students and lecturers had divergent experiences and

perception of the electronic way of teaching and learning and rendering assessment, discussions and among others. The aim of this research was to investigate the vision of distance education by students and lecturers during the Covid-19 Era contrary to the normal regular in person instructional interactions. The study's specific objectives were to: (a) investigate how lecturers at Valley View University view online learning, (b) find out how students at Valley View University view the

effectiveness of online learning, (c) determine whether there is a statistically significant difference in students' perceptions of online learning based on their gender and age, and to (d) determine whether there is a statistically significant difference in lecturers' and students' perceptions of online learning.

Research Aim and Research Questions

The overall aim of the research was to evaluate how lecturers and final year students at Valley View University's Techiman Campus in Ghana, West Africa, perceived the online instructional mode of teaching in times of pandemic. The paper specifically answers the questions: (a) How do lecturers at Valley View University view online learning, (b) How do final year students at Valley View University view the effectiveness of online learning, (c) Is there any statistically significant difference in students' perceptions of online learning based on their gender and age? (d) Is there any statistically significant difference in lecturers' and students' perceptions of online learning.

Research Methodology

General Background

According to Saunders et al. (2009) reviews, there are three (3) main categories of study project: explanatory, exploratory, and descriptive. The explanatory research design is used in this study. Explaining the connection among the features of a state or phenomenon is the main goal of the explanatory study. The connection among the dimensions or qualities of people, groups, conditions, or events is studied using inferential analysis. The t-test and ANOVA analysis were evaluated in this paper's descriptive research design. The research assumed the descriptive paper structure because apart from examining the perception of lecturers and students' perception on online learning, it also evaluates the use of inferential data analysis for determining the presence of statistically important changes in students' opinions of online learning based on their gender and age.

Sample / Participants / Group

The residents of the research comprised lecturers and student of Valley View University – Techiman Campus in Ghana. The population size consisted of 36 lecturers and 2341 students. For the lecturers, all 36 lecturers were used in the study to constitute a census sampling. The study, therefore, used the purposive sampling technique. In purposive sampling, respondents are selected based on a criterion. Students and lecturers were selected on the criterion that, they participated in the online teaching and learning during the covid-19 era and hence deemed to have their perception of online teaching strategies. In this study members in the population are lecturers at the university; either part-time or full-time teaching online as well as the registered students to the courses they teach. In all, a total of 378 respondents comprising 36 lecturers and 342 students, were used in the study. The researchers deemed this representative and appropriate since a census sampling was considered to give equal chances for everybody in the population to be part of the study. Research choice of census sampling (for such students studying mathematics by online modes) is sufficient, efficient and unbiased about any estimation about the population mean and variances in parametric and inferential statistical analyses (Creswell & Creswell, 2017).

Instrument and Procedures

Statistics used in this study came from many sources. Data collected from respondents through surveys makes up the main sources of data. The main data is information that is directly gathered by the researchers for the study task and is information that is especially gathered for a research endeavor. The researchers decided to use questionnaires for this investigation. Google Documents form was used to build two online questionnaires. There were two sections to the survey for lecturers. The demographic profile was in the first section, while the second asked about professors' opinions of online learning. The survey given to the pupils has 2 sections as well. The demographic portion made up the first section. The second part had questions on the perceived efficiency of distance education at Valley View University. Scientific Research procedures were followed to ensure validity, reliability and ethical consideration for study participants through the data collection process. Google online questionnaire survey forms revealed validity and reliability coefficient of 0.91 which was highly strong and reliable.

Data Analysis

Data were analysed with the help of the SPSS (Statistical Package for Social Sciences software). Both descriptive and inferential data analysis were implemented in the study. The 1st objective examines the perceptions of lecturers on online learning in Valley View University. The one-sample t-test was used in the research. Objective two investigated how students perceive the efficiency of distance education at Valley View University. Also, the one-sample t-test was adopted. The third objective evaluated whether there is a statistically important differences in scholars' attitude toward distance education based on their gender and age. The study used both the independent t-test and the ANOVA analysis. The fourth objective also examined whether there is a statistically significant difference in lecturers' and students' perceptions of online learning at Valley View University. The independent t-test analysis was adopted for that analysis.

Research Results

A one-sample t-test in order to evaluate how lecturers felt about online learning was used. Using a one-sample t-test, it was possible to found if the model means differed statistically from a real or imagined residents mean. On the basis of a five-Likert scale, the study is appraised. The conclusion is that students strongly agree with the statement and expressed a favourable perception when a factor is significant (sig. 0.05) and the mean difference is positive, as opposed to when it is negatively perceived.

From the results (Table 1), it is observed that lecturers negatively perceive that online learning provides clear instructions for students' comprehension (mean difference = -0.133, sig = 0.000). Lecturers also negatively perceived that online learning is costly (mean difference = -0.260, sig = 0.001). There was also a negative but non-significant perception that online learning promotes students to learn effectively (mean difference = -0.740, sig = 0.214 > 0.05).

In terms of instructional delivery, lecturers positively perceive that there are increased flexibility and learning opportunities (mean difference = 0.240, sig = 0.000 < 0.05). Additionally, there is a favourable opinion that online education gives the opportunity to use a diversity of learning resources to aid in learning (mean difference = 0.421, sig = 0.015 < 0.05) but the quality of the content is compromised in online learning delivery (mean difference = 0.251, sig = 0.000 < 0.05).

Table 1*Opinions of Lecturers on Distance Education*

	t	Sig. (2-tailed)	Mean Diff	95% Confidence Interval	
				Lower	Upper
Test value = 4					
INSTRUCTIONAL DELIVERY					
Provides clear instructions for students' comprehension	-9.908	0.000	-0.133	0.153	0.103
Increased flexibility and learning opportunities	10.001	0.000	0.240	0.140	0.340
Utilizes a wide range of learning sources to support learning	4.619	0.015	0.421	0.031	0.811
The quality of contents is compromised in online lesson delivery	11.141	0.000	0.251	0.182	0.380
LECTURER INVOLVEMENT					
There is reduced time for lesson delivery	5.115	0.012	0.331	0.130	0.582
Improve on lecturers' digital creativity	8.704	0.000	0.410	0.305	0.515
The possibility to deliver lessons everywhere makes online learning more convenient	7.127	0.000	0.231	0.210	0.252
This means of lesson delivery is costly	-5.678	0.001	-0.260	-0.49	-0.03
STUDENT INVOLVEMENT					
There is lower student interest due to the lack of in person meetings	8.903	0.000	0.660	0.480	0.840
Promotes students' motivation in learning	3.045	0.214	-0.740	-0.97	-0.51
Promotes autonomous learning environment	10.400	0.000	0.402	0.222	0.582
Lessons are flexible and everybody can learn individually	8.911	0.000	0.310	0.301	0.319
Students actively involved with learning	8.078	0.000	0.480	0.301	0.660
Possibility for solutions to be sought from the internet	9.021	0.000	0.580	0.451	0.711

Source: authors' development.

With the involvement of lecturers in online learning, there was a positive perception that there is reduced time (mean difference = 0.331, sig = 0.012 < 0.05), improvement on lecturers' digital creativity (mean difference = 0.410, sig = 0.000 < 0.05) and that online learning provides the possibility to deliver lessons everywhere makes online learning more convenient (mean difference = 0.231, sig = 0.000 < 0.05). With student involvement, lecturers perceived that there is low student interest due to the lack of in person meetings (mean difference = 0.660, sig = 0.000 < 0.05), promotes autonomous learning environment (mean difference = 0.402, sig = 0.000 < 0.05) with flexible lessons where each student can learn from his/her own pace (mean difference = 0.310, sig = 0.000 < 0.05). In addition, lecturers positively perceived that online learning gives the opportunity where students actively participate in learning (mean difference = 0.480, sig = 0.000 < 0.05) and that there is a possibility for solutions to be sought from the internet (mean difference = 0.580, sig = 0.000 < 0.05). On whether the online instruction helps promotes students' motivation in learning, it was tested to be insignificant. Hence students seem to be displeased or unsatisfied with the new trend of teaching compared to their face-to-face instructional delivery.

Opinions of Students on Distance Education

The study adopted the one sample t-test. The grades are offered in Table 2.

Table 2

Perceptions of Students on Online Learning

	t	Sig. (2-tailed)	Mean Diff	95% Confidence Interval	
				Lower	Upper
Test value = 4					
INSTRUCTIONAL DELIVERY					
Provides clear instructions for students' comprehension	-9.011	0.000	-0.132	0.151	0.105
Increased flexibility and learning opportunities	9.987	0.000	0.052	0.021	0.081
Utilizes a wide range of learning sources to support learning	12.870	0.000	0.333	0.203	0.463
The quality of contents is compromise in online lesson delivery	-5.765	0.010	-0.071	0.129	0.021
LECTURER INVOLVEMENT					
There is reduced time for lesson delivery	8.704	0.000	0.316	0.306	0.416
Improve on lecturer's digital creativity	7.127	0.000	0.123	0.106	0.136
Possibility to deliver lessons everywhere makes online learning more convenient	8.903	0.000	0.660	0.487	0.847
This means of lesson delivery is costly	8.176	0.000	0.480	0.301	0.661
STUDENT INVOLVEMENT					
There is lower student interest due to lack of in person meetings	7.717	0.000	0.680	0.538	0.838
Promotes students' motivation in learning	8.872	0.000	0.460	0.321	0.605
Promotes autonomous learning environment	8.098	0.000	0.780	0.651	0.915
Lessons are flexible and everybody can learn individually	9.008	0.000	0.780	0.642	0.927
Students actively involved with learning	-9.216	0.000	-0.640	-0.851	-0.437
Possibility for solutions to sought solution from the internet	-5.975	0.003	-0.360	-0.596	-0.133

Source: field data survey.

From the results, there is a negative student's perception that online learning provides clear instructions for students' comprehension (mean difference = -0.132, sig = 0.000 < 0.05) and that the quality of contents is compromise in online lesson delivery (mean difference = -0.132, sig = 0.000 < 0.05). Students also negatively perceived that they are actively involved with learning (mean difference = -0.640, sig = 0.000 < 0.05) and that there is a possibility that they can seek solution from the internet (mean difference = -0.640, sig = 0.000 < 0.05) mean difference = -0.360, sig = 0.000 < 0.05).

However, students positively perceive that online learning increase flexibility and opens up opportunities for learning (mean difference = 0.052, sig = 0.000 < 0.05), utilizes a wide range of learning

sources to support learning (mean difference = 0.333, sig = 0.000 < 0.05), lead to a reduction time for lesson delivery (mean difference = 0.316, sig = 0.000 < 0.05), improves lecturers digital creativity (mean difference = 0.123, sig = 0.000 < 0.05), present possibility to deliver lessons everywhere (mean difference = 0.660, sig = 0.000 < 0.05) and that online lesson delivery is costly (mean difference = 0.480, sig = 0.000 < 0.05).

There was also a positive perception that student interest decreases due to the lack of in person meetings (mean difference = 0.680, sig = 0.000 < 0.05), that online promotes students learning (mean difference = 0.460, sig = 0.000 < 0.05), promote autonomous learning environment (mean difference = 0.780, sig = 0.000 < 0.05) and that online lessons are flexible and everybody can learn individually (mean difference = 0.480, sig = 0.000 < 0.05).

To evaluate if there is a statistic important differences in students' perceptions of distance learning based on their gender

To determine whether there is a mean alteration in observation between males and females, the study performed an independent t-test analysis. Determine whether there is a statistically important alteration among two means of dissimilar groups using the independent t-test. Males and females are the unrelated groups in this study.

Table 3

Group Statistics of Students' Perceptions of Online Learning Based on Their Gender

Variable	Category	Mean	Std. Deviation
Gender	Female	3.13	2.523
	Male	4.52	1.626

Source: field data.

According to Table 3, the male mean is 4.52 with a average aberration of 1.626 and the feminine mean is 3.13 with a average aberration of 2.523. The average mean value for males is higher than the average mean value for females, according to the provided averages. The standard deviation indicates the degree to which each person's perceptions diverge from the mean. The majority of the responses are likely to be grouped around the average if the standard deviation is smaller. A high average aberration indicated that the data were discrete. The females have a wider value based on the standard deviation readings. This indicates that perceptions of female respondents are more widely distributed. Table 3 shows the analysis of the Levene's Independent Sample Test.

Table 4

Levene's Independent Sample Test Analysis

Category	Levene's Variance	Test of	t-test for Equality of Means		
	F	Sig.	Sig. (2-tailed)	Mean Diff	Std. Error

Gender	Equivalent alterations presumed	7.719	0.009	0.970	-1.39	1.25719
	Equivalent alterations not presumed			0.007	-1.39	1.25719

Source: field data.

As seen in Table 4, the F-test statistic for the Levene's test corresponds to the Sig. p-value in the column for the Levene's test for equality of variances. According to Table 4, the Levene's test result (0.009) is less than 0.05, indicating that there is a substantial difference in the variance of the perceived mean values between males and females. As a result, the analysis uses the column for equal variance not assumed. The analysis indicates that there is a significant difference between the mean value for males and females because the sig (2-tailed) value for this column is similarly less than the 0.05 significance level (therefore, p-value = 0.007 0.05) period such that the males highly perceives improvement in online than females by 1.39 times.

However, Perkowski (2013) found that males positively perceived online learning than females. Cuadrado-García et al. (2017) revealed that the use of online learning by male and female students differed significantly. Gašević et al. (2016) looked at how men and women behaved differently when using computers and discovered that men utilized computers far more frequently and had more positive sentiments around it.

To evaluate whether there is a statistically significant differences in students' perceptions of online learning based on their Age, the study utilised the Chi-Square test statistic for the analysis. The Chi-Square test was then used to ascertain the association between the age and perception of students on online learning. The results of the Chi-Square test are indicated in Table 5.

Table 5

Chi-Square Tests of Students' Perceptions of Online Learning based on their Age

	Value	df	Asymptotic Sig. (2-sided)
Pearson Chi-Square	26.340a	15	0.135
Likelihood Ratio	26.217	15	0.036
Linear-by-Linear Association	2.853	1	0.091
N of Cases	342		

Source: field data.

The Pearson Chi-Square value from the data in Table 5 is 0.135. This value exceeds the significance threshold of 0.05, indicating that there is no statistically important alteration in how students are perceived based on their age.

To identify the Significant Differences between Lecturers' and Students' Perceptions of Online Learning, the study performed an independent t-test analysis. In Table 6, the group statistics are displayed.

