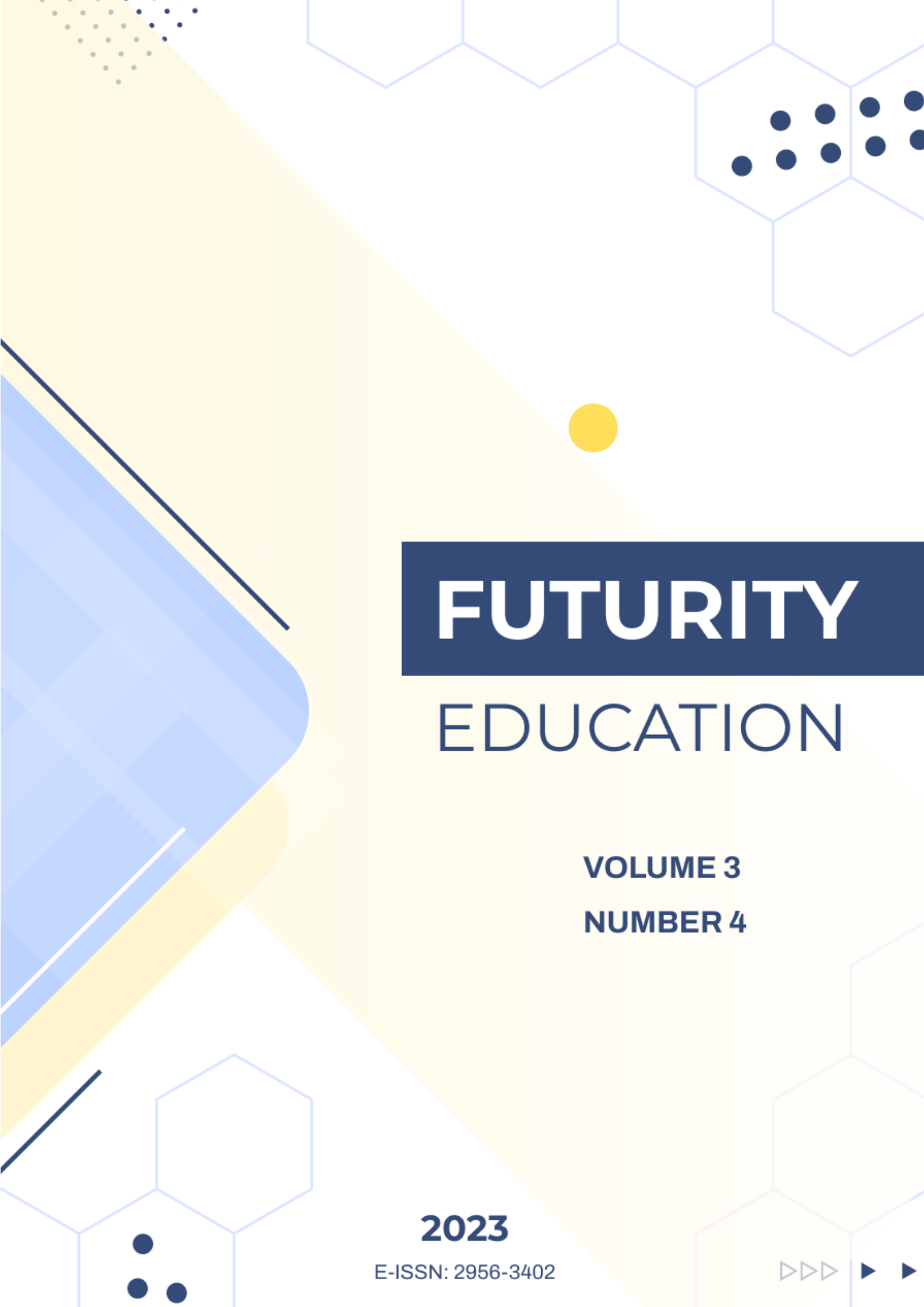




FUTURITY

EDUCATION

VOLUME 3
NUMBER 4

2023

E-ISSN: 2956-3402



Futurity Education

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<https://futurity-education.com/index.php/fed/issue/view/1>

Publisher:

Futurity Research Publishing, Poland,
Lodz, STEFANA ŻEROMSKIEGO street
53, 90-625.

info@futurity-publishing.com;
<https://futurity-publishing.com/>

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Publication schedule

Futurity Education is published four times a year, on March 25, June 25, September 25 and December 25.

Type of publication: electronic **Country**

of publication: Poland

Date of Number: December 7, 2023

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DOI: <https://doi.org/10.57125/FED.2023.12.25.01>

How to cite: Sakpla, G. K., Owusu-Darko, I. & Iddrisu, A. (2023). Factors that Contribute to Junior High School Female Students' Negative Attitudes toward the Study of Mathematics in the Fanteakwa District, Ghana. *Futurity Education*. 3(4). 6-30. <https://doi.org/10.57125/FED.2023.12.25.01>

Factors that Contribute to Junior High School Female Students' Negative Attitudes toward the Study of Mathematics in the Fanteakwa District, Ghana

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Received: July 20, 2023 | **Accepted:** September 27, 2023 | **Available online:** October 19, 2023

Abstract: Students negative emotions, beliefs, and behaviours toward the study of mathematics have tremendously contributed to their poor performance in the subject and it is caused by factors emanating from home, socio-cultural background, school, students and teachers. The aim of this study

was to examine factors promoting the negative attitudes of female students toward the study of Mathematics in five selected Junior High Schools within the Fanteakwa District of Ghana. The researchers, therefore, used the sequential explanatory mixed method in order to generate the data from 125 respondents comprising of 120 female students and 5 mathematics teachers using a questionnaire, a semi-structured interview, and a focused group discussion. The result showed that female learners in the district exhibited negative attitudes toward mathematics as a subject; they developed fear and hatred for the subject, lacked self-confidence. The causative factors of these attitudes included sociocultural backgrounds; the lack of female role models, early marriage, and gender stereotypes. Home factors were the lack of parental support, illiterate parents, overburden household chores and poverty. Teacher factors included not creating the enabling environment for teaching and learning, the lack of teaching learning resources during lesson. The lack of reward pages for teachers and students, in-conducive environments were factors relating to school environment. The study concluded that students in the district had negative attitudes toward learning of mathematics; they considered the subject to be difficult and developed hatred for it. These were attributed to factors relating to home, socio-cultural, school, students and mathematics teachers. The study implied that the government of Ghana and policy makers should develop gender-friendly curriculum, sensitise parents to support their children's education, train teachers to handle the subject well. The researchers, therefore, suggest that further studies on the topic should be undertaking using a larger sample or the study can be repeated in other districts and or the entire country so that a more holistic picture can be generated.

Keywords: academic performance, gender stereotypes. negative attitudes, socio-cultural background.

Introduction

In recent times, Ghana has been restructuring its educational system to train a skilled, knowledgeable human resource in the areas of science, technology, engineering, and mathematics (STEM) for them to function well in this contemporary world. Mathematics serves as the foundation on which every economy is built. It is important in the field of financial services, physical sciences, business, Information, Communication and Technology (ICT) and many areas of technology in most countries.

It is also of high demand in social sciences, biology, and many areas of medicine (Yadav, 2019). It forms the basis of many carers including scientific and industrial research and evolution. Davadas and Lay (2020) stated that mathematics was critical for human civilization and development. Henceforth, mathematics is a subject in the school curriculum from primary to secondary levels in most countries including Ghana. It is these indispensable roles of mathematics that is why it serve as an entry requirement into higher institutions in the country.

However, many students in Ghana especially the female counterparts have been reported to performed poorly in the subject due to negative attitudes toward the study of the subject (Ansah et al., 2020). Attitudes can be explained as psychological orientations formed as a result of one's experiences that influence a person's perception of circumstances, objects, and people, as well as how to respond to them positively or negatively, favorably or unfavorably (Mensah et al., 2013). They further explained that learning in any educational environment is related to learners' attitudes hence, attitude plays crucial roles in academic performance (Mensah et al., 2013). Many researchers confirmed that attitudes were important factors that could contributed to student's success in mathematics (Aysun, 2017; Wakhata et al., 2022). However, many students especially their female counterparts thought that mathematics was a complex subject and they were concerned that they could not be successful in

mathematics, which affects their attitudes toward the subject negatively (Chand et al., 2021). Unfortunately, these attitudes occur within the school years. As a result, most female students have negative attitudes toward mathematics and thus they lose their self-confidences in mathematics resulting in poor performance in the subject. Moreover, these students begin thinking that they are not clever enough to learn mathematics and may not regard mathematics as their area of interest.

Other researchers like Arko and Kporyi (2018) conducted a study among senior high students at Ordoben on students' attitudes toward mathematics. It was established that, many of these students cannot do well in mathematics and performed poorly in their final examinations. In Ghana, learners' achievement in mathematics in the first and second cycle institutions has been deteriorating over the years. Candidates for certificate examinations are reported to have shown a lack of understanding of mathematical concepts and were unable to form the exact mathematical models when solving questions that could be tackled with the requisite skills during their Basic Education Certificate Examination (B.E.C.E) and West Africa Senior School Certificate Examination (WASSCE) exams (Chief Examiner's Report, as cited in Arko & Kporyi, 2018). This means that many students in the first and second-cycle institutions in Ghana were lacking the basic skills in mathematics and could not apply the knowledge they have to solve other problems and this was blamed on the various factors including their attitudes toward the study of the subject.