Table 6*Group Statistics of Lecturers and Students' Perceptions of Online Learning*

Variable	Category	Mean	Std. Deviation
Perception	Lecturers	4.035	0.785
	Students	3.831	1.018

Source: field data.

From the results, the overall mean for the perception of lecturers is 4.035 with a standard deviation of 0.785 while that for the students is 3.831 and standard deviation of 1.018. There is therefore a variation between the mean perception of lecturers and students with the lecturers registering a higher perception value than the students. To confirm this variation of the difference in the means the Levenes Independent sample test analysis is indicated in Table 7.

Table 7*Levene's Independent Sample Test Analysis*

		Levene's Test of Variance		t-test for Equality of Means		
Category		F	Sig.	Sig. (2-tailed)	Mean Difference	Std. Error
Lecturer-Student Perception	Equal variances assumed	3.187	0.208	0.510	-0.204	0.9671
	Equal variances not assumed			0.087	-0.204	0.8309

Source: field data.

From the results, the significance value for the Levene's test is 0.208 is greater than 0.05. The implication is that there is no appreciable difference between the lecturers' and the students' variance of the perceived mean values for the associated perception. The analysis therefore makes use of the column with the anticipated equal variance. The study's findings indicate that there is no significant difference between lecturers' and students' perceptions of online study because the sig (2-tailed) value for this column is also greater than the 0.05 significance level ($p\text{-value} = 0.087 > 0.05$).

Discussion

Tables 1–7 analysed how lecturers and scholars perceived the distance education and learning environment during the pandemic. The outcomes support earlier findings on how teachers felt about online learning. The study found that throughout the Covid-19 epidemic, applicants had a favourable estimation of the worth and ease of distance learning platforms. According to a comparable study, the majority of respondents (70 percent) are prepared to choose online classes to handle the curriculum during this pandemic. According to Minghat et al. (2020), online learning uses a variety of learning resources and offers clear instructions to help students understand what they are learning. The quality of contents to be delivered is also perceived to be compromised in online lesson delivery (Egielewa et

al., 2021).

To investigate how lecturers at Valley View University view online learning, the findings revealed that most lecturers registered a higher positive perception of online learning than students. This is in consistency with Allen and Seaman (2017), who agreed to the fact that lecturers find it comfortable teaching distance students with necessary ICT tools by digitalised online mode systems. This is also agreed upon and supported by Klapproth et al. (2020) as well as Giovannella et al. (2020) who suggests that teachers should improve their digital literacy to help students better understand mathematics lesson through online modes. There was also a positive perception that student interest decreases due to the absence of face-to-face meetings. Face-to-face teaching approach according students perception promotes students learning, autonomous learning environment with each student having the opportunity to learn at his/her own pace. However, there was no significant difference between the perception of lecturers and students on online studies.

To find out how students at Valley View University view the effectiveness of online learning mode, majority of the students were of the view that, there were no technological resources to guide them while learning at their various homes. They missed the face-to-face lecturing encounter where they can see the lecturer teaching. Teaching mathematics by online can be a little confusing if teachers lack technological skills in the online delivery and hence students perceive online lesson delivery as unbeneficial (Tusubira et al., 2013). There was however, an indication that online learning provides no clear instructions for students' comprehension just like Tusubira et al. (2013) support it. Online teaching and learning are perceived to be cost intensive and do not promote effective students learning participation. Students positively perceive that online learning increase flexibility and opens up opportunities for learning, utilizing a wide range of learning sources, improves lecturers' digital creativity, and present possibility to deliver lessons everywhere.

The study considered determining whether there is a statistically significant difference in students' perceptions of online learning based on their gender and age. There is significant difference between the perception of females and males' students such that the males highly perceive improvement in online than females by 1.39 times. The results were tested to be significant for equal variance assumed for gender disposition in learning of mathematics by online mode. This is in consistency with Owusu-Darko et al, (2017) who investigated into how students engage in mathematics lesson based on their dispositional empathy by gender and age. Mathematics learning seems to be male dominated than females. Age variation in studying seems to favour students who conform to the average age category for grade level, otherwise students becomes deficient in understanding concept.

To determine whether there is a statistically significant difference in lecturers' and students' perceptions of online learning, this variation was however not tested to be significant. Specifically, lecturers perceived an increased flexibility in online learning, with learners utilizing a wide range of learning sources. This according to Panigrahi et al. (2018) may be attributed to lack of technological tools to support online learning. The development of virtual technology may significantly enhance the effectiveness of online teaching and learning. This leads to a reduction in lesson delivery time and improve on lecturer's digital creativity. In addition, lecturers perceived that online learning promotes autonomous learning environment with flexible lessons, giving the opportunity for students to actively participate with learning and presenting a possibility for solutions to be sought from the internet.

As an implication to this findings, Institutions that intends using elearning or online learning system of instruction beyond face-to-face teaching should equip both students and lecturers with the requisite tools, materials, resources such as computers, ipad, tablets and andriod supported apps as well as means of internet access to help stakeholders cope well with online teaching and learning. Students

and lecturer's inability to enjoy online teaching and learning are as a result of necessary resources to support medium of e-instruction.

Conclusions and Implications

In conclusion, lecturers registered a higher positive perception of online learning than students. This variation was however not significant. Specifically, lecturers perceived an increased flexibility in online learning, with learners utilizing a wide range of learning sources, leading to a reduction lesson delivery time and improve on lecturer's digital creativity. In addition, lecturers perceived that online learning promotes autonomous learning environment with flexible lessons, giving the opportunity for students to actively participate with learning and presenting a possibility for solutions to be sought from the internet. There was however, an indication that online learning provides no clear instructions for students' comprehension, is costly and do not promote effective students learning. Students positively perceive that online learning increase flexibility and opens up opportunities for learning, utilizing a wide range of learning sources, improves lecturers' digital creativity, and present possibility to deliver lessons everywhere.

There was also a constructive insight that scholar interest decreases in terms of the lack of in person meetings, promotes students learning, promote autonomous learning environment with each student having the opportunity to learn at his/her own pace. There is an important alteration between the perception of females and males' students such that the males highly perceive improvement in online than females by 1.39 times. However, there was no important alteration between the perception of lecturers and students on online studies.

The study's conclusion is however limited to students' and lecturers' (teachers') perception of online teaching and learning modes during the covid-19 pandemic only. Responses analysed are based on students and lecturer's perception only in the chosen case study. It is however delimited to the chosen study setting of Valley View University online teaching during the Covid-19 era only, a situation which hard-pressed both lecturers and students to find convenient means of reaching out teaching and learning. No generalizability is associated with the key findings and conclusions.

Suggestions for Future Research

There was however, an indication that online learning provides no clear instructions for students' comprehension. Students can interact with the subject more successfully and consequently have more fruitful experiences when provided clear instructions. According to the study, instructors should employ concise, complete, and exact sentences that use specific terminology to help students understand what is expected of them. In order for students to understand what is being taught, professors can also upload videos and voice messages to clarify certain points. Therefore, greater study into this aspect of online system instruction, which is supposed to give teaching and learning meaning, is advised.

From the results, students perceived that they are not actively involved with learning. There is therefore the need for lecturers to incorporate online video conferences and discussions to compensate for the lack of in person meetings. There was an important alteration among the awareness of distance classes for the females and males such that the males highly perceive improvement in online studies than females. There is no doubt however, that online learning has to stay. It is recommended that Universities who hold this teaching modes should frequently organize training session to enlighten students on online learning. This training could target female students so that they could positively perceive online learning as better. It is suggested that further studies should be conducted in other universities to either refute or confirm these findings. Also, future studies should consider working out a model of online learning in tertiary institutions in Ghana.

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References

- Allen, I. E., & Seaman, J. (2017). *Digital compass learning: Distance education enrollment report 2017*. Babson Survey Research Group, e-Literate, and WCET. <https://eric.ed.gov/?id=ed580868>
- Almahasees, Z., Mohsen, K., & Amin, M. O. (2021). Faculty's and students' perceptions of online learning during COVID-19. *Frontiers in Education*, 6, Article 638470. <https://doi.org/10.3389/feduc.2021.638470>
- Alwi, S. K. K., Rauf, M. B., & Haider, K. (2015). Teachers' job satisfaction and the role of principles for effective educational system in secondary schools of Karachi, Pakistan. *Research Journal of Educational Sciences*, 3(2), 1–5. http://www.isca.me/EDU_SCI/Archive/v3/i2/1.ISCA-RJEduS-2014-026.php
- Anwar, I. W., & Wahid, J. H. (2021). Learners' perception on online learning implementation during Covid-19 pandemic. *Journal of Languages and Language Teaching*, 9(2), 126–138. <https://doi.org/10.33394/jollt.v9i2.3576>
- Armstrong, M. (2011). *Armstrong's handbook of strategic human resource management*. Kogan Page Publishers.
- Bali, S., & Liu, M. C. (2018, November). Students' perceptions toward online learning and face-to-face learning courses. In *Journal of Physics: conference series* (Vol. 1108, Article 012094). IOP Publishing. <https://doi.org/10.1088/1742-6596/1108/1/012094>
- Baticulon, R. E., Alberto, N. R. I., Baron, M. B. C., Mabulay, R. E. C., Rizada, L. G. T., Sy, J. J., ... Reyes, J. C. B. (2020). Barriers to online learning in the time of COVID-19: A national survey of medical students in the Philippines. *Medical Science Educator*, 31(2), 615–626. <https://doi.org/10.1007/s40670-021-01231-z>
- Beck, C. W., & Blumer, L. S. (2016). Alternative realities: Faculty and student perceptions of instructional practices in laboratory courses. *CBE—Life Sciences Education*, 15(4), Article 52. <https://doi.org/10.1187/cbe.16-03-0139>
- Boling, E. C., Hough, M., Krinsky, H., Saleem, H., & Stevens, M. (2012). Cutting the distance in distance education: Perspectives on what promotes positive, online learning experiences. *The Internet and Higher Education*, 15(2), 118–126. <https://doi.org/10.1016/j.iheduc.2011.11.006>
- Butnaru, G. I., Niță, V., Anichiti, A., & Brînză, G. (2021). The effectiveness of online education during Covid 19 pandemic — A comparative analysis between the perceptions of academic students and high school students from Romania. *Sustainability*, 13(9), Article 5311. <https://doi.org/10.3390/su13095311>
- Chandran, M., Srikrishnan, A., & Kandasamy, A. (2020). A study on the challenges in implementation of digitization in higher education during Covid-19. *Palarch's Journal Of Archaeology Of Egypt / Egyptology*, 17(7), 4000–4006. <https://archives.palarch.nl/index.php/jae/article/view/2302>

- Coman, C., Ț C., L. G., Meseșan-Schmitz, L., Stanciu, C., & Bularca, M. C. (2020). Online teaching and learning in higher education during the coronavirus pandemic: Students' perspective. *Sustainability*, 12(24), Article 10367. <https://doi.org/10.3390/su122410367>
- Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.
- Cuadrado-García, M., Ruiz-Molina, M. E., & Montoro-Pons, J. D. (2017). Are there gender differences in e-learning use and assessment? Evidence from an interuniversity online project in Europe. *Procedia - Social and Behavioral Sciences*, 2(2), 367–371. <https://doi.org/10.1016/j.sbspro.2010.03.027>
- Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems*, 49(1), 5–22. <https://doi.org/10.1177/0047239520934018>
- Egielewa, P., Idogho, P. O., Iyalomhe, F. O., & Cirella, G. T. (2021). COVID-19 and digitized education: Analysis of online learning in Nigerian higher education. *E-Learning and Digital Media*, 19(1), 19–35. <https://doi.org/10.1177/20427530211022808>
- Eromafuru, E. (2020). Covid-19 pandemic, the ultimate time bomb?: Guaging the socio-cultural & socio-economics impacts of the scourge on the Nigerian SMBEs. *Academy of Strategic Management Journal*, 19(5). <https://www.abacademies.org/articles/covid19-pandemic-the-ultimate-time-bomb--guaging-the-sociocultural--socioeconomics-impacts-of-the-scourge-on-the-nigerian-smbes-9809.html>
- Evans, H. K. (2014). An experimental investigation of videotaped lectures in online courses. *TechTrends*, 58, 63–70. <https://doi.org/10.1007/s11528-014-0753-6>
- Frazer, C., Sullivan, D. H., Weatherspoon, D., & Hussey, L. (2017). Faculty perceptions of online teaching effectiveness and indicators of quality. *Nursing Research and Practice*, 2017, Article 9374189. <https://doi.org/10.1155/2017/9374189>
- Gašević, D., Dawson, S., Rogers, T., & Gasevic, D. (2016). Learning analytics should not promote one size fits all: The effects of instructional conditions in predicting academic success. *The Internet and Higher Education*, 28, 68–84. <https://doi.org/10.1016/j.iheduc.2015.10.002>
- Giovannella, C., Passarelli, M., & Persico, D. (2020). The effects of the Covid-19 pandemic on Italian learning ecosystems: The school teachers' perspective at the steady state. *ID&A Interaction Design & Architecture(s)*, 45, 264–286. <https://hdl.handle.net/2108/262993>
- Goldstein, D., Popescu, A., & Hannah-Jones, N. (2020, April 6). *As school moves online, many students stay logged out*. The New York Times. <https://www.nytimes.com/2020/04/06/us/coronavirus-schools-attendance-absent.html>
- Gómez-Rey, P., Barbera, E., & Fernández-Navarro, F. (2018). Students' perceptions about online teaching effectiveness: A bottom-up approach for identifying online instructors' roles. *Australasian Journal of Educational Technology*, 34(1). <https://doi.org/10.14742/ajet.3437>
- Govindarajan, V., & Srivastava, A. (2020). What the shift to virtual learning could mean for the future of higher ed. *Harvard business review*, 31(1), 3–8.
- Hidayat, A. (2020). Students' perception of e-learning during Covid-19 pandemic. *Mathema Journal*, 2(2), 34–45. <https://doi.org/10.33365/jm.v2i2.689>