With numerous measures put in place by governments, mathematics achievement in Ghana has not undergone much change; there are consistently low achievement levels in mathematics among students especially junior high schools (JHS) and senior high school (SHS) students (Ansah et al., 2020). These researchers Ansah et al. (2020) claimed that the performance of learners in mathematics has been progressively declining at various levels in JHS and SHS in the country. They provided the evidence that for instance, SHS students had a pass rate of 36.68% in 2013. In 2014, it has decreased to 32.45% and eventually deteriorated to 24.09% in 2015. There was appreciable improvement in the performance (33.12% and 41.66%) in 2016 and 2017 respectively. Although there was no definitive pattern in the performance data, it is important to emphasise that over 50% of the students who sat for the examination each year were not qualify to be admitted in any tertiary institution in Ghana. This is an issue of concern for stakeholders, students and parents in the country.

The attitudes of learners toward the study of mathematics were affected by number of factors including (1) the socio- economic status of parents, involvements of parent in their children's education (home factors). (2) wrong believes of the society about girls in studying mathematics, early marriage, lack of female role model (socio- cultural factors), (3) class size, Teaching Learning Resources, i.e. (TLR), the atmosphere of the school (school factors), (4) the anxiety of students about mathematics as a difficult subject, laziness, truancy, absenteeism (students' factors) and (5) teachers' attitudes, beliefs and instructional strategies (teacher factors). Students who have full financial support and encouragement from their parents tend to develop positive attitudes toward mathematics and had high success in the subject than those with less support and encouragement (Eriksson et al., 2021). Socio-cultural stereotypes concerning boys and girls in studying mathematics that the subject is preserved for boys, male was better than female in STEM-related courses have significant impact on students' attitudes which contributed to the gender gap in STEM related courses (Eble & Hu, 2018). Research conducted in Ghana by Bosson-Amedenu (2018) established the fact that the most contributing factor to mass failure in mathematics during B.E.C.E. every year was attributed to the large class size. Factors relating to students themselves i.e., their anxiety and low self- confidence in studying mathematics also affect their attitudes toward mathematics and mathematics achievement (Fokuo et al., 2022; Karikari et al., 2020). Students who believed that mathematics was difficult and that they cannot understand the subject perform low in mathematics. The recent research works on mathematics showed that there was

a significant correlation between attitudes and success in mathematics (Wakhata et al., 2022). Attitudes toward mathematics played crucial roles in determining learners' performance in mathematics; those with positive attitudes toward the subject will have high success in mathematics and vice versa. In this regard, some other contemporary researches Maamin et al. (2022), Rozgonjuk et al. (2020), and Zakariya et al. (2020) confirmed that there was a positive relationship between learners' attitudes and success toward mathematics. Also, teachers who adopted creative pedagogy such as differentiated learning helped students to exhibit positive attitudes and achieve high success in mathematics (Asempapa, 2022; Wijaya et al., 2022).

It is obvious that students' negative attitudes toward mathematics is crucial, and needs to be probe to comprehend factors that tend to negatively promote learners' attitudes towards the study of mathematics which resulted in their poor performance.

Research Problem

The continuous feeling reluctant of Girls to pursue and excel in education, especially in the area of science, mathematics, and technology (SMT) is an issue of concern to many policy makers in general (Jones, 2016). Despite expected increasing demand for human resource, opportunities and returns to the study in the STEM fields, women remain under-represented in STEM fields (Anaya et al., 2022). As explained by Rodriguez et al. (2020), even though there are no significant gender differences in academic performance, as expected, the positive attitudes toward mathematics were clearly more significant in boys than in girls. Research on gender gap in USA, Organisation for Economic Cooperation and Development (OECD) countries and Europe indicated that boys were better performing in mathematics than girls, especially at the top of the performance distribution (Bahar, 2021).

Ghana took part in the Trend in International Mathematics and Science Study (TIMSS) three occasions (i.e., 2003, 2007, & 2011) and obtained the rankings of 45th out of 46 countries in 2003, 47th out of 48 in 2007 and 42nd out of 42 countries in 2011 (Mullis et al., 2012). The consecutive poor performance of Ghanaian students in the TIMSS indicated that the country has challenges in these subject areas and need to be investigated.

As explained by Rodriguez et al. (2020) that, in Spain, whereas both boys and girls had similar levels of negative feelings toward mathematics, the girls exhibited higher rates of math anxiety than did their male counterparts. Most girls fail to participate in science and mathematics related subjects due to the lack of confidence in performance in these subject areas. The issue in the Fanteakwa district is no different. Many learners in the district have negative attitudes toward the subject, considering mathematics and Science as not only a field for male but also, a course meant for the students with high intellectual abilities. This perceptions about the subject resulted in debilitating interest of female learners in its study. Continuous failure of women to pursue Mathematics at higher level of education, led to their underrepresented in mathematics careers and which further resulted in income disparity between male and female (Ganley & Lubienski, 2016). It was these reasons why the study into factors contributing to negative attitudes of learners toward mathematics is worth investigating.

Research Focus

This study focused on factors that contributed to negative attitudes of learners toward the study of mathematics in the five chosen JHS within the Fanteakwa district of Ghana.

Despite the numerous efforts put in place by the Fanteakwa district education directorate to enhance female participation in mathematics and science education, the majority of the female students continued to poorly perform in these subject areas. The analysis of B. E. C. E results in almost every through school performance appraisal meetings (SPAM) by circuit supervisors in Fanteakwa district revealed that the majority of students performed abysmally in mathematics, especially female students. It was prudent to resolve this problem by first identifying the factors accounting for these negative attitudes among female learners. It was this reason why a study into the factors that contribute to the attitudes of JHS female students in the Fanteakwa district of the Eastern region of Ghana needs to be taken as a very serious issue.

Research Aim

The aim of this research was to examine the factors influencing the negative attitudes of female students toward the study of Mathematics in selected JHS within the Fanteakwa District of Ghana.

Specific Objectives

1. To find out the JHS female students' negative attitudes toward the study of mathematics in the Fanteakwa district.
2. To find out the home, students, school, teacher, and socio-cultural factors that contribute to JHS female students' attitudes toward mathematics in the Fanteakwa district of Ghana.

Research Questions

This study answered the following questions:

1. What were Fanteakwa District Junior High School female students' negative attitudes toward mathematics?
2. Which home, socio-cultural, school, teacher, and student factors contributed to JHS female students' negative attitudes toward mathematics in the Fanteakwa District of Ghana?

Research Methodology

General background

The researchers deemed it important to examine factors influencing the negative attitudes of female students toward the study of mathematics in selected JHS within the Fanteakwa district of Ghana. The district is located in the Eastern region of Ghana which contains forty-nine (49) junior and three (3) senior high schools at the time of the study.

Because the researchers base on pragmatic philosophy, the sequential explanatory mixed method design was adopted for the study; a single study containing quantitative data collection followed by qualitative data was used (Creswell, 2012). The choice of this method was very important because it helped the researchers to probe the factors influencing the attitudes of JHS female students toward the study of mathematics in the Fanteakwa district such that the findings were validated by the evidence generated by each method.

Population

The targeted population comprised all females of the five (5) selected JHS in the Fanteakwa district of the Eastern region of Ghana, as well as the mathematics teachers in these schools. The schools were;

Ahomam JHS, consist of 84 students, 3 mathematics teachers, Darko JHS had 81 students, 2 mathematics teachers, Nteso JHS had 63 students, 2 mathematics teachers, Akoradako JHS had 95 students, 3 mathematics teachers, Oboaho JHS had 76 students, 2 mathematics teachers.

Sample

In this study, the researchers through the use of purposive sampling procedure, selected the sample size of 125 participants (24 female students and 1 mathematics teacher from each school), from the five chosen junior high schools out of the forty-nine. The schools were selected by using simple random sampling procedure. The sample selected (125) truly represents the population (399 female students and 12 mathematics teachers), since it was more than the minimum required 10% of the population (Andrade, 2020). Also, the researchers chose these types of samples because the female students were the groups in which the issue of negative attitudes toward the study of mathematics were concerned; mathematics teachers were also sampled because they directly involved in teaching and learning of the subject. The researchers chose to effectuate a focus- group discussion and interview because of lack of enough time and resources, they employed a relatively manageable sample size of twenty (20) student respondents from the already chosen 125 respondents or participants in addition to the five (5) mathematics teachers (one from each of the five schools).

Instruments and procedures

In all, a questionnaire with forty-three (43) items were also designed using five points Likert scale ranging from strongly agree to disagree. 21 of the items measured students' self-confidence, emotion or anxiety, motivation, mathematics enjoyment and how students value mathematics. 22 items measured home, socio-cultural, students, teacher and school factors that impact students' attitudes toward the study of mathematics. Seven (7) interview and focused group guides were also designed to collect the qualitative data on students' negative attitudes and its causative factors from the participants.

The researchers ensured the validity by employing the following strategies: one, the drafted questionnaire and the interview guides were foremost discussed among the researchers for comments, suggestions, and corrections. The questionnaire was piloted at Ahomahomasu JHS. Two, the researchers did not only use "rich and thick" descriptions of participants responses during the interview and focus group but also, they captured the exact responses from the participants to buttress some points as deemed necessary.

Also, researchers used different research instruments (questionnaire, face-to-face one-on-one interview and focus group discussion) to collect the data from the same participant and compared the results of the various method to ensure consistency.

Data analysis

The data from the questionnaires were analysed using descriptive statistics with the aid of IBM Statistical Package for Social Sciences (IBMSPSS) version 25. The qualitative data gathered from the respondents were analysed manually or by the content analysis.