- Isaeva, R., Eisenschmidt, E., Vanari, K., & Kumpas-Lenk, K. (2020). Students' views on dialogue: improving student engagement in the quality assurance process. *Quality in Higher Education*, 26(1), 80–97. <https://doi.org/10.1080/13538322.2020.1729307>
- Kituyi, G., & Tusubira, I. (2013). A framework for the integration of e-learning in higher education institutions in developing countries. *International Journal of Education and Development using ICT*, 9(2). <https://www.learntechlib.org/p/130284/>
- Klapproth, F., Federkeil, L., Heinschke, F., & Jungmann, T. (2020). Teachers' experiences of stress and their coping strategies during COVID-19 induced distance teaching. *Journal of Pedagogical Research*, 4(4), 444–452. <https://files.eric.ed.gov/fulltext/EJ1282769.pdf>
- Landrum, B., Bannister, J., Garza, G., & Rhame, S. (2020). A class of one: Students' satisfaction with online learning. *Journal of Education for Business*, 96(2), 82–88. <https://doi.org/10.1080/08832323.2020.1757592>
- Lau, H., Khosrawipour, V., Kocbach, P., Mikolajczyk, A., Schubert, J., Bania, J., & Khosrawipour, T. (2020). The positive impact of lockdown in Wuhan on containing the COVID-19 outbreak in China. *Journal of travel medicine*, 27(3), Article taaa037. <https://doi.org/10.1093/jtm/taaa037>
- Li, Z., Anaba, O. A., Ma, Z., & Li, M. (2021). Ghanaian smes amidst the covid-19 pandemic: Evaluating the influence of entrepreneurial orientation. *Sustainability*, 13(3), Article 1131. <https://doi.org/10.3390/su13031131>
- Li, C., & Lalani, F. (2020). *The COVID-19 pandemic has changed education forever. This is how*. World Economic Forum. <https://www.weforum.org/agenda/2020/04/coronavirus-education-global-covid19-online-digital-learning/>
- Littlefield, J. (2018). *The difference between synchronous and asynchronous distance learning*. ThoughtCo. <https://www.thoughtco.com/synchronous-distance-learning-asynchronous-distance-learning-1097959>
- Marfo, J. S., & Okine, R. K. (2016). Implementation of e-learning in Ghanaian tertiary institutions (A case study of KNUST). *E-Learning*, 3(9), 29–41. <https://linc.mit.edu/linc2010/proceedings/session6Kabutey.pdf>
- Matsunaga, S. (2016). College students' perceptions of online learning: knowledge gain and course effectiveness. *The Online Journal of Distance Education and e-Learning*, 4(2), 20–30. <https://tojqi.net/journals/tojdel/volumes/tojdel-volume04-i02.pdf#page=27>
- Me, A., & Fu, H. (2020). How COVID-19 is changing the world : a statistical perspective. *Committee for the Coordination of Statistical*. <https://unstats.un.org/unsd/ccsa/documents/covid19-report-ccsa.pdf>
- Minghat, A. D., Ana, A., Purnawarman, P., Saripudin, S., Muktiarni, M., Dwiyanti, V., & Mustakim, S. S. (2020). Students' perceptions of the twists and turns of e-learning in the midst of the Covid 19 outbreak. *Revista Romaneasca Pentru Educatie Multidimensionala*, 12(1Sup2), 15–26. <https://doi.org/10.18662/rrem/12.1sup2/242>
- Nemetz, P. L., Eager, W. M., & Limpaphayom, W. (2017). Comparative effectiveness and student choice for online and face-to-face classwork. *Journal of Education for Business*, 92(5), 210–219. <https://doi.org/10.1080/08832323.2017.1331990>

- Olayemi, O. M., Adamu, H., & Olayemi, K. J. (2021). Perception and readiness of students' towards online learning in Nigeria during Covid-19 pandemic. *Library Philosophy and Practice (e-journal)*, Article 5051. <https://digitalcommons.unl.edu/libphilprac/5051>
- Owusu-Darko, I., Osei-Boadu, Y., & Ansah-Hughes, W. (2017). Gender dispositional empathy on student's mathematical engagement: A qualitative approach. *World Wide Journal of Multidisciplinary Research and Development*, 3(1), 51–58. <http://wwjmr.com/upload/1507797291.pdf>
- Panigrahi, R., Srivastava, P. R., & Sharma, D. (2018). Online learning: Adoption, continuance, and learning outcome—A review of literature. *International Journal of Information Management*, 43, 1–14. <https://doi.org/10.1016/j.ijinfomgt.2018.05.005>
- Pérez-Pérez, M., Serrano-Bedia, A. M., & García-Piqueres, G. (2020). An analysis of factors affecting students' perceptions of learning outcomes with Moodle. *Journal of Further and Higher Education*, 44(8), 1114–1129. <https://doi.org/10.1080/0309877X.2019.1664730>
- Perkowski, J. (2013). The role of gender in distance learning: A meta-analytic review of gender differences in academic performance and self-efficacy in distance learning. *Journal of Educational Technology Systems*, 41(3), 267–278. <https://doi.org/10.2190/et.41.3.e>
- Rahayu, R. P., & Wirza, Y. (2020). Teachers' perception of online learning during pandemic Covid-19. *Jurnal Penelitian Pendidikan*, 20(3), 392–406. <https://doi.org/10.17509/jpp.v20i3.29226>
- Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research methods for business students* (5th ed.). London, United Kingdom: Printice Hall Financial Times.
- Sharma, K. (2020). Corporate social responsibility - An undeniable helper amidst the Covid-19 pandemic. *International Journal of Law Management & Humanities*, 3(4), 29–46. <https://www.ijlmh.com/corporate-social-responsibility-an-undeniable-helper-amidst-the-covid-19-pandemic/>
- Suryawanshi, D. M., & Venugopal, R. (2020). Preferences, perceptions and barriers to E-learning among medical students during COVID-19 pandemic lockdown in India. *International Journal Of Community Medicine And Public Health*, 7(10), 4100–4104. <https://doi.org/10.18203/2394-6040.ijcmph20204383>
- Tusubira, P. I., Mayoka, K. G., & Nyeko, S. (2013). How can e-learning integration be realized? An exploratory study in Higher Education Institutions. *Asian Journal of Computer Science And Information Technology*, 3(12), 162–172. <https://nru.uncst.go.ug/handle/123456789/5167>
- Yu, Z. (2021). The effects of gender, educational level, and personality on online learning outcomes during the COVID-19 pandemic. *International Journal of Educational Technology in Higher Education*, 18, Article 14 (2021). <https://doi.org/10.1186/s41239-021-00252-3>

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The Role of Virtual Platforms in Modern Astronomy Education: Analysis of Innovative Approaches

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Abstract: The purpose of the article was to study the role of virtual platforms in modern astronomy teaching by identifying and using innovative approaches as well as conducting an empirical study on this topic. To achieve this goal, the scientific methods of descriptive statistics and comparative analysis were used. Subsequently, qualitative interviews were transcribed, and the thematic analysis was used in order to identify recurring themes and patterns in the data. At the same time, a content analysis of the professional literature (41 items) on the integration of virtual platforms into the educational process (including the use of its achievements for teaching astronomy) was carried out. The results showed that the use of virtual platforms in the process of teaching astronomy is one of the promising innovative technological trends that requires further study. The study found that almost all the surveyed specialists used digital tools in their teaching and learning process at least once a week, which is in line with international standards. The interest in the latest technologies, such as artificial intelligence, indicates the relevance of global trends in education in Ukraine, especially in the context of astronomy. In this regard, it is important considering the issues of corporate ethics, the introduction of new approaches to the organisation of the educational process, structural and managerial changes, and pedagogical strategies aimed at adapting to new realities. The scientific novelty of the paper is the use of empirical data to determine the role of virtual platforms in teaching astronomy in Ukraine. The

conclusions indicated that these innovative approaches contribute to the improvement of the level of astronomy understanding and to the increase of students' interest in learning about the universe. They allow creating more dynamic and interactive lessons for the learning process.

Keywords: astronomy, virtual platforms, application, education, programme, digitalisation.

Introduction

Today's world is characterised by the development of information environments and the rapid evolution of digital means of information transmission. Thus, learning is acquiring new technological features that distinguish it from similar processes of relatively recent times. This revolution in education is changing the way we think about learning and transforming traditional methods into dynamic and interactive processes where virtual platforms play a key role (Osore, 2020). These platforms become essential tools for modern education, transform the way of learning and expanding learning opportunities at all levels of the education system. Virtual platforms provide access to a vast amount of knowledge and resources that were previously unavailable. Their impact spans all areas of learning, from early childhood education to higher education. They allow teachers and students effectively communicating, working together on projects, and developing creative and analytical skills.

Qualitative transformations in the education system are impossible without digital changes in the educational process, which aims to maximise the potential of digital technologies. For this reason, digital platforms for online classes and supplementary learning allow all participants in educational interactions facilitating the access to the learning management, online courses, etc. These resources become increasingly important due to several factors such as the total integration of digital technologies into all spheres of public life, large-scale educational changes caused by quarantine restrictions, and the global COVID-19 pandemic (Abumalloh et al., 2021). For Ukrainian realities, the intensification of online learning technologies was caused by the Russian military invasion, as a result of which a return to traditional forms of education was absolutely impossible for a long time due to the threat to the physical life as well as teachers and students health.

Research Problem

These changes are undoubtedly also relevant for astronomical science, which plays an important role in the study of the universe, solar systems, constellations, etc. Given the current proficiencies of digital technologies and the success of modelling, the use of digital platforms for educational purposes is an integral part of modernity. The peculiarities of such use are an innovative phenomenon that will require additional reflection, given the constant evolution of digital educational environments and the Internet in general. As educational environments change, the teaching and learning astronomy aspects are also transforming. This issue was partially studied by Cui et al. (2017), who in their conclusions emphasised the use of certain important programmes. Similarly, Chaiyarak et al. (2021) identified the relevance of digital technologies, including for teaching astronomy. The importance of virtual reality and other digital opportunities for teaching astronomy has also been repeatedly emphasised (de Moraes Rossetto et al., 2023; Haleem et al., 2022), as well as national experience in distance learning (Gargano et al., 2018). However, some issues of improving astronomy teaching (given the continuous development of learning platforms) require some improvement and further development.

Research Focus

In this article the role of virtual platforms in modern astronomy education by examining their advantages and challenges was discussed. The extent to which these platforms can change and improve

approaches to education at different levels was explored, as well as their contribution to the development of skills and knowledge in astronomy were demonstrated. Using specific examples and statistics, it was expected to illustrate the impact of virtual platforms on modern education and to discuss the prospects for their future development.

Research Aim and Research Questions

The purpose of the article was to analyse the role of virtual platforms in modern astronomy teaching by identifying and using innovative approaches. The realisation of this goal involved the examination of the following tasks:

1. The consideration of modern virtual platforms in teaching astronomy importance.
2. The significance and results of the empirical study explanation.
3. The main shortcomings and difficulties in further developing the use of digital tools and virtual platforms identification.

Research Methodology

General background

The research process began with the selection of participants in the experiment. All participants – were teachers of Ukrainian educational institutions of different levels that used modern interactive platforms for studying astronomy for 3 months. The main emphasis was placed on using such tools as Stellarium, SkySafari, NASA's Eyes on the Solar System, WorldWide Telescope, etc. Subsequently, the respondents had to identify the specifics of using these platforms. Based on the obtained data, the role of using these platforms in teaching astronomy was characterised. The obtained information was compared with the results of other scientists, and a general conclusion about the importance of innovative platforms in the educational process was made.

Sampling Procedure

First, the target group was identified: teachers involved in teaching astronomy at different levels (e.g., primary, secondary, college, or university). The sampling method was a stratified random sample, which helped ensuring the representation from different educational levels (e.g., primary, secondary, high school, college) and geographical regions. The sample size was 65 teachers.

Participants

The study involved 65 teachers with different experience in teaching the discipline “Astronomy” and different experience in using innovative methods and forms of teaching.

Criteria for inclusion in the study:

1. Teachers who teach astronomy.
2. Teachers with different levels of experience.
3. Teachers of different types of educational institutions (public schools, private schools, colleges, etc.).
4. Teachers who wish to participate voluntarily.

Participants were recruit through an email invitation to participate in the experiment. This letter

provided clear information about the objectives and procedures of the study. After that, consent was obtained from each participant.

Research Design

Mixed methods research was used in this study, combining both quantitative and qualitative research methods. A sequential research design was used, starting with the collection and analysis of quantitative data, followed by the collection and in-depth analysis of qualitative data.

Instruments and Data Collections

At the first stage of the study, a structured online questionnaire was developed in order to collect quantitative data on the experience and perception of virtual platforms in the process of teaching astronomy. The online questionnaire was created based on Google Forms and distributed through social media. Thus, the empirical materials were collected in stages from 15.02.2023 to 27.05.2023, i.e., throughout the second semester of the academic year. In general, a questionnaire was developed, which consisted of some open and closed questions.

The first level. Open questions.

1. How often have you used innovative technologies in your teaching of astronomy? (Please select one answer)

- a) Constantly
- b) Once a week
- c) Several times a month
- d) Not often
- e) I do not use it at all

2. Has the use of interactive platforms influenced students' attitudes towards learning? (Select one answer)

- a) Yes
- b) No

3. In your opinion, what is missing for the effective use of digital learning platforms in the educational process? (Please select one or more answers)

- a) High level of digital literacy
- b) Suitable material and technical conditions
- c) Motivation for use
- d) Satisfaction with everything

The second level. Closed questions.

1. Do you use innovative approaches to teaching astronomy through virtual platforms? If so, please provide examples of innovative methods or projects you are implementing.

2. Which approach have you used most often in your professional activities?
3. How do you assess the effectiveness of using virtual platforms in teaching astronomy?
4. Please briefly describe the features of using interactive platforms in your astronomy teaching. How do they help you and your students to understand the subject better?
5. What are the benefits of using learning platforms in teaching astronomy?
6. What challenges have you faced in using certain platforms?
7. How do you assess the overall value of using interactive platforms in teaching astronomy?
8. What improvements or recommendations would you suggest for the use of interactive platforms in astronomy education?

Subsequently, semi-structured interviews were also conducted with some teachers to gain an in-depth understanding of their experiences.

Data analysis

To analyse the quantitative data, descriptive statistics were used to summarise the data. A comparative analysis was also used to compare and evaluate the responses of the participants. Subsequently, qualitative interviews were transcribed, and an analysis was used to identify recurring themes and patterns in the data. After that, the results were integrated: the results of the quantitative and qualitative analyses were combined to draw comprehensive conclusions.

Research Results

Modern Virtual Platforms in Teaching Astronomy: The Essential and the Unessential

According to researchers, the main directions of digitalisation of astronomy education may be the use of augmented, virtual, and mixed realities, cloud computing technologies, special online learning platforms, mobile applications, and other digital technologies (Potkonjak et al., 2016). At the same time, the possibilities of distance and blended learning should not be dismissed, as they will require appropriate digitalisation of library collections in educational institutions (Chaiyarak et al., 2021; Kamińska et al., 2019). According to researchers, the most popular virtual platforms with educational content within Europe are Coursera (37 million users), Edx (18 million users), XuetangX (14 million users), Udacity (10 million users), FutureLearn (8.7 million users) (Anthony Jnr & Noel, 2021). Popular platforms in the Ukrainian context are Prometheus, MIT Open Course Ware, Moodle, Classroom, MixSumDu (Malchenko et al., 2021). All of these platforms have their own potential for learning and teaching astronomy.