Research Results

Demographic Characteristics of Respondents

There were twenty-four (24) participating students from each of the five schools for the quantitative data. Sixteen (16) of them were between the ages of eleven to twelve years, ninety-seven

(97) of them were between the ages of thirteen to fourteen years and seven (7) of them were within fifteen to sixteen years. The information is presented in Table 1.

Table 1

Ages of the students involved in the study

Age Group	Frequency	Percent	Valid Percent	Cumulative Percent
11 to 12 years	16	13.3	13.3	13.3
13 to 14 years	97	80.8	80.8	94.1
15 to 16 years	7	5.8	5.8	99.9
Total	120	100.0	100.0	

From the Table 1, 13.3% of the students were between the age group of 11-12 years, 80.8% of them were between the age group of 13-14 years and lastly, and 5.8 percent of them were 15 years and above. From the analysis of this data the majority of the respondents of the study were between the ages of 13-14 years.

Research Question 1

What is Fanteakwa District Junior High School Female Students' negative attitudes toward Mathematics? In order to answer the first research question relating to students' attitudes toward mathematics, the respondents were asked to indicate their agreement to twenty-one (21) statements concerning the various dimensions of attitude such as students' self-confidence, students' emotion/anxiety, students' mathematics enjoyment, students' mathematics motivation and value of mathematics. The responses of students on their self-confidence in mathematics which is a sub-scale of their attitude are presented in Table 2.

Table 2

Rating students' self-confidence in mathematics

Statement	SA		A		U		D		SD	
	%	N	%	N	%	N	%	N	%	N
a) Girls who are brilliant in maths are extraordinary.	70.8	85	7.5	9	0		8.3	10	13.4	16
b) Girls have the same maths ability as boys.	7.5	9	11.7	14	0		75	90	5.8	7
c) I can solve mathematics problems quite easily; it does not scare me at all.	10	12	10.8	13	0		50	60	29.2	35

d) I am comfortable when answering maths problem.	12.5	15	6.7	8	1.7	2	48.3	58	30.8	37
e) Girls certainly are brilliant enough to do well in difficult maths topics.	13.4	16	5.8	7	0		43.3	52	37.5	45

From Table 2, SA means strongly agree; A = agree, U = uncertain, D = disagree and SD = strongly disagree. The majority 78.3% of the respondents agreed that Girls who were brilliant in maths were extraordinary whilst the remaining 21.7 % indicated otherwise. In the second statement, 19.2 % of the respondents agreed that girls had the same maths ability as boys. But 80.8 % of the respondents were of the contrary view. The responses from the third statement indicated that 20.8 % of the respondents agreed they could solve mathematics problems quite easily and it doesn't scare them whilst 79.2 % of them were of opposite view. This means that most of the participants disagreed that they can solve mathematics problems with ease. In the fourth statement 19.2 % of the respondents agreed that they were comfortable when solving mathematics problems, 1.7 percent were uncertain that they could solve mathematics problems with ease. But the remaining 79.1 % disagreed to this statement. It means that the majority of the respondents disagreed that they were comfortable when answering mathematics questions. The response from the last statement showed that 80.8 % of the participants disagreed that girls certainly were brilliant enough to do well in difficult maths topics. Moreover, 19.2 % of the participants were of opposite view.

In addition to the results above, when the participants were asked concerning students' attitudes toward mathematics during the focus group and the interview (interview guides for teachers, item one), the findings from the focus group and interview results, therefore, showed that students generally had low self-confidence for mathematics, especially their female counterparts. *Compared with boys, females did not have enough confidence and were anxious about Mathematics in the district* (2 mathematics teacher participants).

With regards to students' emotion or anxiety about mathematics as a subscale of attitude dimension, four statements were provided concerning the subscale (emotion/anxiety) for the respondents to provide their responses and the results were displayed in Table 3.

Table 3

Rating students' emotion/ anxiety about mathematics

Statement	SA		A		U		D		SD	
	%	N	%	N	%	N	%	N	%	N
a) I feel hopeless when taking maths exams.	65.8	79	12.5	15	0		8.3	10	13.3	16
b) I feel panic in maths classes.	75	90	5.8	7	0		11.7	14	7.5	9
c) I worry that I get low grades in maths.	45.8	55	29.2	35	0		14.2	17	10.8	13

d) Compared with other subjects, I worry more about maths.	46.7	56	37.5	45	0	7.5	9	8.3	10
e) I feel anxious when solving maths problem.	35.8	43	42.5	51	0	10	12	11.7	14

From Table 3, 78.3 % of the respondents agreed that they feel hopeless when taking maths exams, whilst the remaining 21.7 % were of contrary view. When the participants were asked whether they felt panic in maths classes, 80.8 % of them agreed to this statement. Moreover, 19.2 % of the participants disagreed to this statement. This means that the majority of respondents agreed that they were panicking in maths classes. When participants were probed concerning getting low grade in maths, 75 % of them were of the view that, they worried whenever they get low grade, but 25 % of them disagreed. 84.2 % of the participants agreed that they worry more about mathematics when compare to other subjects. But the other 15.8 % were of the contrary view. The response from the last statement showed that 78.3 % of the participants agreed that they felt anxious when solving maths problems. However, 21.7 disagreed.

After the interview analysis on students' anxiety toward the study of mathematics (interview and focus group guides for teachers, instrument one), students perceived mathematics as problematic and a barricade for future development. *In my view, most students consider mathematics as problem and barrier that prevent future development.* (Claimed by mathematics teacher participant).

Concerning the students' enjoyment of mathematics as a subscale of attitude dimension, they were provided with three statements concerning how they enjoy mathematics to indicate their agreement and the results were presented in Table 4.

Table 4

Rating how students enjoy mathematics

Statement	SA		A		U		D		SD	
	%	N	%	N	%	N	%	N	%	N
a) Studying mathematics in school is full of fun.	10.8	13	6.7	8	3.3	4	57.5	69	21.7	26
b) I enjoy sharing my mathematical knowledge with the rest of the class.	15.8	19	9.2	11	0		48.3	58	26.7	32
c) I like studying mathematics in school.	12.5	15	16.7	20	0		38.3	46	32.5	39

From Table 4, 17.5 of the respondents agreed that studying mathematics in school was full of fun, 3.3 percent were uncertain. However, the majority 79.2 % disagreed to this statement. 75 % the majority of respondents disagreed that they enjoyed sharing their mathematical knowledge with the rest of the class, whilst 25 % agreed to this assertion. In addition, 29.2 % of the respondents confirmed that they

liked studying mathematics in school. However, 70.8 % of them disagreed that they liked studying mathematics in school.

As to whether pupils enjoyed studying mathematics, they were asked to provide their responses to this research question during the interview “What are your experiences, views, and opinions concerning the study of mathematics?” (Teachers and students interview guides, question one). The result from their responses indicated that the majority of them considered the subject to be bored and un motivating which is an indication that they had no zeal to in learning the subject. *To me mathematics is very boring and un motivating* (affirmed by female participant).

In order to understand how well students are motivated to study mathematics, five statements were provided for the respondents to indicate their responses and the results were displayed in Table 5.

Table 5

Students’ mathematics motivation rating

Statement	SA		A		U		D		SD	
	%	N	%	N	%	N	%	N	%	N
a) My school rewards me for brilliant performance in mathematics	10.8	13	6.7	8	0		60.9	73	21.7	26
b) As a student, my teacher encourages me to study mathematics even if I get answers wrong during lessons.	14.2	17	9.2	11	0		48.3	58	28.3	34
c) As a girl, I get support from the family and school to study mathematics	12.5	15	14.2	17	0		40.8	49	32.5	39
d) My parents provide opportunity for me to study maths	5.8	7	9.2	11	0		54.2	65	30.8	37
e) Our district organizes inter-school science and maths quiz for us.	10.8	13	7.7	9	0		49.2	59	32.5	39

From Table 5, 82.5 % the majority of the respondents disagreed that they were rewarded for brilliant performance in mathematics. Moreover, 17.5 % were of contrary view. 23.4 % of the participants confirmed that they were encouraged by their teachers to study mathematics even if they had answers wrong during lessons. This means that 76.6 majority of the respondents were of opposite view. As whether the students got support from the society to study mathematics, 73.3 % of the participants disagreed that they got support from society to study mathematics while 26.7 % of the participants agreed to this. It can be observed that the majority of the respondents disagreed that their

parents provided equal opportunities for them to study mathematics (85 %) as against the 15 % who agreed. The response from the last statement had a percent of 81.5 indicating that most participants disagreed that their district organises inter-school science and maths quiz for them compared to 18.5 % of the participant who agreed to this statement.

The responses from the interview result also supported the above findings. In relation to how well students were motivated to study maths (interview guide for teachers and students, instrument 6), it is very debilitating that most pupils considered mathematics as uninteresting and failed to put in the maximum efforts possible to achieve their set goals in life. From the responses, most learners were not prepared to attempt any difficult mathematical problems. They perceived mathematics as problematic and a barricade for future development. *Most students consider mathematics as problem and barrier that prevent future development.* (Claimed by 3 mathematics teacher participants).

With regard to how much value students placed on mathematics, respondents were to indicate their agreements to three statements with respect to values of mathematics and the results were presented in Table 6.

Table 6

Rating how students value mathematics

Statement	SA		A		U		D		SD	
	%	N	%	N	%	N	%	N	%	N
a) I want to study mathematics because I will need it in everyday life	9.2	11	6.7	8	0		62.5	75	21.6	26
b) Mathematics is needed to keep the world in business	13.3	16	9.2	11	0		48.3	58	29.2	35
c) I want to study mathematics in school just to pass my B.E.C. E	38.3	46	29.2	35	3.3	4	16.7	20	12.5	15

From Table 6, 84.1% of the respondents disagreed that they wanted to study mathematics because it will be useful in everyday life as compared to 15.9 % who agreed to this statement. In the second statement, 77.5 % of the respondents disagreed that Mathematics was needed to keep the world in business. But 22.5 % were with contrary view. The third statement had a percent score of 67.5 indicating that most of the respondents agreed that they wanted to study mathematics in school just to pass their B. E. C. E. with 32.5 % holding contrary view.

Respondents were interviewed to enquire about their attitudes toward mathematics (interview guide 4). From the responses, students thought that mathematics was very difficult to study, felt anxious, and lacked self-confidence in studying the subject. *mathematics is very difficult subject to study, we feel anxious when studying mathematics, we don't have confidence in studying it* (explained by 4 female participants). From the responses, students considered mathematics as irrelevant, they complained that they study the subject for nothing, and would not pursue any mathematics-related course in future. *I think mathematics is not needed, we study the subject for nothing, I will not pursue any mathematics-related course in future* (explained by 3 female student participants).

Research Question 2

Which home, socio-cultural, school, teacher and student factors that contribute to Fanteakwa District Junior High School female students' attitudes toward mathematics in Ghana?

To solicit information on the factors that contributed to the Fanteakwa district junior school female learners' negative attitudes to the study of mathematics, the female participants were given twenty-two questionnaires concerning home, socio-cultural, school, teacher and the students' factors to provide their responses.

Home Factors. The researchers solicited information from the participants on home factors that impacted learners' attitudes toward the study of mathematics. They provided four statements concerning home factors that could have influenced the students' attitudes toward the subject and the data were presented in Table 7.

Table 7

Rating home factors that contribute to students' attitudes

Statement	SA		A		U		D		SD	
	%	N	%	N	%	N	%	N	%	N
a) As a girl, my parents support me financially to study mathematics.	9.1	11	10	12	0		59.2	71	21.7	26
b) In my house, there is electricity to study at night.	13.3	16	5.8	7	0		47.5	57	33.4	40
c) Peer pressure and household chores prevent me from studying maths.	38.3	46	32.5	39	0		16.7	20	12.5	15
d) My parents make sure that I study at night.	5	6	7.5	9	0		55.8	67	31.7	38

The findings from Table 7 revealed that 80.9 % of girls disagreed that they were supported by their parents financially to study mathematics. However, 19.1 % agreed to this assertion. 80.9 % of the participants disagreed that they have electricity at home to study at night. Other 19.1 % of the participants have agreed to this statement. From the analysis of the data, respondents lacked support from their peers and overburden with household chores which made it difficult for them to study mathematics (70.8 of the respondents agreed to this) as against 29.2 %. The analysis also indicated that most of the learners established that their parents failed to check on them to learn at night as 87.5 % of them provided affirmative answers as against 12.5 % who stated otherwise.

Socio-Cultural Factors. The participants were asked to respond to statements concerning sociocultural practice and the result is presented in Table 8.

Table 8

Rating socio-cultural factors that contribute to students' attitudes

Statement	SA		A		U		D		SD	
	%	N	%	N	%	N	%	N	%	N
a) As a girl, I am encouraged by family, school and the state to study mathematics	9.2	11	7.5	9	0		64.1	77	19.2	23
b) As a girl, my parents prioritise sending me to a school than for marriage	10.8	13	5.8	7	0		48.4	58	35	42
c) My society believed that girls were to be engage in household chores	55.8	67	31.7	38	0		5	6	7.5	9
d) My parent's educational background and peer pressure negatively impact my studying of maths	51.7	62	18.3	22	0		16.7	20	13.3	16

The data analysis from Table 8 established that girls were not encouraged by the society to study mathematics as 83.3 % of responses confirmed that. The other 16.7 % opposed the statement. Also, from the data, parents prioritised giving girls for marriage than sending them to school (83.4 % the majority of the participants agreed to this) as against 16.6 %. From the participants, there was a belief in their society that boys normally pursued mathematics and girls occupied the kitchen (87.5 % of the participants were in this direction) as against 12.5 %. 70 % of respondents agreed that parental educational background and peer group impacted students' attitudes to study mathematics as compared to 30 % who disagreed.

In order to be certain about the report of the quantitative data, the twenty female student participants and the five mathematics teacher participants were interviewed on some socio-cultural factors that contributed to students' attitudes toward mathematics (interview and focus group guides for teachers and students, instrument 2), followed up with focused- group discussion and they listed the following as socio-cultural factors that influence female students negatively to the study of mathematics:

- peer influence: *Our friends advised us not to study mathematics.*
- a lot of household chores: *in the house we do a lot of work because of that we don't have time for our home works.*
- Gender stereotypes: *the adults always say mathematics is for boys.*
- The lack of female role model: *we don't have literate people to assist us do our home works.*

Other provided responses were (1) the lack of electricity to study at home. *The students have no electricity in their homes to study at night* (mathematics teacher participant 1), (2) students lacked mathematics literate people to assist and encourage them to do their assignments. *Some of them have*

nobody to assist them to do their assignments (mathematics teacher participant 2), (3) the majority of female learners were residing in polygamous home that were financially handicap and therefore lacked support from home. *Many of these learners were coming from polygamous homes that were financially strained and cannot provide for their children's needs such as exercise books, textbooks, tables and chairs to study at home* (mathematics teacher participants 3).

The result from the focused group discussion appeared as, some of the parents did not help the students to do homework, some of the female end up given themselves to men for money.

Female students are allowed to do a lot of work in the home so they do not have enough time for their books. Some of the female students have to walk for kilometres to school without taking vehicles because of that they may already be tired before lesson commence. (Explained by 2 mathematics teacher participants).

School Factors. Better still, the information from the participants on school factors that affect learners' attitudes toward the study of mathematics was solicited. Five statements concerning school factors that could have influenced the students' attitudes toward the subject and the data were provided and displayed in Table 9.

Table 9

Rating school factors that influence students' attitudes

Statement	SA		A		U		D		SD	
	%	N	%	N	%	N	%	N	%	N
a) The school environment is walled and conducive for learning Mathematics.	9.2	11	13.3	16	0		41.7	50	35.8	43
b) The school provides teaching learning resources to support lesson.	13.3	16	8.3	10	0		48.4	58	30	36
c) The lack of reward package for teachers and students affect the study of mathematics.	38.3	46	30.6	37	0		18.3	22	12.5	15
d) We have enough tables and chairs in the Classrooms	8.3	10	7.5	9	0		52.5	63	31.7	38
e) Motor bikes, vehicles and people do pass by during lessons	40.8	49	36.7	44	0		7.5	9	15	18

From Table 9, 77.5 % of the respondents disagreed that schools in the district had wall around them with conducive environment. However, 22.5 % had contrary view. Most of the respondents disagreed that the school provides teaching learning resources to support lesson with a whopping 78.4 % as against 21.6 % who agreed to this. For the statement that lack of reward package for teachers and students affect the study of mathematics 68.9 % of participant affirmed to this as against 31.1 %. With regard to whether there were enough tables and chairs in the classroom to support lesson, 84.2 % of the participants disagreed to this as against the 15.8 % who agreed. 77.5 % of the respondents agreed that motor bikes, vehicles and people passed by during lessons. However, 22.5 % of the participants disagreed to this statement.

The interview and group discussion (the interview and focus group guides for teachers and students, instrument 3) with the twenty female students and five mathematics teacher participants supported the findings above. After gathering the responses from the participants, the following were outlined as factors emanating from the school environment that impacted female learners' attitudes negatively to learn mathematics in the district:

The students are too many in the class because of that, individual differences are not taking care of. The school lack enough teaching learning resources to support mathematics lesson, there are no fans in the classrooms so students learn mathematics in hot environments, most of the Junior High Schools do not have wall around their compounds so community members move up and down in the school creating unnecessary noise pollution in the environment which make the environment uncomfortable for learning. Adding to that, most Junior High Schools do not have enough technological tools to support mathematics lesson (3 mathematics teacher participants).

Teacher Factors. To probe teacher factors that impacted learners' attitudes toward the study of mathematics, the respondents or participants were asked to indicate their agreement with the statements provided and the findings are displayed in Table 10.

Table 10

Teacher factors ratings

Statement	SA		A		U		D		SD	
	%	N	%	N	%	N	%	N	%	N
a) The teacher creates the enabling environment for teaching and learning.	9.2	11	15	18	0		41.7	50	34.1	41
b) The teacher uses teaching learning resources during maths lessons	10.8	13	8.4	10	0		50.8	61	30	36
c) The teacher adjusts the pace of the class to students' level of understanding.	12.5	15	18.3	22	2.5	3	28.3	34	38.4	46
d) The facilitator is well prepared.	8.3	10	10.8	13	0		49.2	59	31.7	38
e) The teacher makes mathematics lesson	7.5	9	8.3	10	0		38.4	46	45.8	55

From Table 10, it is clear that 75.8 % of the participants disagreed to the fact that the facilitator created the enabling environment for teaching and learning of mathematics whilst the remaining 24.2 % were of opposite view. 80.8 % of the respondents disagreed that the facilitator utilised TLRs during lesson delivery. But 19.2 % agreed to this statement. 30.8 % indicated that the facilitator adjusted the pace of the class to students' level of understanding during lesson with whopping the majority of 66.6 % in opposite direction, but 2.5 percent were uncertain. From the analysis of the data from respondents, most of the facilitators did not prepare well before going to class (80.9 % affirmed the statement as against 19.1 % who said otherwise). Some of the teachers failed to promote effective learning that explain mathematics concepts clearer to the student by adopting practical approach when handling the subject (84.2 % of the participants were with this view, but 15.8 % hold opposite view). The interview and the group discussion result below confirmed these claims.