Special virtual platforms are important for learning astronomy (Hasan & Hasan, 2019; Sarkar et al., 2021). Particularly, a free software product is Stellarium, which allows users observing stars, planets, and other astronomical objects in real-time. Here, you can choose the date and place of observation to study astronomical phenomena (Taghizadeh-Popp et al., 2020). Another important application is SkySafari. It allows users exploring the sky by using smartphones or tablets (Mickaelian & Mikayelyan, 2019) and contains useful features for amateur astronomers. Celestia is a free computer application that allows users exploring the space by moving from planet to planet, star to star (Zhang & Zhao, 2015). NASA's Eyes on the Solar System virtual platform provides an opportunity to explore the solar system and other astronomical phenomena using 3D models and visualisations (Kersting et al., 2023). At the same time, WorldWide Telescope is a special application created by Microsoft that allows users

exploring the universe by viewing a large amount of astronomical data and visualisations. On the other hand, an important resource for learning astronomy is Slooh. It is an online service for observing the sky in real-time using webcams and telescopes located in different parts of the world (Sit, 2022). It provides an opportunity to join online events and the community of astronomers. Table 1 provides basic information about the above programmes and describes their functional mechanisms.

Key information	Functions
Stellarium	
Stellarium is a freely available computer application that allows users tracking astronomical objects in real-time.	Stellarium allows setting the time and place of observation, observing planets, stars, galaxies, and other astronomical objects. The application allows quickly moving to the celestial sphere and observe moving objects.
SkySafari	
SkySafari is a mobile application for smartphones and tablets available on iOS and Android platforms.	SkySafari provides many different features for exploring the sky (including interactive sky maps, detailed descriptions of astronomical objects) the ability to track satellites and other objects, and information about planets and their satellites.
Celestia	
Celestia is a computer application that allows users traveling through the space and explore the universe.	It has a large number of astronomical objects, and it is possible to choose any of them for a closer look. The application allows moving from planet to planet, observing the movement of stars and galaxies.
NASA's Eyes on the Solar System	
This virtual platform from NASA provides an opportunity to explore the solar system through interactive visualisations.	This application allows visualising planets, their satellites, asteroids, and comets in detail, observing NASA missions, and much more.
WorldWide Telescope	
The platform allows users exploring the universe with a large amount of astronomical data and visualisations.	WorldWide Telescope allows exploring galaxies, stars, planets, and other astronomical objects (Nakata et al., 2014). The app allows creating the own tours and exploring the space from different angles.
Slooh	
Slooh is an online service for observing the sky in real-time.	Slooh provides an opportunity to join online observations of astronomical phenomena that are carried out on various telescopes around the world. Users can take part in joint observations and communicate with astronomers.

Source: author's development.

In the context of the analysed problem regarding the peculiarities of teaching astronomy in the modern era, hypotheses about the gradual transition from the quantitative accumulation of technological means to a smooth change of goals and priorities, the manifestation of corporate ethics, new principles of training, appropriate structural and managerial changes and pedagogical techniques focused on the new reality are relevant (Haleem et al., 2022). Educational institutions are faced with a number of challenging tasks (Kruss et al., 2015). These include improving the information and technological infrastructure for providing educational space, productive use of up-to-date digital tools in teaching astronomy, the importance of training, retraining, and upgrading of teaching staff in the context of the growing influence of digital technologies on the new quality and efficiency of learning;

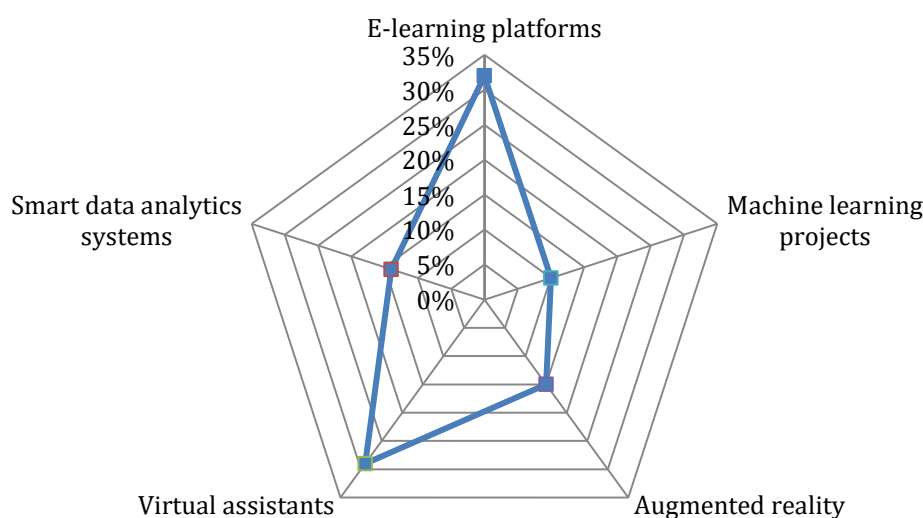
creating a new look for educational content in astronomy.

Virtual Platforms for Teaching Astronomy in Ukraine: An Empirical Aspect

Innovative educational platforms are actively used in modern Ukrainian education. As evidenced, particularly, 70% of respondents use modern educational technologies in the implementation of the astronomy learning process (See Figure 1).

Figure 1

Diagram of the use of Modern Educational Technologies in the Process of Studying Astronomy



Source: author's development.

When reviewing and analysing the survey results, some peculiarities of using virtual learning platforms in education were identified. The results are presented in the form of tables (See Tables 2-4). Innovative educational technologies are actively used in the process of studying astronomy. As evidenced, 41% of respondents used modern learning platforms in the process of teaching astronomy regularly. 45 percent of respondents said they used them once a week (See Table 2).

Table 2

Frequency of Use of Innovative Educational Technologies

How often have you used innovative technologies during your studies? (Please select one answer)		
Answer	Quantity	Percentage
Constantly	26	41 %
Once a week	30	45 %
Several times a month	5	7 %
Not often	4	6%
I do not use it at all	1	1%

Source: author's development.

Nevertheless, the use of special platforms for studying astronomy affects the transformation of students' attitudes to learning. This is confirmed by the answers of the respondents (See Table 3).

Table 3

Transformation of Students' Attitude to Learning as a Result of Using Virtual Platforms in the Process of Studying Astronomy

Has the use of artificial intelligence influenced students' attitudes to learning? (Please select one answer)		
Answer	Quantity	Percentage
Yes, motivation has improved	42	65 %
Nothing has changed	13	20 %
On the contrary, the results have deteriorated	6	9%
No answer	4	6%

Source: author's development.

At the same time, the respondents' opinions were divided when asked "What is missing for the effective use of virtual platforms in teaching astronomy." 45% of respondents said it was important to have a high level of digital literacy. Others noted that Ukrainian institutions lack the appropriate material and technical conditions to actively use virtual platforms (25%). Another 15% said they lacked motivation. At the same time, 15% of respondents emphasised that their institutions have all the conditions for the introduction and use of learning platforms and are therefore satisfied with everything (See Table 4).

Table 4

Notes on the Use of Virtual Platforms

What do you think is lacking for the effective use of artificial intelligence in the educational process? (Choose one answer)

Answer	Quantity	Percentage
High level of digital literacy	30	44 %
Suitable material and technical conditions	13	25 %
Motivation to use	10	14 %
Everything suits me	10	14 %

No answer	2	3
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Source: author's development.

At the same time, the respondents' opinions were also divided when determining the benefits of using virtual learning platforms in the study of astronomy. The majority of them noted the possibilities of individualised learning - artificial intelligence is able to adapt to the needs of students, and therefore develop an individual approach to learning (40% of respondents). Slightly fewer pointed out the importance of monitoring the progress of students (26%), while others focused on the availability of online platforms (18%). It should be noted that the survey results generally correlate with the opinions of researchers, although, for example, respondents did not mention the importance of the ability of digital learning platforms to help people with special needs. At the same time, the majority of respondents clearly emphasise the positive impact of learning platforms on the quality of the educational process (68% of respondents).

When using virtual platforms in modern astronomy teaching, teachers had ample opportunities to implement modern innovative approaches (Mokhun et al., 2022). It was particularly important to use virtual 3-D tours or other digital tools (in particular, based on the use of WorldWide Telescope, Slooh, Celestia and other programmes) (54% of respondents). Another important approach was the use of game-based learning methods and simulations. This approach contributed to the individualisation of learning and improved motivation of students (Malchenko et al., 2020). When using virtual platforms, the use of cooperative projects was also implemented (cooperative learning - indicated by 42%), etc. However, such an approach as involving students in astrophotography was not widely popular among the spitters. Only 5% of respondents mentioned it (See Table 5)

Table 5

Characteristics of Innovative Approaches

Approach	Features of use
Active learning through simulations and virtual labs	Use of interactive simulations and virtual laboratories to explore astronomical phenomena (Gargano et al., 2018; Impey, 2019). Students can independently experiment and observe the consequences, which contributes to a deeper understanding of the material.
Using virtual tours	Organising virtual journeys to space objects, galaxies, planets, and other astronomical objects using virtual reality applications or interactive platforms (Atta et al., 2022). This allows students exploring the space from different perspectives.

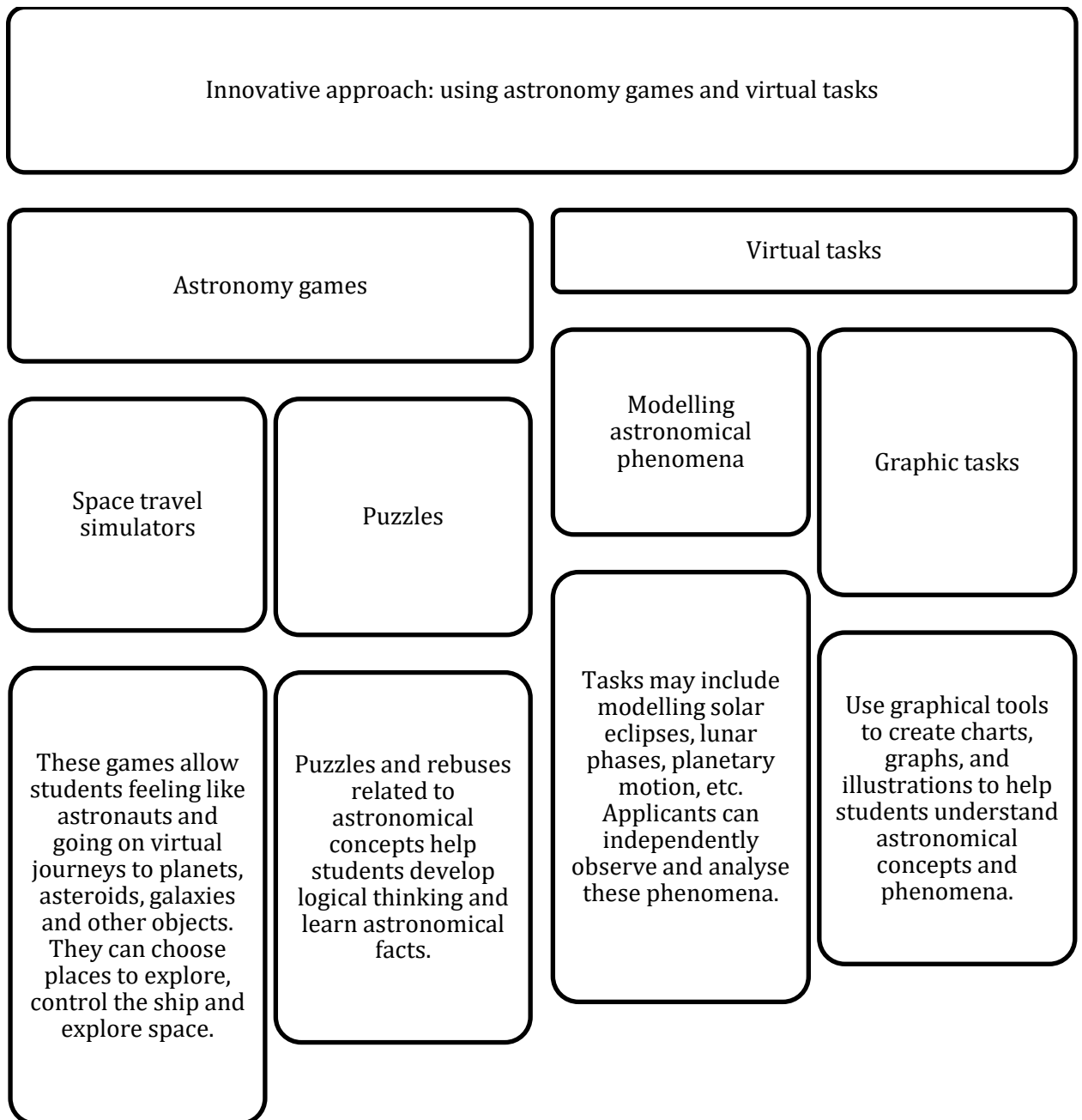
Cooperative learning	The use of virtual platforms for students to work together on astronomy projects or tasks (Abichandani et al., 2019). Students can communicate, share opinions, and research, even if they are at a great distance from each other.
Astronomy games and virtual tasks	Developing game environments or virtual tasks (Bedregal-Alpaca et al., 2020) that allow students learning astronomy by solving puzzles, problems, and simulations.
Astrophotography Astronomical observation networks:	Involving students in astrophotography, where they can take pictures of astronomical objects using virtual platforms and special photo-processing software (Cui et al., 2017). Separately, astronomical observations contribute to the involvement of students in global observing networks, where they can join joint projects and exchange observations with other students around the world.

Source: author's development.

Respondents stated that the use of games that can be used by students outside of class time plays an important role in the system of additional learning (about 62% of respondents emphasised this). Thus, in the system of innovative approaches, it is important to use astronomy games, which can be divided into space travel stimulators, puzzles, or star study games (see Figure 2).

Figure 2

Scheme of Using Astronomical Games and Virtual Tasks in the Process of Studying Astronomy



There are several ways to use this approach:

1. In-class activities. It means that games and virtual tasks can be included in the curriculum and used as additional materials for studying astronomy in class.
2. Distance learning. Students can complete assignments and play astronomy games at home if they are studying remotely.
3. Extracurricular work. Teachers can provide game assignments or virtual research for additional study of astronomy outside of class.