During the interview and focus group discussion, the respondents were asked to state some of the things their mathematics teachers did that made them have negative feeling towards the study of Mathematics (interview guide 5). After gathering the responses from the 5 student respondents during the interview and focus group discussion, these were outlined as factors relating to mathematics teachers that have contributed to the negative attitudes of girls to the study of mathematics:

- Lateness. *the teacher does not come to school early.*
- Inappropriate teaching strategies. *when he comes too, he will be rushing us through the lesson.*
- Teachers negative attitudes toward learners. *some of them insult us for not understanding difficult topics during mathematics lessons.*
- The lack of individual differences during lesson delivery. *Mathematics teachers neglect individual differences during teaching; they even punish us when we failed in the subject and even discourage us.*

Teachers rushing female students through mathematics lessons, humiliating slow learners especially female students, insulting students for not understanding difficult topics during mathematics lessons, sometimes in a rush to cover a lot of topics they neglect the individual differences, sometimes they will not come to class early and punishing students when they failed exams, class tests or exercises were the provided responses. Some of the responses from mathematics teacher participants were as follows:

Some of our teachers do not master their subject area let alone to use technology in teaching mathematics. The learners do not have female mathematics teachers as role model. The mathematics teachers we have in our school are all male so the students think only men can do mathematics because of that they do not have the zeal for the subject. The male teachers do not have patience for learners, they rush them through the subject, some of them engage students in unnecessary conversation to kill time- (4 Emphasised by mathematics teacher participants).

Our teachers shout and use harsh words on us, not drilling the students in Mathematics topic. Failure to give enough exercises after Mathematics lessons by some teachers. Undesirable teaching strategies mostly employed by some teachers; students are not motivated at the early stage to develop interest in the subject, Students perceived mathematics to be very cumbersome and have debilitating interest in the subject (2 Mathematics Teacher participants).

Students Factors. In regard to students' factors that contributed to their attitudes toward mathematics, the responses from the questionnaire, interview and focus group discussion, were presented below.

Table 11

Students' factor ratings

Statement	SA		A		U		D		SD	
	%	N	%	N	%	N	%	N	%	N
a) I think questions given are within our range	9.1	11	7.5	9	0		46.7	56	36.7	44
b) I can cope with harder maths courses	10.8	13	8.4	10	0		50.8	61	30	36
c) When it comes to maths, I'm motivated, have interest and study hard	12.5	15	15.8	19	4.2	5	29.2	35	38.3	46
d) I feel that I will fail in maths, it is problematic	52.5	63	35	42	0	5	6		7.5	9

It has been indicated from Table 11 that students complained that mathematics questions were more difficult than they could understand and any question given to them were not within their range. 83.4 % of the respondents agreed to this statement as against 16.6 % who disagreed. With regard to whether students coped with harder maths topic, 80.8 % disagreed with the remaining 19.2 % stating otherwise. Furthermore, when it comes to studying maths, students feel lazy, lack interest and are unmotivated to study the subject (67.5 % of the respondents confirmed this, 4.2 percent were uncertain, but 28.3 % hold opposite view). Learners considered mathematics as problematic and saw themselves as a failure when they hear of mathematics as confirmed by 87.5 % of the respondents with a few 12.5 % who disagreed to this statement. Also, some female students view the subject as a very complex concept that was a problematic and less feminine advantage. The responses from the interview and focus group discussions resulted below buttress the findings.

The respondents were asked to state other factors they thought were responsible for the poor achievement of the JHS in Mathematics (interview guide for students and teachers, instrument 7). From the participants the following issues were reported as factors emanating from students that influenced their achievement in mathematics; (1) most students thought they were not good in mathematics, the subject was too complex to learn, don't understand most of the concept, *feel anxious about mathematics and feared that they will get low grade* in the subject and it can only be learn by talented students. *I feel anxious about mathematics and feared that I will get low grade, it is problematic and don't favour us; as for me, am not good in mathematics, I don't understand most of the concept, it too complex, I think maths is for only the gifted, I feel anxious about mathematics and feared that I will get low grade, it is problematic and don't favour us.* (Emphasized by 4 female student participants). (1) Inattentiveness in class, laziness on the part of students, students failed to manage their time well, consider mathematics as difficult and

boring. *Majority of the learners are lazy to study mathematics and failed to manage their time well and are inattentive in class, consider mathematics to be difficult and boring, absent themselves from class* (affirmed by 2 mathematics teacher participants).

Discussion

The discussions of the findings were accomplished in light of research questions and the corresponding literature. The responses from the, interview, focus group discussion, and questionnaire in Table 2 – Table 6 showed that many female students in Fanteakwa district have a negative attitude toward mathematics. They lacked self-confidence (from Table 2, 80.9 % of the participants disagreed that girls are also brilliant enough to do well in difficult maths topics), and felt panic when solving mathematics problem (80.8% of participants from Table 3), were emotional/ anxious (78.3% of participants from Table 3), lacked interest in the subject (79.2% of participants from Table 4), were not motivated and they were neutral about whether mathematics was useful in everyday life which negatively affected their attitudes toward mathematics.

The findings above confirmed the research conducted by Wakhata et al. (2022) on the relationship between students' attitudes and mathematics performance, it appeared that despite the crucial role of mathematics in development of human resource, many learners in the first and second cycle institutions are not very much enthused over mathematics due to their poor attitudes toward the study of the subject at various level of education. It also corroborated the work by other researchers like Arko and Kporyi (2018) in senior high school at Ordoben on students' attitudes toward mathematics and the result showed that, in this modern world, many of these learners found it difficult to solve mathematics problems and hence perform very poorly in their final examinations. Learners' achievement in mathematics at the basic education certificate examination has been deteriorating over the years, the reports about the candidates were that they lacked understanding of mathematical concepts and find it difficult to form the appropriate mathematical equations which could be tackled with the fundamental knowledge (Chief Examiner's Report, as cited in Arko & Kporyi, 2018). All of these are blamed on students' attitudes toward the subject.

Although the data analysis from Table 6 shown that 15.9% of learners concede that mathematics has important uses in everyday life, the majority 84.1% of them considered the subject to be irrelevant and simply a barrier that prevents future development. The expression of this feelings happens at their school times. consequently, most female learners demonstrate negative attitudes toward mathematics and tend to lack self-confidences in mathematics. Moreover, these students perceived themselves as subservient to boy and may not consider mathematics as their area of interest, many of them perceived mathematics as a field for boys and were worried about the subject. Majority of the participants were of the view that most female learners feel reluctant to make any effort to comprehend the concepts, so they always blamed their mathematics teachers and perceived the subject as difficult. The excerpt below from the interviewees confirmed these assertions. *I think mathematics is very difficult subject to study, mathematics is a male dominated field, our teachers do not help us* (explained by female participants).

These students' attitudes are linked with many factors, including mathematics teachers' instructional approaches, roles, teaching methods, cultural stereotypes, lack of parental support, inconducive school environment and their attitudes toward mathematics play vital part in this problem (Table 7 – Table 10 support this findings). As to whether pupils enjoy studying mathematics, their responses from Table 4 indicated that the 79.2% the majority of them considered the subject to be boring and that they didn't make any fun out of it, which is an indication that they had no interest in studying the subject. The responses from the interviewees also confirmed this report. *To me*

mathematics is very boring and unmotivating (affirmed by female participants). Thus, it is very debilitating that most pupils consider mathematics uninteresting and failed to put in the maximum effort to attain their set targets in life. From the responses, most pupils were not prepared to attempt any difficult mathematics problems. They perceived the subject as problematic and a barricade for future development. *In my view, many students consider mathematics as a problem and barrier that prevent future development* (claimed by mathematics teacher participants). To add to this, learners absent themselves from mathematics class; thinking that studying the subject is irrelevant and worrying.

As appears from Table 6, the participants did not understand and value the usefulness of mathematics in everyday life and the contemporary world. And therefore, plan not to pursue any mathematics-related course in future. *I think mathematics is not needed; we study the subject for nothing* (explained by female student interviewees).

In this regard, it is clear that learners don't appreciate the usefulness of mathematics in all aspect of their lives. The results from this work support the research carried out by Kiwanuka et al. (2020) which shown that there is a reciprocal effect between attitude and performance in mathematics. That is, high talented students tend to develop positive attitude. In other words, students with positive attitude tend to achieve high success on mathematics tasks. The above findings also confirmed the research study carried out in Spain by Rodriguez et al. (2020) on gender differences in mathematics motivation and its differential effects on performance in education; which pointed out that comparing female learners with boys, females lack the zeal, always demonstrate weak performance, thought that mathematics is only meant for males; and were anxious about mathematics. Research conducted by Armah et al. (2021) in Ghana on sex differences in mathematics achievement among male and female distance learners revealed that both male and female learners' performance in mathematics were below average grades. I.e., D+, D and E. However, the performance of male distance learners outweighed their female counterparts. The findings above affirmed the report of this study that female students generally exhibit negative attitudes toward mathematics and performed poorly in the subject. Based on the findings and my analysis, female students in Fanteakwa district perceived the study of mathematics as a 'witch-hunt and therefore needs tough skin individuals' to study the subject, although there were a few individual students who are intrinsically motivated. In addition, the finding also confirmed the empirical studies Geng et al. (2022), Ata-Aktürk and Demircan (2021) that there exists relationship between teacher and parent support and student well-being. These scholars pointed out that teacher and parent support have numerous benefits that significantly affect student achievement and emotions. Therefore, if mathematics teachers and other stakeholders want to motivate students, they have to use self-regulatory strategies to challenge the learners to develop interest and persevere in studying of the subject. They can motivate learners to utilize self-regulatory actions and plans (Farhana et al., 2020), put in more effort and persevere longer when they are being challenged (De Smedt et al., 2020).

With regards to the second research question, the findings unravelled several factors that promoted the negative attitudes of JHS female learners to the study of mathematics in the Fanteakwa district. The socio-cultural factors include; lack of societal support and encouragement to study mathematics, parent prioritise given their girls into marriage than sending them to school, gender stereotypes, parental educational background. Home factors include; peer pressure, lack of financial support from home, lack of electricity to study at home, household chores. The above finding is in line with Eriksson et al. (2021) that students who had support and encouragement from their parents achieve high success in mathematics. Filade et al. (2019) explained that the influence of peer groups can affect learner's academic performance positively or negatively depending on the subculture of the group. Thus, if the subculture of the group cherished early marriage most students will end up in

marriage and will not make any effort to achieve high success in mathematics and vice versa. Others lack female role models to emulate at homes, learners walking so many Kilometres before getting to their schools, among others. The finding was in line with Schunk and Usher (2019) who pointed out that students who perceive the role model to be similar to themselves are more likely to be influenced by the model. This means that, for students to excel in mathematics, there must be mathematics role models for students to emulate. This is because when students associated themselves to role models and share their values, it encouraged and give them insight of their own chances of succeeding in future (Schunk & DiBenedetto, 2020).

As appeared from the findings, many students see no value in mathematics and are only in the mathematics class because they are expected to be there. Others include students not attentive in class, being truant, playing and conversing during mathematics lessons, refusing to take part in exercises and assignments, not coping mathematics notes and performing poorly in the subject which in turn lead to developing a negative attitude towards mathematics.

Other factors include the following: Many girls in Fanteakwa district have been conditioned by society to see themselves as inferior to boys when it comes to learning of mathematics. The expectations of many families of girls are to be equipped with some basic literacy and arithmetic skills to enable them to manage their daily life well, and also preserve their culture. Boys on the other hand are expected to be hardworking and breadwinners in society. With these expectations, many parents and families will like to spend much of their resources on boys' education than girls. The excerpt below from the interviewees confirmed the report: *our parents always say that girl's education is not important because they would get pregnant along the way and misuse the resources spent on them but for boys, they would work hard to bring back any resource spent on them.* To confirm this report, research conducted by Jin (2023) in China revealed that gender stereotypes impact female students and pointed out negative influences from family, schools and society would lead to lower confidence in girls. Consequently, girls exhibit lower grades in specific subjects, and got fewer academic achievements. The findings highlight that educators, parents and public media need to encourage both male and female development in all fields.

Some factors emanating from the mathematics teachers that contribute to the negative attitude of female students in the Fanteakwa district are: teachers' attitudes, mathematics teaching beliefs and instructional strategies. Many teachers believe mathematics is difficult and could only be effectively learnt by certain categories of students. So, during teaching, these teachers discourage the girls that they are not capable of studying mathematics and failed to adopt appropriate instructional strategies to cater for individual differences. *Mathematics teachers neglect individual differences during teaching; they even punish us when we failed in the subject and even discourage us.* (Female student participants) This is in line with Ngeche (2017, p. 2) that learner draws from his teacher's disposition to form his own attitude which may likely affect his learning outcome. In addition to that, teachers' instructional practices have also contributed to the negative attitude of female students in the district. It was shown that many teachers don't use appropriate teaching strategies, teaching and learning resources during mathematics lessons. Some teachers still teach the subject in an abstract way without any teaching aid to arouse the students' interest. concerning the teaching pedagogical strategies employed by teachers during mathematics lessons, the study revealed that some mathematics teachers were not competent in handling the subject and for that matter do not allow learners to ask questions to get clarifications in class. And this was in contrary to Asempapa (2022) that the teachers' instructional strategies which make the use of differentiated learning by considering individual students' differences may change learners' attitudes, thereby providing them with support academically and socially. Some students complained that their teachers use insults and other offensive languages on them any time they try to

ask questions in class. Some teachers are not only using inappropriate teaching methods but also, teaching in abstraction without the use of teaching and learning materials.

Again, the lack of excitement during mathematics lessons was mentioned as another cause for the dislike for the subject.

Limitations of the Study

The research work was characterised by some shortcomings. Some of these challenges included (1) the time; the researcher has to spend more time than expected explaining the questions to individual respondents mostly in their local language to enable them to provide the needed and accurate information. (2) the use of five schools out of a total of forty- nine Junior High Schools in the District as a result of time and resource constraints affect the generalizability of the research findings.

Conclusion

The study revealed that junior high schools' learners demonstrated negative attitudes toward the study of mathematics in the Fanteakwa district due to their perceptions and beliefs about mathematics as a difficult subject to understand.

It further found out what home, students', school, teacher and socio-cultural factors that contribute to Junior High School female students' attitudes toward mathematics in the Fanteakwa District of Ghana. These include but not all: poor and illiterate parents, laziness and absenteeism on the part of students, large class size, early marriage and lack of appropriate teaching methods and beliefs about the subject on the part of mathematics teachers, lack of electricity for learners to study at home, and lack of role models.

The researchers made the following ***recommendations*** from the findings:

Firstly, the findings in this thesis (the majority of students don't value mathematics, from Table 6) suggest that attempts can be made to reframe mathematics as a social endeavour. Girls need to understand the role of people in mathematics as a discipline both historically and in the present day.

Secondly, the study revealed that most teachers handling mathematics were not enough competent. The government can set up a national mathematics centres where all stakeholders in mathematics education can research and share ideas on the best way to teach and learn mathematics which will promote mathematics education in the country.

And finally, government can set up district counselling teams in various education directorates who would periodically visit schools in the district to sensitise and educate parents on the need to support the wards in school and also, the government should develop gender friendly curriculum to provide equal opportunity for girl child.

Suggestions for Future Research

The gender-based research on attitudes toward mathematics education still has a long way to go and requires more investigation. Even for nations such as Chile and Jordan, which have achieved a high level of gender equity in mathematics education (Dodee & Innabi, 2018, Mejias et al., 2021), gender disparity favouring boys and the pattern of lower interest in mathematics among girls in various level of education is still persisting. Despite the highly demanded and recognized importance of mathematics and the fact that it is the basic requirement for most of the courses in tertiary institutions, poor performance and lack of interest in mathematics among students remains as an issue of concern

in junior and senior high schools and even universities in developed and developing countries alike. The report of this study revealed that there is a countless factor that contribute to the negative attitudes of female students towards the study of Mathematics in the study area. In view of the adverse effects of these negative attitudes not only on the female student, but also, it may have consequential effects on the country at larger or even beyond. In other to get clear understanding and the gravity of the problem of this nature among the junior high school female students in Ghana, the researchers, therefore, advise that further studies on the topic should be undertaking using a larger sample or we think the study can be repeated in other districts and or the entire country so that a more holistic picture can be generated. This will go a long way to enable the governments, headteachers, various education directorates, and other stakeholders in education to provide a lasting solution to the problem.

Acknowledgements

The authors would like to express their sincere gratitude to all Students, teachers, headteachers, the supervisor and the education directorate at Fanteakwa district of Ghana, for their contributions to this research, as well as their significant time and effort for assisting in the data collection process.

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DOI: <https://doi.org/10.57125/FED.2023.12.25.02>

How to cite: Koniari, D. & Raftouli, G. (2023). Death Anxiety of Students and Teachers of High Schools in the Region of Thessaly, Greece. *Futurity Education*. 3(4). 31-45.
<https://doi.org/10.57125/FED.2023.12.25.02>

Death Anxiety of Students and Teachers of High Schools in the Region of Thessaly, Greece

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Received: July 25, 2023 | **Accepted:** October 2, 2023 | **Available online:** October 19, 2023

Abstract: The main purpose of this study was to investigate the effect of the five personality factors such as religiosity, well-being and the central mechanism of self-evaluations on the overall performance in death anxiety. At the same time, other individual variables were also taken into account and formulated in order to investigate this specific issue. The relationship between the effect of personality factors to death anxiety was examined. As personality is a complex and multidimensional object, for this reason researchers attempt to create a systematic taxonomy in order to analyse it. The result of this research emerged both from the literature review that follows and from the survey that was conducted on a sample of 235 people (before adulthood students and teachers), between 17-63 years old of the region of Thessaly. The method of probability sampling and a specifically simple random sampling was used. The questionnaire was used for the needs of this quantitative research. Descriptive statistics was used in order to present the demographic data of the research and also to give the trend that arose from the answers to the research questions. Additionally, the methods of inductive statistics were focused on the question in order to rely on the findings of a sample observations. With the help of inductive statistics examination the confidence of the finding was proved. In the descriptive statistic the main characteristics of the individual variables were described. In the presented survey mainly the

descriptive statistic was used in order to present the data of research participants. These results were presented schematically. Consequently, no significant differences were found between people's well-being and gender. According to research men were slightly happier than women, however, this was a negligible difference. Despite the above finding, this study significantly contributed to the promotion of the research in the specific field.

Keywords: anxiety, death, religiosity, self-evaluation, well-being.

Introduction

Initially, the death anxiety, which is the dependent variable of this research, was treated by various researchers sometimes as a unidimensional and sometimes as a multidimensional issue each time using different scales (Conte et al., 1982; Ellis et al., 2013; Soleimani et al., 2020; Wong et al., 2023). For example, Collet and Lester (Conte et al., 1982; Cheong et al., 2020) have distinguished four dimensions of death anxiety: fear of the own death, fear of another person's death, fear of dying, and fear of others dying. More recent research (Spitzenstätter & Schnell, 2022; Testoni et al., 2019) distinguished three categories, the avoidance of death, the fear of death and the individual's disengagement from it.