Discussion

The development of modern educational systems is influenced by the general impact of digitalisation and, in general, leads to an important challenge (Reynosa Navarro et al., 2022; Zhang et al., 2020).

First of all, on the one hand, it is already extremely important to ensure that astronomy specialists are trained with appropriate digital competences (Cortiz & Silva, 2017). At the same time, on the other hand, the educational system is faced with the urgent task of adapting its internal organisational and institutional logic to improve its competitiveness in the current market conditions (Domingo & Bradley, 2017). Therefore, the expansion of the use of information technologies and virtual platforms in the near future will lead to fundamental changes in the processes of supply and demand formation in the labour markets, which in turn will adjust the requirements for the need to learn and teach astronomy as an important worldview discipline.

Under current conditions, learning takes place with the active use of digital channels (Ergüzen et al., 2021; Plass et al., 2022). We are talking about cloud services, digital platforms, and tools. Distance and blended learning, which are popular due to quarantine restrictions, use the potential of online platforms, because it is impossible to function otherwise while providing quality educational services without modern technologies (Schneps et al., 2014). Researchers have drawn attention to the fact that the quality of education in general (a broad understanding of this process) is presented as a certain balanced ratio of knowledge (both results and the learning process itself, which is the basis of this system (Cejas Martínez et al., 2021)) with different needs, searches, goals, rules, principles (standards) (Smith et al., 2022; Volioti et al., 2022). At the same time, it is a systemic set of hierarchical and organised in a certain sequence of socially significant important properties (features and attributes of parameters) of education. In practice, this does not mean that traditional forms of education will completely disappear (as well as educational institutions in general). However, much more can be achieved with the use of virtual platforms and new learning technologies - the use of ordinary gadgets (everyday smartphones and other Internet-connected devices) can significantly facilitate the process of learning and gaining knowledge from anywhere and at any time.

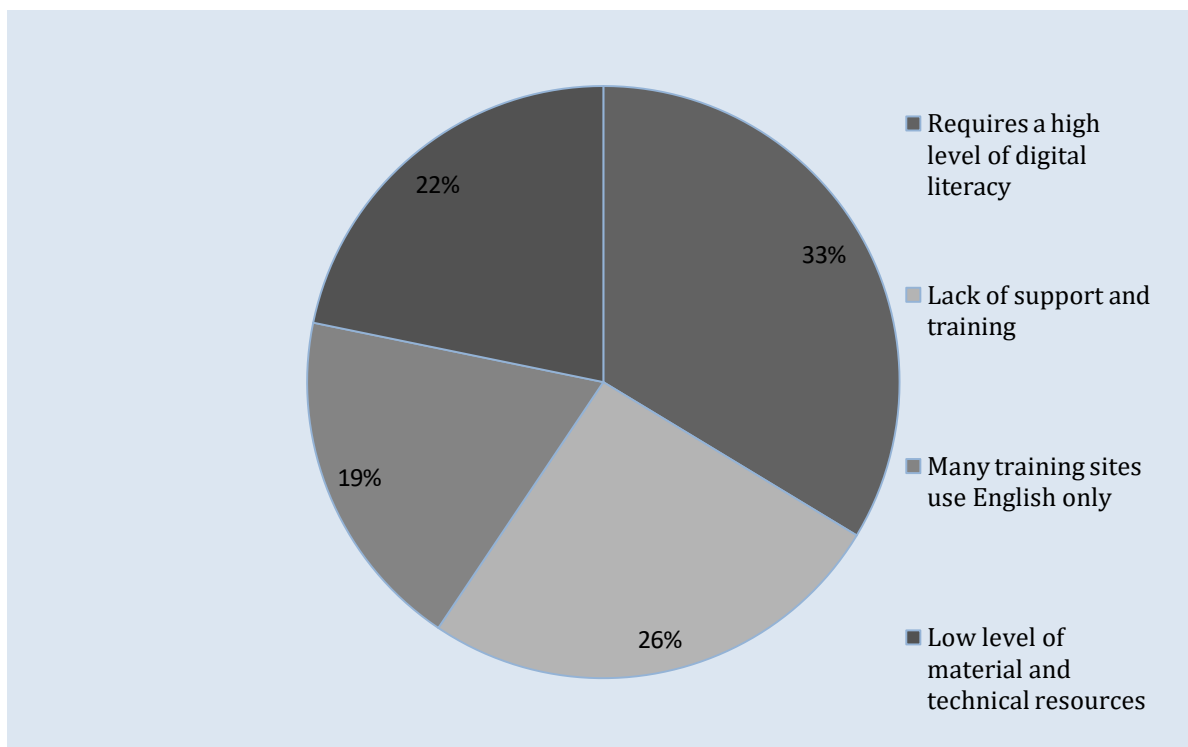
The findings are in line with the trends noted by scholars. Particularly, the vast majority of respondents (86% in total) use innovative technologies in teaching astronomy at least once a week. These figures correlate with those of other researchers (Bedregal-Alpaca et al., 2020; Herwig et al., 2018). In general, it can be argued that the interest in using virtual platforms as innovative teaching tools will be further developed and obviously continued after the COVID-19 pandemic. One of the manifestations of this process is the interest in the use of artificial intelligence, which, according to the study, has found a response in the Ukrainian environment of education seekers (almost 90%). This trend reflects the general direction of the development of astronomy teaching.

However, the implementation of these innovative approaches in the study of astronomy may face some difficulties for teachers (Cole et al., 2018; de Moraes Rossetto et al., 2023). Respondents emphasised that their effective use requires a high level of digital literacy (34%). For this reason, a major challenge for today teachers is to close the gap they may have in digital literacy (Cheng et al., 2021). For teachers who have no previous experience of using interactive learning approaches, it can be difficult to understand how these technologies work and how to apply them in the educational process.

Accordingly, time and effort must be invested in familiarising themselves with the basics of using innovation platforms and their capabilities. Another difficulty in using them is the lack of support and training (22% of respondents). Consequently, a modern educational institution should have adequate training resources so that teachers can understand and effectively use interactive tools in their work. An important disadvantage of using modern innovative platforms in the process of studying astronomy is that almost all available sites are in English (19%), because the level of understanding English is low. Despite this, an important challenge is the inadequate material and technical base. This was emphasised by many respondents (22%) (See Figure 3).

Figure 3

Diagram of the Main Disadvantages and Difficulties of Using Interactive Approaches (Based on the Use of Virtual Platforms) in the Process of Teaching Astronomy



Source: author's development.

Thus, the use of innovative approaches based on the use of virtual learning platforms in the process of teaching astronomy has several advantages and several disadvantages because of the widespread use of modern innovative educational technologies, the above problems should be solved.

Conclusions and Implications

The use of virtual platforms in teaching astronomy is one of the promising innovative technological areas that will require further consideration. Based on the study, it was found that the vast majority of respondents used digital tools in teaching and learning at least once a week, which is in line with European and global indicators. The interest in new technologies, such as Artificial Intelligence, indicates the relevance of other global trends in the Ukrainian educational space (for example, astronomy). In the context of the problem under consideration, which concerns the peculiarities of teaching astronomy in the modern era, hypotheses about a gradual transition from the simple accumulation of technological resources to a smooth change in targets and priorities are relevant. In this context, it is especially important considering the corporate ethics, new approaches to the organisation of the educational process, structural and managerial transformations, and pedagogical strategies aimed at considering new realities. In general, these innovative approaches encourage independent research. The use of virtual tours, virtual laboratories, and games encourage students to explore astronomy on their own and gain a deeper understanding of space phenomena. The above-mentioned innovative approaches lead to more dynamic and interactive lessons resulting in better understanding of astronomy for students and increased interest.

Suggestions for Future Research

Promising areas for further research include the improvement of the tools for acquiring the

necessary digital competencies in the future, as virtual platforms will continue to evolve. These changes will require technological upgrades and the work of both teachers and students. Thus, it is believed that the research on the role of different virtual platforms in modern astronomy education is a dynamic field with ample opportunities for future research. For example, it is necessary to conduct studies to assess the effectiveness of virtual astronomy labs in comparison to traditional hands-on labs. Investigate whether virtual labs provide the same level of learning outcomes and whether they can replace or complement physical labs. Therefore, it is worth conducting an empirical study that will determine the effectiveness of virtual online platforms in comparison with the traditional education system. Research should be conducted in special focus groups and based on the results, describe ways to improve the system of astronomy teaching in modern educational institutions. At the same time, a separate direction for further research is the analysis of interactive modelling. It is worth investigating the impact of interactive simulations and simulation tools on students' understanding of complex astronomical phenomena. An important aspect of this research is to analyse how these tools can improve conceptual understanding and problem-solving skills. Therefore, one believes that by addressing these research areas, scholars can contribute to the ongoing advancement of virtual astronomy education, providing insights and evidence-based practices to enhance the learning experiences of students interested in astronomy.

References

- Abichandani, P., McIntyre, W., Fligor, W., & Lobo, D. (2019). Solar energy education through a cloud-based desktop virtual reality system. *IEEE Access*, 7, 147081–147093. <https://doi.org/10.1109/access.2019.2945700>
- Abumalloh, R. A., Asadi, S., Nilashi, M., Minaei-Bidgoli, B., Nayer, F. K., Samad, S. ... Ibrahim, O. (2021). The impact of coronavirus pandemic (COVID-19) on education: The role of virtual and remote laboratories in education. *Technology in Society*, 67, Article 101728. <https://doi.org/10.1016/j.techsoc.2021.101728>
- Anthony Jnr, B., & Noel, S. (2021). Examining the adoption of emergency remote teaching and virtual learning during and after the COVID-19 pandemic. *International Journal of Educational Management, ahead-of-print*, 35(6), 1136–1150. <https://doi.org/10.1108/ijem-08-2020-0370>
- Atta, G., Abdelsattar, A., Elfiky, D., Zahran, M., Farag, M., & Slim, S. O. (2022). Virtual reality in space technology education. *Education Sciences*, 12(12), Article 890. <https://doi.org/10.3390/educsci12120890>
- Bedregal-Alpaca, N., Sharhorodska, O., Jiménez-González, L., & Arce-Apaza, R. (2020). A gamification experience and virtual reality in teaching astronomy in basic education. *International Journal of Advanced Computer Science and Applications*, 11(5). <https://doi.org/10.14569/ijacsa.2020.0110566>
- Cejas Martínez, M. F., Navarro Cejas, M., Venegas Alvarez, G. S., Proaño Rodríguez, C. E., & Mendoza Velazco, D. J. (2021). Student perceptions of ecuadorian virtual platforms during the Covid-19 pandemic. *Problems of Education in the 21st Century*, 79(2), 241–254. <https://doi.org/10.33225/pec/21.79.241>
- Chaiyarak, S., Nilsook, P., & Wannapiroon, P. (2021). An empirical study of intelligent virtual universal learning platforms. In *2021 research, invention, and innovation congress: Innovation electricals and electronics (RI2C)*. IEEE. <https://doi.org/10.1109/ri2c51727.2021.9559785>
- Cheng, L., Niu, W.-C., Zhao, X.-G., Xu, C.-L., & Hou, Z.-Y. (2021). Design and implementation of college

- physics teaching platform based on virtual experiment scene. *The International Journal of Electrical Engineering & Education*. <https://doi.org/10.1177/0020720920984688>
- Cole, M., Cohen, C., Wilhelm, J., & Lindell, R. (2018). Spatial thinking in astronomy education research. *Physical Review Physics Education Research*, 14(1), Article 010139. <https://doi.org/10.1103/physrevphyseducres.14.010139>
- Cortiz, D., & Silva, J. O. (2017). Web and virtual reality as platforms to improve online education experiences. In *2017 10th international conference on human system interactions (HSI)* (pp. 83–87). IEEE. <https://doi.org/10.1109/hsi.2017.8005003>
- Cui, C.-Z., He, B.-L., Li, C.-H., Fan, D.-W., Li, S.-S., Mi, L.-Y. ... Han, X. (2017). AstroCloud: A distributed cloud computing and application platform for astronomy. In J. Wang, H. Wang, B. Cheng, & T. Chen (Eds.), *3rd international conference on wireless communication and sensor networks (WCSN 2016)*. Atlantis Press. <https://doi.org/10.2991/icwscn-16.2017.108>
- de Moraes Rossetto, A. G., Martins, T. C., Silva, L. A., Leithardt, D. R. F., Bermejo-Gil, B. M., & Leithardt, V. R. Q. (2023). An analysis of the use of augmented reality and virtual reality as educational resources. *Computer Applications in Engineering Education*. <https://doi.org/10.1002/cae.22671>
- Domingo, J. R., & Bradley, E. G. (2017). Education student perceptions of virtual reality as a learning tool. *Journal of Educational Technology Systems*, 46(3), 329–342. <https://doi.org/10.1177/0047239517736873>
- Ergüzen, A., Erdal, E., Ünver, M., & Özcan, A. (2021). Improving technological infrastructure of distance education through trustworthy platform-independent virtual software application pools. *Applied Sciences*, 11(3), 1214. <https://doi.org/10.3390/app11031214>
- Gargano, M., Gasperini, A., Schiavone, L., & Brunetti, F. (2018). Polvere di stelle The Italian platform for data-sharing and data-preserving of modern and ancient astronomical resources. *EPJ Web of Conferences*, 186, Article 07002. <https://doi.org/10.1051/epjconf/201818607002>
- Haleem, P. A., Javaid, D. M., Qadri, P. M. A., & Suman, D. R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, 3, 275–285. <https://doi.org/10.1016/j.susoc.2022.05.004>
- Hasan, P., & Hasan, S. N. (2019). Astronomy data, virtual observatory and education. *Proceedings of the International Astronomical Union*, 15(S367), 151–154. <https://doi.org/10.1017/s174392132100034x>
- Herwig, F., Andrassy, R., Annau, N., Clarkson, O., Côté, B., D'Sa, A. ... Woodward, P. (2018). Cyberhubs: Virtual research environments for astronomy. *The Astrophysical Journal Supplement Series*, 236(2). <https://doi.org/10.3847/1538-4365/aab777>
- Impey, C. (2019). Online resources for astronomy education and outreach. *Proceedings of the International Astronomical Union*, 15(S367), 105–115. <https://doi.org/10.1017/s1743921321000399>
- Kamińska, D., Sapiński, T., Wiak, S., Tikk, T., Haamer, R., Avots, E. ... Anbarjafari, G. (2019). Virtual reality and its applications in education: Survey. *Information*, 10(10), Article 318. <https://doi.org/10.3390/info10100318>
- Kersting, M., Bondell, J., Steier, R., & Myers, M. (2023). Virtual reality in astronomy education: Reflecting

- on design principles through a dialogue between researchers and practitioners. *International Journal of Science Education, Part B*. <https://doi.org/10.1080/21548455.2023.2238871>
- Kruss, G., McGrath, S., Petersen, I.-h., & Gastrow, M. (2015). Higher education and economic development: The importance of building technological capabilities. *International Journal of Educational Development*, 43, 22–31. <https://doi.org/10.1016/j.ijedudev.2015.04.011>
- Malchenko, S. L., Mykoliuk, D. V., & Kiv, A. E. (2020). Using interactive technologies to study the evolution of stars in astronomy classes. In A. E. Kiv & M. P. Shyshkina (Eds.), *Proceedings of the 2nd International Workshop "Augmented reality in education" (AREdu 2019)* (pp. 145–155). <https://doi.org/10.31812/123456789/3752>
- Malchenko, S. L., Tsarynnyk, M. S., Poliarenko, V. S., Berezovska-Savchuk, N. A., & Liu, S. (2021). Mobile technologies providing educational activity during classes. *Journal of Physics: Conference Series*, 1946(1), Article 012010. <https://doi.org/10.1088/1742-6596/1946/1/012010>
- Mickaelian, A. M., & Mikayelyan, G. A. (2019). The role of Big Data in astronomy education. *Proceedings of the International Astronomical Union*, 15(S367), 214–217. <https://doi.org/10.1017/s1743921321000570>
- Mokhun, S., Fedchyshyn, O., Kasianchuk, M., Chopyk, P., Basistyi, P., & Matsyuk, V. (2022). Stellarium software as a means of development of students' research competence while studying physics and astronomy. In *2022 12th international conference on advanced computer information technologies (ACIT)*. IEEE. <https://doi.org/10.1109/acit54803.2022.9913116>
- Nakata, M., Hamacher, D., Warren, J., Byrne, A., Pagnucco, M., Harley, R. ... Bolt, R. (2014). Using modern technologies to capture and share indigenous astronomical knowledge. *Australian Academic & Research Libraries*, 45(2), 101–110. <https://doi.org/10.1080/00048623.2014.917786>
- Osores, J. J. V. (2020). Virtual university education in the context of the health emergency due to COVID-19: Challenges in the evaluation processes. *International Journal of Early Childhood Special Education*, 12(1), 467–477. <https://doi.org/10.9756/int-jecse/v12i1.201027>
- Plass, J. L., Hovey, C., Maso, A. S., Fröhlich, F., Ghosh, S., Olsen, A., & Perlin, K. (2022). Designing effective immersive VR learning experiences. *Immersive Learning Research – Practitioner*, 1(1), 32–37. <https://doi.org/10.56198/A6PFY1CBT>
- Potkonjak, V., Gardner, M., Callaghan, V., Mattila, P., Guetl, C., Petrović, V. M., & Jovanović, K. (2016). Virtual laboratories for education in science, technology, and engineering: A review. *Computers & Education*, 95, 309–327. <https://doi.org/10.1016/j.compedu.2016.02.002>
- Reynosa Navarro, E., Montero, J. M. C., Meléndez, L. V., & Navarro, E. R. (2022). Development of social skills of high school students on virtual platforms, 2021. *World Journal on Educational Technology: Current Issues*, 14(1), 231–242. <https://doi.org/10.18844/wjet.v14i1.6720>
- Sarkar, B., Saha, D., & Das, A. (2021). Voice of the future classroom: Virtual and augmented reality. In S. Pal, T. Quang Cuong, & R. S. S. Nehru (Eds.), *Digital education for the 21st century* (pp. 181–206). Apple Academic Press. <https://doi.org/10.1201/9781003180517-8>
- Schneps, M. H., Ruel, J., Sonnert, G., Dussault, M., Griffin, M., & Sadler, P. M. (2014). Conceptualizing astronomical scale: Virtual simulations on handheld tablet computers reverse misconceptions. *Computers & Education*, 70, 269–280. <https://doi.org/10.1016/j.compedu.2013.09.001>

- Sit, E. C. L. (2022). Astronomy for special education needs. *Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias*, 54, 104–106. <https://doi.org/10.22201/ia.14052059p.2022.54.23>
- Smith, J. R., Snapp, B., Madar, S., Brown, J. R., Fowler, J., Andersen, M. ... Orban, C. (2022). A smartphone-based virtual reality plotting system for STEM education. *Primus*, 33(1), 1–15. <https://doi.org/10.1080/10511970.2021.2006378>
- Taghizadeh-Popp, M., Kim, J. W., Lemson, G., Medvedev, D., Raddick, M. J., Szalay, A. S. ... Rippin, M. (2020). SciServer: A science platform for astronomy and beyond. *Astronomy and Computing*, 33, Article 100412. <https://doi.org/10.1016/j.ascom.2020.100412>
- Volioti, C., Keramopoulos, E., Sapounidis, T., Melisidis, K., Zafeiropoulou, M., Sotiriou, C., & Spiridis, V. (2022). Using augmented reality in K-12 education: An indicative platform for teaching physics. *Information*, 13(7), Article 336. <https://doi.org/10.3390/info13070336>
- Zhang, Q., Wang, K., & Zhou, S. (2020). Application and practice of VR virtual education platform in improving the quality and ability of college students. *IEEE Access*, 8, 162830–162837. <https://doi.org/10.1109/access.2020.3019262>
- Zhang, Y., & Zhao, Y.(2015). Astronomy in the Big Data era. *Data Science Journal*, 14(11), 1–9. <https://doi.org/10.5334/dsj-2015-011>

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The Role of Legal Education in Shaping the Legal Culture of the Future: Strategies and Prospects for Development

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Abstract: Aims: The purpose of the article was to highlight the current guidelines of the legal education segment in the context of forming a strategy for the development of legal culture in society. The article focused on the educational and legal principles which determine the level of legal awareness, legal education. **Study design:** The study was focused on the educational process subjects who receive professional legal education or acquire legal education skills for non-legal professionals. **Place and Duration of Study:** The research focused on the educational and legal environment in general in terms of strategy and prospects for the development of legal education and awareness. **Methodology:** The research methodology was focused on the use of general scientific methods and special methods of scientific and legal discourse. The analysis was the key rationalist research method, and online surveys occupied an empirical niche in the methodology of the given scientific research. The scientific novelty of the study is focused on determining the level of support for the use of the principles of legal culture in the educational process (both for legal professionals and non-legal professionals). **Results:** The results of the study indicated the dominance of the views of students of different levels and different specialties, which point to the need to include legal norms in educational and legal training or education. Among the surveyed representatives of the educational community, more than 90% of respondents had a positive attitude towards the process of establishing legal culture in the educational environment. **Conclusion:** Thus, legal education is an integral component of the formation of legal culture in both the individual and social dimensions. General legal competence in the modern educational and legal sense implies not only adherence to practice-oriented legal principles but also extrapolation of moral and legal guidelines to the worldview of the world.

Keywords: legal education, legal literacy, legal awareness, legal culture, rule of law, legal competencies.

Introduction

In today's socio-cultural space, certain stereotypes have been formed regarding the positioning of legal knowledge in both the individual and social dimensions. Orientation in the legal intricacies often remained the prerogative of the professional legal segment. The general legal competence is limited to the awareness of rights and obligations concepts by a citizen or a subject of social activity. However, the realities of modern social life require new formats of legal knowledge:

- The pragmatism highlights the need for a person's versatility in professional, every day, and social life, which requires awareness of the legal aspects of life and activity;
- The dynamism requires a response to stimuli that need to be assessed in an almost instantaneous and objective legal manner;
- The pluralism and multiculturalism imply the need for a non-linear approach to the possession and operation of legal competencies and the need to apply them in various variations.

In order to understand the problem, it is worth highlighting the current terminology of the educational and legal dimension. Legal culture is a general paradigm that concentrates knowledge, skills, competences, ideas and perceptions of legal elements. Legal education forms the principles of mastering these components of legal culture and the tools that help to use legal aspects at the individual, social and civilizational levels.

Research Problem

The research problem was focused on the search for educational guidelines that will meet the

requirements of the times and will ensure high-quality training of both legal professionals and the formation of appropriate legal competencies of applicants for non-legal specialities. The multi-vector nature of educational and legal strategies made it impossible to build a coherent global paradigm of legal culture. On the one hand, this is due to the specifics of individual communities in terms of the positioning of law in society; on the other hand, the need to synchronise the principles of legal culture (not necessarily the normative elements of law).

Research Focus

The focus of the study was on the need to comply with the principle of continuity of legal knowledge and skills acquisition, which should contribute to the formation of a harmonious legal culture. The educational and legal paradigm faces many difficulties (like other areas of social activity) in disseminating and perceiving legal nuances by society and individuals. The absence of unified principles for the functioning of the educational and legal system at the global, national, and professional levels is a real problem for the cultural and legal environment.

Research Aim and Research Questions

The purpose of the article was to highlight the modern guidelines of legal education and their use in the context of functioning and development of the social paradigm of legal culture. The purpose of the article also was to update the educational and legal principles which determine the level of legal awareness, legal education of individuals and society.

The main research question of the study was to reorient the understanding of the concept of legal culture from the abstract to the substantive and practical dimension. The acquisition by the legal environment of a clear and understandable algorithm of acquisition in the educational process will significantly contribute to raising the overall level of legal awareness (both in the individual and social dimensions).

Research Methodology

General Background

The methodological basis of the study included general scientific methodological approaches. The method of analysis in its various manifestations (systemic, comparative) in the current study served as a paradigm where the legal culture was interpreted as a systemic phenomenon of social development. At the same time, the educational and legal elements were compared with other educational segments that have similar and distinctive features and characteristics.

To collect the data, an online survey of higher education students was conducted using the same type of generalised question on the demand for the principles of legal culture in the educational process. The obtained data were interpreted through a comparative analysis of previous surveys and studies.

Literature review

Cotterrell (2019) suggests that using the methodology of comparative jurisprudence in order to analyse the idea of legal culture is vital. In this article, a similar methodological approach allows distinguishing the differences between legal education and legal awareness.

Semiotic methodological elements (Bandura et al., 2022) help to identify the integration potential of law in relation to other areas of social activity that have synergistic interaction in the educational process.

Andrukhiv et al. (2023) emphasise the importance of systematising all components of the educational and legal process in order to develop sustainable and understandable principles of legal culture formation for both public use and personal needs.

The scientific and legal discourse on the problem of the prospects of legal culture in the educational space has been revived with the processes of globalisation. The beginning of the twenty-first century defined a synergistic model of legal culture, which determined the trends in scientific research on this issue. In the current study, legal culture in the educational space is interpreted in three key aspects that have been actively studied by scholars. The problem of legal awareness has been raised in the studies of Ma and Ma (2020) (sociopsychological aspect). More generalised ideas of an educational nature are expressed in the concept of legal literacy in the works of Grimes (2020), Hardie et al. (2020). The following aspects of legal education in the system of legal culture have been specified: emotional and volitional element (Jones, 2021), human-centred (Madhloom & Antonopoulos, 2022), public and communication (McFaul et al., 2020).

An analysis of scientific publications on the issue of legal education indicates the actualisation of educational and innovative elements (Kohn, 2020). Denvir (2020a) emphasises the ways to modernise the ways of acquiring legal competences using innovative technologies. Goldsworthy (2020) identifies the priority areas of an innovative educational environment.

Sample / Participants / Group

The study participants were structured into several clusters:

- representatives of professional legal education who formed the environment of legal culture, guided by legal knowledge and skills;
- stakeholders of legal culture, whose role was actualised with direct involvement in legal processes or phenomena;
- neutral representatives whose participation in the legal education process was potential and limited to legal awareness.

The article also used data from an online survey of non-law students on their vision of ways to transform educational programmes on legal culture. The survey has involved 102 representatives of non-legal educational institutions that were compactly located in a culturally similar environment and in a single professional educational space. This made it possible to analyse the attitude to legal culture in a particular educational environment.

Research Results

There is no single understanding of the concept of legal culture in the modern scientific discourse. Contradictions arise both in the general understanding of the limits of legal culture for society as a whole and for individuals in particular. Silbey (2018) interprets legal culture in two contexts: general legal phenomena and processes; specific legal systems (individual, national, cultural, and ideological). At the same time, Shevchuk (2023) proposes to differentiate between the concepts of “legal tradition” and “legal culture”, defining the universality and relevance of the latter term.

A special place in the understanding of legal culture is occupied with the national dimension of this concept. The current study analyses the peculiarities of legal culture formation in the education system and in other areas in the national context, in particular:

- the German educational and legal paradigm, which is traditionally characterised with an

impeccable logical and coherent system (Koch, 2023) and meticulous accuracy with attention to detail;

- the American educational and legal system, which is characterised with a skilful combination of institutionality and intellectuality (Wilson, 2023), which ensures its universality and pragmatism;
- the European Union's educational and legal cluster is interesting for its combination of many state, national, ethnic, and cultural legal elements (Leiss, 2023) in a unified legal dimension;
- the Eastern educational tradition on the example of India, which has faced the problem of correlation between strong fundamental traditional legal norms and the dynamic influence of innovations and globalised understanding of the law (Sudhan Ramaswamy, 2020);
- the Ukrainian educational and legal case, which is interesting for its predictability (Chernykh, 2023), stable state regulation and conservatism (Andrukhiv et al., 2023), the influence of foreign cultural destabilising factors (Popadych, 2023) and all the positive and negative manifestations of these processes;
- educational and legal elements in Norway as an example of the use of innovative elements (Sunde, 2023) in the classical legal educational process (the role of information, communication, and technological dimensions);
- international, intercultural educational, and legal reflections implemented by Chanock (2019) in the course of comparing the civilizational priorities of the global West, East, or South.

The formation of legal culture is a complex multi-level process that indicates the maturity of a society and the effectiveness of the educational, legal, moral, ethical, and cultural systems in that society. Legal culture requires the existence of ideological beliefs that are supported with a clear and structured regulatory and legal framework. Education is the area where both of these elements can be implemented. Worldview and ethical guidelines are formed in the cluster of educational activities, while legal norms are updated in the segment of legal knowledge and skills.

Legal education in the classical sense is divided into two segments: legal awareness and legal education. Legal awareness is part of the concept of civic education (Siregar & Kemala, 2023). Legal awareness has the potential to support the legal system as a whole (Yi & Li, 2022).