Although there is much interest in the five-factor model, the self-esteem, neuroticism, and control could perhaps be characterised as the "Big Three" of recent organisational psychology and personality research. The self-esteem is the self-acceptance and the extent to which one sees oneself as "competent, important, successful, and worthwhile" (Judge et al., 2005). Particularly, the self-esteem appears to be the most broad and essential central mechanism of the self-evaluation and is thought to be the result of emotional influences such as personal success. The self-efficacy reflects the self-confidence and is defined as the ability to present appropriate behaviors in possible situations. Neuroticism is one of the five personality factors. Neuroticism manifests itself in at least two tendencies: one is related to worry and the other is directed towards euphoria.

As research proves, there is a significant correlation between the self-esteem and extroversion. Particularly, the self-esteem and neuroticism are correlated with extraversion and conscientiousness. Thus, the central mechanism of self-evaluations is correlated with extraversion and conscientiousness, but these correlations are not as strong in magnitude (Bono & Judge, 2003; Yan et al., 2018). Bleidorn et al. (2016), examined the relationship between the self-esteem and all five personality factors and found that the self-esteem was associated with emotional stability, extraversion, receptivity to experience, conscientiousness, and agreeableness (Bono & Judge, 2003). Xu et al. (2016) also found a correlation (0.48) between job satisfaction and the central mechanism of self-evaluations

Very interesting are the correlations of researches between demographic characteristics and the fear of death. According to the findings of research carried out by (Conte et al., 1982) it was initially found that there was a little systematic relationship between age, sex, education, religiosity and death anxiety. Lester (Calvo et al., 2023; Dursun et al., 2022) observed that as more well organised were the studies, the smaller was the relationship that was found between demographic characteristics and the fear of death. From the other hand, the scientist considered that personality and life experiences were the most determining parameters about the fear of death. The research of Koocher et al. who used the same instruments, have found that students of high school with an average age of 16 years old had scored higher on scales of death anxiety, general anxiety, and depression than have done younger students of the same school grade or night school students (Cicirelli, 2002; Testoni et al., 2019). The researchers attributed the death anxiety of teenagers to their intense anxiety as they face new emotional and physical changes during their development (McNamara, 2000; Muris, 2007; Shaver & Mikulincer, 2007).

Continuing with the term religiosity, it is referred to a person's positive attitude towards a supernatural principle that is of great importance to his existence and that has come beyond and outside of all experience. The term religiosity is a multidimensional "construct" that includes cognitive and affective behavioral characteristics, (Hardy et al., 2019; Villani et al., 2019). On one hand, there has been found a positive relationship, according to which a high degree of religiosity is associated with a strong feeling of fear of death, while on the other hand, an inverse relationship has been found between religiosity and death. The conflicting interpretations are likely due to the one-dimension measurement of the variables and the use of a single research instrument (Hardy et al., 2019; Pandya & Kathuria, 2021; Saleem & Saleem, 2020).

According to the research by Wittkowski (1988) it has been found that there was a positive correlation between the acceptance of death, either that who has happened or who that will happen having belief in god. At the same time, there are inverse relationships between the fear of the death of others and all aspects of religiosity. Regarding the female sample, the researchers concluded that those women who were identified with the moral principles of the Catholic Church, have a high fear of death either for themselves or for others. However, negative correlations were observed between individuals' religiosity and the fear of their own death, as well as those of women participating in religious activities (Koscielniak et al., 2022; Saleem & Saleem, 2020; Torres, 2023).

The personality and the way that people, through its characteristics evaluate the quality of their life and either or not they are afraid of death is the other variable. Although there are several definitions about it and each theorist interprets it based on a different theoretical framework, the model of the five-factor is undoubtedly an important revelation in the field of personality and is one of the most documented models that includes those characteristics that make people different from each other (Abood, 2019; Tsaousis & Kerpelis, 2004; Ypofanti et al., 2015). The first is the one developed by Costa and McCrae who used the New Personality Questionnaire as their main tool and the second is related to the lexical hypothesis, which uses lists of adjectives derived from dictionaries. According to Costa and McCrae's 5-factor model there are five personality dimensions: extroversion, agreeableness, consistency, neuroticism and receptivity to experience, while according to the lexical hypothesis the terms are assigned as follows: impulsiveness, agreeableness, consistency, emotional stability and culture or intelligence (Tsaousis et al., 2007).

Another variable is the well-being factor. The well-being is a broad category of phenomena that includes people's emotional judgments and overall assessments of life satisfaction. The well-being researchers (SWB) consider that only the social indicators do not determine the quality of life. They assume that people react differently to the same circumstances, and evaluate conditions based on their personal expectations, values, and past experiences. While crime statistics and income status are relevant to discussions of quality of life, the subjective element is essential (Anglim et al., 2020; De Kock et al., 2021; Diener et al., 1999). The well-being has many aspects that must be evaluated through overall assessments, moods, memory, psychology, and the individual's emotional state. It can also be assessed through social characteristics and behaviors (Diener, 2000; Lucas & Diener, 2009).

Regarding the relationship between health and well-being, it was found that it depends on the personal assessment of a situation. Especially, when a condition is bad it can negatively affect the well-being. A significant correlation exists between the well-being and religion. A number of studies prove that the well-being is significantly related to religious belief, prayer, the relationship that one develops with the religion element, while religion can give meaning to people's daily lives and serve social goals bringing together people who share common attitudes and values (Anglim et al., 2020; Diener, 2012).

The self-esteem, is the value that one person assigns to oneself as an individual. It is the most important and comprehensive indicator of our self-evaluation, an alternative parameter of positive self-evaluations. It is often the result of opportunistic influences such as happiness, which is why it is more prone than other personality traits to transitory effects which means it is also less stable compared to others. However, it has been found to be stable over time and, like the five personality traits, much of its variability is attributable to the factor of heredity (Erkmen & Esen, 2019; Filosa & Alessandri, 2023; O'Brien et al., 2006).

Research Problem

The purpose of the presented paper was to fill the research gap that exist in Greece concerning the death anxiety in male and female students as well as teachers and to represent the picture of its reality. The main research problem of this study was formulated in the investigation of the five personality factors: religiosity, the well-being and the central mechanism of self-evaluations in the overall performance of death anxiety of students and teachers in Greece.

Research Focus

Around the 1950s, psychology and other related disciplines became interested in death as an object of scientific inquiry (Anwer et al., 2020; Chan & Yap, 2009; Jong et al., 2019). A series of articles in newspapers and books were written around this topic, while, at the same time, it formed the content of courses and seminars for medical students, professionals and paraprofessionals who dealt with aging and death. However, the scientific community was concerned by is the fear of death or the anxiety that the fear of death causes in students and teachers as well as the various factors-variables that shape it.

The death anxiety may arise as a result of environmental influences such as death education programs or everything that is associated with other emotional associations such as general anxiety and depression (Jong et al., 2019). Studies have been done regarding the contribution of personality to increase or decrease well-being (Pyszkowska & Rönnlund, 2021). A happy person is one who is outgoing, optimistic and free from stress. Extraversion and neuroticism have been found to predispose individuals to experience positive and negative life events, respectively (Stoeber et al., 2020).

The self-esteem is closely related to the well-being, although research has found that the correlation was not universal and varied across cultures. The correlation was found to be high in Western societies, but not in cultures that prioritised the group over the individual (Kamushadze et al., 2021; Megawati et al., 2019).

Research Aim and Research Questions

The goal of this study was focused on the role of personality, religion, well-being and the central self- assessment mechanism in the death anxiety of students and teachers in Greece.

The research questions were the following:

- Does the attitude of the male and female students and teachers towards overall stress performance differ?
- Does the psychological health of male and female students and teachers correlates with the overall performance on death anxiety?
- Is there any difference between the three health levels of male and female students and teachers in the overall performance on death anxiety?

Research Methodology

General Background

In this quantitative research took part a sample of male and female students and teachers of high schools in Greece. This approach was favored due to its ability to uncover the underlying factors driving shifts in diverse social scenarios through objective quantification and numerical analysis. It aimed to verify the research questions through numerical data. Data were presented quantitatively with numbers, which were coded, analysed and interpreted with statistical figures, charts and statistical indicators. It highlighted general trends and through the simple random sampling it could be applied to a small sample of population having all the properties for applying the probabilities.

Sample / Participants / Group

In the region of Thessaly which is in the center of Greece there are 98 high schools. In Thessaly there are about 1000 teachers who teach in the last class of high school and about 700 students who are 17 years old. In this survey through the method of random sampling took part 235 students and their teachers. From 235 people, 94 of them were male students and teachers (40%) and 140 were female students/teachers (59.6%). In order to collect the data, the method of probability sampling and specifically the method of simple random sampling were used. In this way, the representativeness of the sample was ensured, in an attempt to gather the characteristics of the population the same probability for all members of the population was included. The questionnaire was sent to high schools of the province and urban centers so as to have a total picture of this topic. The participants were informed through a cover letter which was sent via email before the questionnaire about the anonymity of the research. Then, there was a phone call to remind the deadline of the questionnaire.

The age of the research population ranged from 17 to 63 with a mean age of 37 ($M = 37$, $SD = 10.8$).

Instrument and Procedures

In order to gather the data instruments that were designed to measure death anxiety, religiosity, personality, central mechanism of self-evaluations, and mental and physical health were used. These were numerical and verbal rating scales and questionnaires that included a series of statements to which subjects were asked to agree or disagree.