Among the principles of legal education that are necessary for sustainable educational development are structured, reasoned (Grimes, 2020), innovative (Vučić, 2023), critical, pragmatic, etc. A separate element worth emphasising is the systematic and balanced nature of legal education. Spencer (2022) insists on the harmfulness of an aggressive method of teaching the law and suggests using more sustainable educational principles.

To form legal culture, a scheme is used that includes several stages of legal culture formation through educational activity (see Fig. 1).

Figure 1

Educational Activity in Mastering the Elements of Legal Culture



Source: author's own development.

All of these elements of educational activity have their own internal characteristics and external guidelines for the coexistence of legal culture with other spheres of public life. It is important to understand the impact of external cultural factors on educational and legal practice.

When considering the concept of legal awareness, the key dimension is provided by the information and communication factor (Mamura & Bahronov, 2022). In this context, innovative educational elements become more relevant. Particularly, online learning becomes a popular and effective learning environment able to offer legal competencies (Kohn, 2020). The use of a simulation component, a virtual environment (Cho et al., 2021), or artificial intelligence (Denvir, 2020a) significantly expands the capabilities of the legal education process. On the other hand, Goldsworthy (2020) warns against excessive pressure from automation and technologisation of education.

Silva and Azevedo (2023) emphasise the role of the individual in the dissemination of legal education and the formation of legal culture. The willingness to interpret legal nuances in an individual and societal dimension is indicative of the universality of legal culture (Nizioł, 2022).

Legal education has traditionally been positioned in the social dimension. However, in today's world, there is a reorientation towards personal orientation of the educational and legal potential. People form their own level of legal training using the educational process. This means that legal education is undergoing a radical transformation. Whereas previously, the acquisition of legal knowledge and skills was binding, now legal competences are based on initiative. The dynamism of the present day, which implies the promptness of obtaining and the possibility of effective application of legal knowledge, skills or basic legal awareness, contributes to the revival of interest in legal culture.

In modern society, there is a powerful synergistic activity that implies the need (and to some extent even dependence) on legal awareness. Legal culture implies both passive education and the ability to actively use legal knowledge and skills. The educational strategies of the future are built in such a way that legal knowledge is integrated into the system of interdisciplinary multicultural competences of a person. Not only the process of acquiring legal skills, but also the ability to use them

in the future remains an urgent issue. This creates a sequence that ensures the formation of practice-oriented dimensions of legal culture through the acquisition of theoretical knowledge in the educational process.

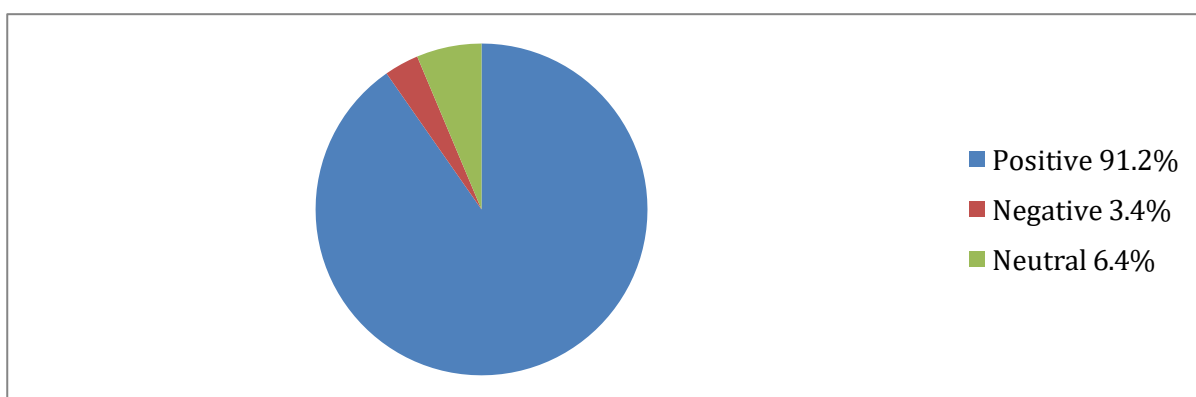
Pragmatism is a priority principle in the legal culture paradigm. The format according to which legal knowledge was formal in the educational environment (for representatives of non-legal specialties) and special legal education was eliminated from the general socio-cultural context has now lost its relevance precisely because of the inconsistency with the requirements of civilisation development.

Legal education is expressed in the activity of educational institutions that train legal professionals (Deo et al., 2019). Kimball et al. (2019) analysed the attitudes of future lawyers towards the principles of legal culture. The results indicated that lawyers are virtually unanimously interested in fostering the highest possible level of legal culture in the population, which, according to them, will facilitate their professional work in the future.

In the current study, future specialists in non-legal specialties were surveyed and asked one general question: if there was a need to update the principles of legal culture in educational programmes? (Fig. 2).

Figure 2

The Attitude of Students to the Inclusion of Legal Culture Principles in Educational Training Programmes



Source: author's own development.

The study, which was conducted in the form of an online survey, analysed the responses of 102 higher education students in 4 western regions of Ukraine (Chernivtsi, Ivano-Frankivsk, Ternopil, Khmelnytskyi). The respondents included future specialists in pedagogy, economics, engineering, and medicine.

Students' attitude towards the perception of legal skills is evidence of the actualisation of a wide range of socio-humanitarian competences. In modern society, it is difficult to find a field of activity that can be isolated from the socio-cultural development. The interconnectedness of human activity and cultural realities deepens every year. These realities create a greater need for a comprehensive educational dimension. Therefore, legal skills occupy an important place in the system of professional competences, regardless of the type of profession.

Legal education can become a theoretical, methodological and practical basis for the formation of legal culture. It is in the educational process that legal skills can be acquired not only in the theoretical sense, but also with the extrapolation of legal knowledge to the future specialisation of the student.

When comparing the results of previous studies on the relevance of legal culture with the current results, an undeniable trend towards the demand for the principles of legal culture in the educational process for all specialities (both legal and non-legal) is visible.

Discussion

The issue of the spheres of social activity priority which form the fundamental foundations and specific features of legal culture remains a controversial issue in the scientific and legal discourse. Awareness of normative and regulatory aspects in cultural and civilizational development has been ensured at different times by religion, state regulation, social contracts, etc.

Since the 70s of the twentieth century, the period of dominance of the intellectual component in legal culture has begun (Salojärvi, 2019). This led to the popularisation of legal education and an increase in its role in the paradigm of legal culture. The lion's share of knowledge, ideas, and understanding of law is acquired in the educational process. Therefore, education needs appropriate guidelines for the successful dissemination of law and its elements among the educational community. Ashurova (2021) notes that a socio-historical ecosystem of legal education and training is being created.

Legal culture has occupied a separate niche in the issue of public administration and publicity in general (Bosio et al., 2022). Wintersteiger et al. (2021) propose the use of the concept of public legal education (PLE), which will focus on the needs of society in a complex and dynamic development environment. At the same time, they emphasise the crucial role of state support in this process, particularly, financial support (McFaul et al., 2021). One of the elements of professional training for legal professionals is the principle of clinical legal education (CLE), which can be useful for non-legal professionals as well (Hardie et al., 2020).

The socio-cultural cataclysms of our time (pandemic, full-scale war in Europe) shape narratives of danger (Dias & Deluchey, 2020). Crisis phenomena in the educational and legal segment are integral elements of the modern socio-cultural environment (Saula, 2020). It is obvious that society, in response to such realities, will build strategies for a secure environment. Under such conditions, the issue of regulatory and legal support for a dynamic permanent public space becomes more relevant. It is worth noting here that the classical approach of the turn of the twentieth and twenty-first centuries, according to which education plays a dominant role in shaping legal culture, is gradually becoming irrelevant. Education provides an understanding of the legal field not only in a practice-oriented but also in a cultural and historical dimension (Ching & Maharg, 2020).

At the same time, the synergistic principles of legal culture formation in both the individual and social dimensions become more relevant. Education in the modern sense is not limited to the traditional learning process but can be manifested in a variety of formats and environments. The classical educational process is being replaced by short-term or spontaneous trainings, courses, and situational guidance that promote legal culture. If adding to these institutional innovation's transformations of a functional and organisational nature, we can see the emergence of a qualitatively new educational and legal space.

The increase in the environment where legal education segments are provided requires new tools that can help implement innovative efforts. In this context, the role and positioning of ICTs in the process of forming a holistic legal paradigm in society becomes apparent. Information, communication and technology are emerging as innovative mechanisms used to disseminate and perceive legal content. It is the content that changes the traditional format of legal information and semantic information. In connection with such changes, the issue of correlation of innovative formats with the principles of legal culture becomes more relevant.

Education is a clearly regulated area of public life. Therefore, there was no problem of legalising the educational and legal principles taught in the educational process. The situation with innovative sources of legal education was completely different. To avoid the risks associated with the danger of low-quality content, there was a threat of illegitimacy (or harmfulness) of legal content.

The modern pluralistic and multicultural world requires diversification of approaches to the formation of certain knowledge or ideas in individual or social consciousness. For example, legal norms provide for the actualisation of socio-political, socio-economic, cultural, and everyday processes that surround a person every moment. The use of the legal field in the modern civilised world is always active and online. Therefore, the traditional set of legal knowledge and skills that a person acquires during the educational process alone is not enough to ensure legal relevance in modern society.

Considering the concepts of legal education of the future, several options for its development in the socio-legal paradigm are identified:

- legal education is developing in the mode of “subversive activity” (Codling, 2022), when legal norms are studied not after the fact, but in the context of a strategy of anticipation and planning;
- rational-transformational approach (Jones, 2021), which defines the intellectual component as the driver of educational strategies in the legal segment;
- professionally-identified element (Hamilton, 2019), which clearly and unambiguously interprets legal norms in a permanent environment;
- synergistic interdisciplinary approach, according to which professional legal education is designed to train a multidisciplinary legal professional (Denvir, 2020b) and ensure that students of different levels and specialities acquire relevant legal flexibility skills;

The author suggests two main ways out of the situation when legal culture does not have a proper platform for its formation and dissemination among society:

- the use of interdisciplinary approaches within the educational and legal cluster;
- acquiring legal awareness through innovative dimensions of a non-classical educational nature.

The final stage of the study in terms of the legal education paradigm effectiveness is the purpose and goals of educational activities. Madhloom and Antonopoulos (2022) emphasise the adherence to the principles of social justice as key priorities of legal education. It is important to realise that the expected effect of legal education (Ma & Ma, 2020) (awareness and education in the context of the current study) will obviously be delayed, unlike legal education, which provides an immediate result. Traditionally, legal education has focused on the implementation of the human rights function (Syroid & Fomina, 2023). However, the dynamism of modern socio-cultural development requires a legal culture to be proactive, not only able to state but also to anticipate, warn, and prevent.

Competence in legal education should be correlated with ethics (Vlajković & Dabetić, 2023) because, without the moral factor, a set of normative and regulatory norms loses its mission in the worldview sense, which deprives legal education of existential meanings.

Legal culture is given several positions in the education system:

- motivational and stimulating dimension, according to which students of educational levels are interested in acquiring legal knowledge and competencies and initiate the inclusion of a cluster of

educational and legal disciplines in curricula or strategies;

- the programme-binding dimension, which characterises legal education as a compulsory discipline with clearly defined learning objectives and does not leave the student with a choice and opportunities to regulate educational and legal training;
- neutral-formal dimension, the features of which are declarative, quantitative and individually passive formation of the educational and legal environment, in which the subjects of the educational process do not understand the purpose of legal competences.

The task of the scientific and legal discourse is to reorient from the formal status of legal competences to their pragmatic and effective application in educational programmes. This approach will allow to continue the global process of developing legal culture and mobilise the educational system to achieve this goal.

The modern educational paradigm is a favourable environment for organising the educational process in the legal cluster of disciplines. For a long time, there has been a debate about the positioning of legal education in terms of disciplinary or methodological orientation. Usually, legal educational material is concentrated in a practice-oriented educational and legal context. However, the modern socio-cultural space, which is characterised with pluralism and multiculturalism, interprets legal skills not in isolation, but in the context of interdisciplinarity.

Legal skills become a component of general education soft skills, which provide for the universality and diversity of educational training. The peculiarity of legal knowledge in this context is its coherence with other skills of the socio-humanitarian cluster. In today's world, being educated does not imply possession (even perfect) of a set of separate (or separated from each other) knowledge, skills or abilities. Today's world requires versatility in terms of educational level. This means that legal competences are integrated into the general level of the student's professionalism.

The use of separate legal competences remains appropriate in legal practice. Indeed, legal competencies are a fundamental (and sometimes the only possible) element of use in the practical and subject matter dimension. Other knowledge and skills play an auxiliary or secondary role. A completely different positioning of legal competences is observed in the cluster of education for non-legal specialities. In these cases, legal skills can be actively applied as an active element (but one of them) and, as a rule, in interaction with other components of a problematic issue or situation.

Legal culture has one important feature, which is that the legal skills possessed by a person are mostly in a passive state and are rarely used by a person in everyday life. This leads to a certain substitution of attention and relevance of legal training. While economic, social and humanitarian, and psychological skills are practised virtually every day in various manifestations, the legal arsenal is mostly potential. This leads to the formation of stereotypes about legal culture, which include the awareness of the lack of alternatives and the importance of acquiring legal skills while understanding the minimal chances of using them. This is another factor that reorients legal skills to the general paradigm of socio-humanitarian training in the educational process. When legal knowledge plays a reinforcing role, arguing a problem in terms of legality and legitimacy, it is automatically included in the system of general humanities-oriented skills.

In modern education, the synergistic model is becoming increasingly popular and in demand. The actualisation of individual specialised skills is losing its importance, as in modern culture all processes, phenomena or events are closely interconnected and require a comprehensive assessment. This necessitates the use of a range of skills to address situations and problems. Legal skills alone are usually

not enough to justify one's position or defend one's rights. Therefore, a kind of symbiosis of competencies is formed, which are acquired by the student, which in the synergistic dimension appear as a universal solution to the most complex problems.

In general, legal education should not be based on permanent socio-cultural features but should be guided by the principles of the rule of law. Such an existential target vector will contribute to the universality and effectiveness of the human rights system. At the same time, the practice-oriented segment of legal education should not only be saturated with sustainable traditional educational strategies but also focus on the use of innovative socially relevant educational environments where legal training will meet the requirements and challenges of the time.

Conclusions and Implications

Thus, the principles of legal culture have good opportunities for formation in the context of the modern educational paradigm and are characterised by the following features:

- the reorientation of the legal culture positioning from the stereotypical understanding that “knowledge of law is the prerogative of lawyers” to a modern interpretation of legal education as a guarantee of involvement of everyone in legal education or legal upbringing;
- the interpretation of legal culture based on the legal traditions of national, state, religious, and professional aspects, while ensuring the autonomy of legal norms and rules from the influence of foreign cultural factors;
- the clear delineation and structuring of normative and regulatory and ideological and ethical components of law in the practical and educational process;
- the adherence to the stages of educational activity in mastering the elements of legal culture: legal awareness, legal education, legal education;
- the understanding the role and influence of innovative trends in the modern globalised world on the processes of acquiring legal competencies (informatisation, technologisation, digitalisation of the educational and legal space);
- the stating the need to incorporate the principles of legal culture into the legal educational paradigm (based on the unanimity or the overwhelming majority of the subjects of educational and legal activity): both for professional lawyers (according to the research of scientific and legal discourse) and for students of non-law specialities (based on the analysis of the results of the online survey conducted by the authors of the research);
- the need to develop unified principles of legal culture, which will be characterised with the principles of pragmatism, dynamism, reliability, universality, etc;
- the principle of the rule of law should become a fundamental element of educational and legal strategies, which will ensure an increase in the level of professional legal training and the level of legal culture in society as a whole.

Legal education is an important and popular component of the process of formation of legal culture at the individual and socio-civilizational levels. The study proposes an algorithm of educational and legal activity such as legal awareness, legal education, which helps to form an integral system of knowledge and ideas about legal aspects. A synergistic approach based on interdisciplinarity and multiculturalism ensures the acquisition of legal competences that will meet the requirements of the times.

Suggestions for Future Research

1. Legal culture should be formed from several independent (but potentially interrelated) sources with a certain priority of the educational and legal component (in the educational process, information content).
2. Educational strategies for the development of legal education should be based on the principles of pragmatism, interdisciplinarity and cultural diversity, which will ensure a diverse and multifunctional legal culture.
3. Synergistic approaches become the main methodological guideline in the formation of educational and legal strategies and practice-oriented programme components of education and science.
4. Legal education, legal awareness and legal literacy should be characterised by dynamism and the ability to adapt to the conditions of the socio-cultural environment.

The mentioned prospects for the development of the paradigm of legal culture in the educational segment form the priorities of scientific discourse on this issue. The traditional consideration of the legal education concept is gradually losing its relevance. The reasons for the change of research vectors are related to the transformation of the legal space and educational environment. The practical and methodological aspect begins to replace theoretical and ideological guidelines in the system of legal education (eventually, as in all spheres of social activity), guided by the priority of the pragmatic dimension.

Increasingly, the research of a scientific and legal nature takes an interdisciplinary context. Synergistic interaction as a global civilizational trend of our time actualises integration processes between clusters of social activity. Therefore, legal aspects are increasingly combined with social, economic, political, or cultural elements. Under such circumstances, research on legal education and legal culture will not focus exclusively on legal concepts in the future. When this issue is highlighted within the educational space, all pedagogical strategies will also focus on universal competencies (general or professional). In the short term, we can expect interdisciplinary research in which legal education will correlate and synchronise fundamental and flexible legal skills. At the same time, educational and legal competencies will have a unified nature.

Future research will focus on the content and format of legal education. Targeted elements of educational activity will concern not only the statement of legal aspects, but also their individual, social, or civilizational interpretation. The new legal meanings will not be exclusively filled with the legal system (as it used to be before) but will also be expressed in the educational sphere. The format of legal education will also change which will become the subject of scientific research. One of the prospects for legal education research will undoubtedly be a cluster of innovative educational elements in the acquisition of legal knowledge. The use of technological and digital potential is an important issue for the educational and legal space, as it is becoming a factor in the transformation of both of these areas of social activity, often using the same tools and algorithms. This allows us to better understand the ideological and mental meanings and practical manifestations of legal education and the paradigmatic dimensions of legal culture in general.

References

- Andrukhiv, O., Ilyn, L., & Kosmii, M. (2023). Analysis of normative and legal acts of Ukraine in the sphere of national patriotic education. *Scientific and informational bulletin of Ivano-Frankivsk University of Law named after King Danylo Halytskyi*, 1(15(27)), 20–29. <https://doi.org/10.33098/2078->

- Ashurova, O. (2021). Socio-historical traditions of development of ecoesthetic culture of preschool educational professionals. *Current Research Journal of Pedagogics*, 2(05), 46–52. <https://doi.org/10.37547/pedagogics-crijp-02-05-10>
- Bandura, O., Lytvynov, O., Maksymov, S., Pavlyshyn, O., & Smaznova, I. (2022). Semiotics of law in modern philosophical and legal research. *Cuestiones Políticas*, 40(72), 89–107. <https://doi.org/10.46398/cuestpol.4072.05>
- Bosio, E., Djankov, S., Glaeser, E., & Shleifer, A. (2022). Public procurement in law and practice. *American Economic Review*, 112(4), 1091–1117. <https://doi.org/10.1257/aer.20200738>
- Chanock, M. (2019). Some reflections on a research journey in law and society. *Law in Context: A Socio-Legal Journal*, 36(1), 21–28. <https://doi.org/10.26826/law-in-context.v36i1.83>
- Chernykh, Y. (2023). An introduction to Ukrainian legal culture. In S. Koch & M. Kjølstad (Eds.), *Handbook on legal cultures* (pp. 1145–1170). Springer. https://doi.org/10.1007/978-3-031-27745-0_26
- Cho, J., Jung, T., Macleod, K., & Swenson, A. (2021). Using virtual reality as a form of simulation in the context of legal education. In M. Dieck, T. Jung & L. Loureiro (Eds.), *Augmented reality and virtual reality* (pp. 141–154). Progress in IS. Springer. https://doi.org/10.1007/978-3-030-68086-2_11
- Ching, J., & Maharg, P. (2020). ‘Complicitous and contestatory’: A critical genre theory approach to reviewing legal education in the global, digital age. In C. Denvir (Ed.), *Modernising legal education* (pp. 239–257). Cambridge: Cambridge University Press. <https://doi.org/10.1017/9781108663311.015>
- Codling, A. R. (2022). Subversive legal history: A manifesto for the future of legal education. *Legal Pluralism and Critical Social Analysis*, 54(2–3), 318–322. <https://doi.org/10.1080/27706869.2022.2084592>
- Cotterrell, R. (2019). Comparative law and legal culture. In M. Reimann & R. Zimmermann (Eds.), *The Oxford handbook of comparative law* (pp. 710–733). Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780198810230.013.22>
- Denvir, C. (2020a). *Modernizing legal education*. Cambridge University Press. <https://doi.org/10.1017/9781108663311>
- Denvir, C. (2020b). Scaling the gap: legal education and data literacy. In C. Denvir (Ed.), *Modernising legal education* (pp. 73–91). Cambridge University Press. <https://doi.org/10.1017/9781108663311.006>
- Deo, M., Lazarus-Black, M., & Mertz, E. (2019). *Power, legal education, and law school cultures*. Routledge. <https://doi.org/10.4324/9780367199432>
- Dias, B. L. C. V., & Deluchey, J.-F. Y. (2020). The “Total continuous war” and the COVID-19 pandemic: Neoliberal governmentality, disposable bodies and protected lives. *Law, Culture and the Humanities*. <https://doi.org/10.1177/1743872120973157>
- Goldsworthy, D. (2020). The future of legal education in the 21st century. *The Adelaide Law Review*, 41(1), 243–265. <https://search.informit.org/doi/10.3316/informit.20200827035662>
- Grimes, R. (2020). Making and managing change in legal education: Yesterday, today and tomorrow.

- Asian Journal of Legal Education*, 7(2), 178–194. <https://doi.org/10.1177/2322005820919258>
- Hamilton, N. (2019). Review of the formation of professional identity: The path from student to lawyer. *Journal of Legal Education*, 69(1), 224–235. <https://www.jstor.org/stable/27073486>
- Hardie, L., Mcfaul, H., & Ryan, F. (2020). 50 years of clinical legal education: Looking back to the future. In L. Claydon, C. Derry, & M. Ajevski (Eds.), *Law in motion: 50 years of legal change* (pp. 212–227). Open University Law School. <http://www.open.ac.uk/blogs/50YearsOfLaw/?p=210>
- Jones, E. (2021). *Emotions in the law School: Transforming legal education through the passions*. Routledge. <https://www.routledge.com/Emotions-in-the-Law-School-Transforming-Legal-Education-Through-the-Passions/Jones/p/book/9781032240510>
- Kimball, E. W., Slauzis, D., Ryder, A. J., & Hastings, J. (2019). “Whispers and concerns about the lawyers taking over”: How student affairs professionals think about the growing need for legal education. *Journal of College Student Development*, 60(5), 623–628. <https://doi.org/10.1353/csd.2019.0055>
- Koch, S. (2023). An introduction to German legal culture. In S. Koch & M. Kjølstad (Eds.), *Handbook on legal cultures* (pp. 611–662). Springer. https://doi.org/10.1007/978-3-031-27745-0_16
- Kohn, N. (2020). *Online learning and the future of legal education: Symposium introduction*. SSRN. <https://ssrn.com/abstract=3570914>
- Leiss, J. R. (2023). An introduction to EU legal culture. In S. Koch & M. Kjølstad (Eds.), *Handbook on legal cultures* (pp. 463–524). Springer. https://doi.org/10.1007/978-3-031-27745-0_13
- Ma, D., & Ma, Y. (2020). Correlation between psychological empowerment and acceptance behaviour of audience in legal education. *Revista Argentina de Clínica Psicológica*, XXIX(2), 166–172. <https://doi.org/10.24205/03276716.2020.219>
- Madhloom, O., & Antonopoulos, I. (2022). Clinical legal education and human rights values: A universal pro forma for law clinics. *Asian Journal of Legal Education*, 9(1), 23–35. <https://doi.org/10.1177/23220058211051031>
- Mamura, U., & Bahronov, B. (2022). The role of modern educational technologies in the teaching of legal sciences. *ACADEMICIA: An International Multidisciplinary Research Journal*, 12(1), 305–309. <https://doi.org/10.5958/2249-7137.2022.00040.4>
- McFaul, H., FitzGerald, E., Byrne, D., & Ryan, F. (2020). A mobile app for public legal education: A case study of co-designing with students. *Research in Learning Technology*, 28. <https://doi.org/10.25304/rlt.v28.2434>
- Nizioł, G. (2022). Legal content of environmental education. *Journal of Actual Problems of Jurisprudence*, 104(4), 63–69. <https://doi.org/10.26577/JAPJ.2022.v104.i4.07>
- Popadych, O. (2023). Legal education as a way to prevent deviant behavior among adolescents. *Scientific Bulletin of Uzhhorod University Series «Pedagogy Social Work»*, (1(52), <https://doi.org/10.24144/2524-0609.2023.52.163-168>
- Salojärvi, J. (2019). A counter-culture of law: Jurisprudential change and the intellectual origins of the critical legal studies movement. *American Journal of Legal History*, 59(4), 409–443. <https://doi.org/10.1093/ajlh/njz022>
- Saula, M. (2020). Crisis-induced innovation in U.S. legal education. *Journal of Legal Education*, 69(3),

- Shevchuk, M. (2023). Legal tradition and legal culture in the system of national patriotic education of youth. *Scientific and informational bulletin of Ivano-Frankivsk University of Law named after King Danylo Halytskyi*, 1(15(27), 106–111. <https://doi.org/10.33098/2078-6670.2023.15.27.1.106-111>
- Silbey, S. S. (2018). Legal Culture and Cultures of Legality. In J. R. Hall, L. Grindstaff, & M.-C. Lo (Eds.), *Handbook of cultural sociology* (pp. 426–435). Routledge. <http://dx.doi.org/10.2139/ssrn.4342446>
- Silva, C., & Azevedo, K. (2023). The role of the teacher in higher legal education and the impacts on the student's academic training. *Revista Gênero e Interdisciplinaridade*, 4, 230–242. <https://doi.org/10.51249/gei.v4i04.1479>
- Siregar, H., & Kemala, V. D. (2023). Citizenship education as legal education in schools. *EDUCTUM: Journal Research*, 2(1), 30–34. <https://doi.org/10.56495/ejr.v2i1.319>
- Spencer, R. (2022). “Hell is other people”: Rethinking the Socratic method for quiet law students. *The Law Teacher*, 56(1), 90–104. <https://doi.org/10.1080/03069400.2021.2005305>
- Sudhan Ramaswamy, H. H. (2020). The prospect of legal education: an India overview. *Journal of Legal Studies “Vasile Goldis”*, 25(39), 31–43. <https://www.cceol.com/search/article-detail?id=880613>
- Sunde, J. (2023). Legal culture: Ideas of and expectations to law made operational by institutional(-like) practices. In S. Koch & M. Kjølstad (Eds.), *Handbook on legal cultures* (pp. 13–29). Springer. https://doi.org/10.1007/978-3-031-27745-0_2
- Syroid, T., & Fomina, L. (2023). Human rights education for representatives of legal professions: international legal aspect. *Uzhhorod National University Herald. Series: Law*, 2(74), 172–176. <https://doi.org/10.24144/2307-3322.2022.74.62>
- Vlajković, M., & Dabetić, V. (2023). Building transversal skills and competences in legal education. In O. J. Gstrein, M. Fröhlich, C. van den Berg, T. Giegerich (Eds.), *Modernising European legal education (MELE). MELE 2023. European Union and its neighbours in a globalized world* (Vol. 10, pp. 93–106). https://doi.org/10.1007/978-3-031-40801-4_6
- Vučić, F. (2023). Changes in legal education in the digital society of artificial intelligence. In D. Vasić & M. Kundid Vasić (Eds.), *Digital transformation in education and artificial intelligence application. Communications in computer and information science* (Vol. 1827, pp. 159–176). Springer. https://doi.org/10.1007/978-3-031-36833-2_12
- Wilson, L. T. (2023). A view of the legal culture of the United States of America. In S. Koch & M. Kjølstad (Eds.), *Handbook on legal cultures* (pp. 1073–1143). Springer. https://doi.org/10.1007/978-3-031-27745-0_25
- Wintersteiger, L., Morse, S., Olatokun, M., & Morris, C. J. (2021). *Effectiveness of public legal education initiatives: A literature review*. Legal Services Board. <https://www.legalservicesboard.org.uk/wp-content/uploads/2021/02/PLE-systematic-review-report-Feb-2021.pdf>
- Yi, L., & Li, T. (2022). Effective strategies to promote the cultivation of public legal consciousness from the perspective of social psychology. *Journal of Environmental and Public Health*, 2022, Article 827593. <https://doi.org/10.1155/2022/8275938>