More specifically, the Death Anxiety Questionnaire (DAQ) developed by Conte et al. (1982) were given to participants. It consisted of 15 items that measured the individuals' attitudes and beliefs toward death. For each item respondents were asked to indicate whether or not they were bothered by choosing between three scales: not at all (score 0), almost (score 1), or very much (score 2). Scores ranged from 0 to 30. The 15 items that made up the DAQ are then summed to produce a composite score.

In order to measure the dimensions of religiosity, a five-item scale "The Duke Religion Index (DRI)" by Koenig which measure the organisational, non-organisational, and internal dimensions of religiosity were used. The responses for the first two personality dimensions were rated on a six-point frequency scale: (1) = never, (2) = once a year or less, (3) = a few times a year, (4) = a few times a month, (5) = once a week, (6) = several times a week, while responses for the internal aspect of religiosity are rated on a five-point frequency scale: (1) = definitely not true and (5) = definitely true.

The personality was measured with the Greek Personality Adjective Checklist (GPAC) created by Tsaousis and Georgiadis (2009), which consists of 94 adjectives that have emerged from the study of the Greek vocabulary. This psychometric test includes six scales that are corresponded to the six personality dimensions. These six dimensions are Negative Valence/Honesty, Agreeableness/Positive Affect, Prowess/Heroism, Introversion/Melancholia, Even Temper and Conscientiousness. GPAC uses a

5-point response scale for the extent to which each adjective is representative (or not) of the persons' personality ("1" not at all representative and "5" very representative).

To measure the core mechanism of self-evaluations, the Core Self-Evaluations Scale (CSES), constructed by Judge et al. (2002) was used. In Greek language, it was adapted to Greek by Tsaousis et al. (2007). It includes 12 total questions that activate the central mechanism of self-ratings and ask sample participants to agree or disagree for each statement by completing a 5-point scale (1, strongly disagree, 2 disagree, 3 neither disagree/neither agree, 4 agree, 5 strongly agree). Through the answers that constitute the advantage of the specific questionnaire, characteristics, such as neuroticism, self-esteem, general self-sufficiency, control of facts, are estimated. These characteristics are not usually examined together.

Finally, the measurement of physical and psychological health was done with the Cartwright and Cooper (2002) ASSET scale. It is a professional diagnostic tool through which conclusions about physical and psychological health were drawn. The physical health scale includes six items, while the psychological one has 11. Individuals filling in a scale from 1 (= never) to 4 (= very often) are asked to answer how often they experience such situations. High scores on this scale indicate poor mental or psychological health.

All the above scales used to measure the variables of our research were considered reliable and valid tools.

The survey took part in Greece in High schools of secondary education. The ten tools were sent via e mail to students and teachers of high school. Tools were previously classified in the following order: Death Anxiety Scale, Duke Religiosity Scale (DRI), Central Mechanism of Self-Evaluation Scale (CSES), Greek Personality Test, Mental and Psychological Health Scale (Asset). To complete the questionnaires, there were clear instructions at the beginning of each page, while the students and teachers in the sample were informed from the beginning about the purpose and process of the research. In this way, the necessary codes of ethics were respected, ensuring the consent of the participants, but also the observance of their anonymity, as they were not asked to fill in their name but only the demographic characteristics of gender and age.

This survey took place in Greece covering the period from September until December 2021 during the COVID-19 pandemic.

Data Analysis

The completion of the questionnaires needed approximately 45 minutes, they were numbered from 1 to 10. After the data were introduced into the SPSS statistical program for further processing and drawing conclusions. Finally, the analysis of the data was done.

Research Results

- Does the attitude of the male and female students and teachers towards overall stress performance differ?

To test this research question in the presence of a categorical variable, such as gender, we proceeded to apply a t-test statistical criterion for independent samples (table 1).

Table 1

Male and female students and teachers towards overall stress performance T- test

		Levene's Test for Equality of Variances	t- test for Equality of Means						
		F	Sig.	t	df	Sig. (2- tailed)	Mean Differen ce	Std. Error Differences	95% Confidence Lower Upper
Overall performance on death anxiety	Equal variances assumed	,576	,449	-2,922	232	,004	-2,573	,881	-4,308 - ,838
	Equal variances not assumed			-2,881	189,932	,004	-2,573	,893	-4,334 - ,812

Initially, the Levene test for the equality of variances shows that they are equal because the p-value of 0.576 is not statistically significant ($p=0.449$). Therefore, the Equal variances assumed line was used. From the results of the table it was found that the t value (-2.922) was statistically significant ($p=0.004$), since it was less than the lower limit of acceptance ($p=0.05$). Therefore, the male and female students and teachers difference in overall performance on death anxiety was accepted. From the comparison of the averages shown in the first table found that female students as teachers ($M = 28.8$) were more prone to death anxiety than males ($M = 26.2$). The results in a statistical manner are presented as follows: $t(232) = -2,922$, $p = 0,0$

- Does the psychological health of male and female students and teachers correlates with the overall performance on death anxiety?

In order to investigate the above research question, two variables were measured on equally spaced scales and Pearson correlation index was used.

Table 2

Overall performance on death anxiety

		overall performance death anxiety	Psychological Health
overall performance death anxiety	Pearson Correlation	1	.325**
	Sig. (2-tailed)		.000
	N	235	235
Psychological Health	Pearson Correlation	.325**	1
	Sig. (2-tailed)	.000	
	N	235	235

**Correlation is significant at the 0.01 level (2-tailed)

From the results of the table 2, it is found that the correlation index between overall performance in psychological health and overall performance in death anxiety is $r=0.325$. It is statistically significant and it means that the result is not due to random factors but psychological health is correlated with overall performance in death anxiety. Its direction is positive and the correlation between the two variables is low. The results according to the APA are as follows:

Psychological health and overall performance on death anxiety: $r(235) = 0.325$ $p = 0.000$

- Is there any difference between the three health levels of male and female students and teachers in the overall performance on death anxiety?

In order to study the above research question, the One-Way Analysis of Variance (ANOVA) was used. The following table 3 presents the results of the analysis.

Table 3

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
.00	2	30.5000	2.12132	1.50000	11.4407	49.5593	29.00	32.00
Bad	13	29.0000	8.28654	2.29827	23.9925	34.0075	15.00	39.00
Ok	88	29.0455	6.44857	.68742	27.6791	30.4118	15.00	44.00
Good	132	26.7955	6.66967	.58052	25.6470	27.9439	15.00	43.00
Total	235	27.7915	6.72309	.43857	26.9274	28.6555	15.00	44.00

Table 4

Test of Homogeneity of Variances

Levene Statistic	df1	df2	Sig.
1.008	3	231	.390

Table 5

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	302.988	3	100.996	2.271	.081
Within Groups	10273.795	231	44.475		
Total	10576.783	234			

From the results of the table 4 “Test of Homogeneity of Variance” it is found that the Levene's Test which examines the similarity of variances is not statistically significant ($p = 0.390$). So the fluctuations are similar or homogeneous. From the results of the table 5 Anova, it is found that the Fhealth value ($= 2.271$) is statistically insignificant ($p = 0.081$) as it is greater than the minimum acceptance limit. According to the APA, the results are presented as follows:

$$F(3,231) = 2,271, n.s.$$

This means that the averages of the three levels of health, as can be seen from the first table (Descriptives), do not differ significantly from each other. The averages of the three levels of health are as follows:

Bad: M.O.= 29, SD.=8.28, OK: M.O.: 29, SD= 6.44, Good: M.O.: 26.7, SD= 6.66.

It is therefore concluded that the age do not affect the overall performance in death anxiety of male and female students and teachers.

Discussion

The primary objective of this research was to examine a number of variables, such as personality, the central mechanism of self-evaluations, well-being, but also gender, age and other factors for which data were collected, such as anxiety, health, productivity in the overall performance in death anxiety.

More specifically, based on the first question research, it was found that the attitudes of male and female students and teachers differ regarding the overall performance in death anxiety, which means that gender plays a role in the formation of attitudes towards it. The female participants in this survey, particularly, seem to be more prone to the fear of death. However, this result contradicts to those research findings that found that demographic characteristics play a negligible role in death anxiety (Diener et al., 1999; Guo et al., 2022; Megawati et al., 2019; Stoeber et al., 2020; Waugh, 2023).

An exception is the research of Wittkowski (1988) which was carried out on a sample of Catholic women and men, taking into account, however, the variable of religiosity in addition to the gender factor in their perceptions of death. In this research was found that women who had accepted the principles of the Roman Catholic church experienced a stronger fear of their own death and that of others.

Regarding the variable of religiosity, the more researches have reached to unclear and contradictory conclusions as there are many aspects of religiosity that must be taken into account (Abdel-Khalek & Lester, 2009; Çavuşoğlu et al., 2023; Neimeyer et al., 2004). However, because the religiosity is taken as one of the traits of a tender and sensitive person who is characterised by psychological stability it may contribute to a comparatively weak treatment of the fear of death and help understanding and forming one's degree of religiosity whether are we afraid of death or not. Therefore, people who have a high sense of religiosity, whether this means belief in God, or participation in religious organisations, prayers, or any other events, have a reduced fear of death. Regarding the variable of psychological health it was found that there is a statistically significant predictive effect on death anxiety. Taking into account that the psychological health consists a series of positive emotions, such as optimism, extroversion, optimistic and positive mood, life satisfaction, emotional stability, it is possible for those people who are psychologically healthy to have reduced fear of death.

Finally, the result of the third research question found that the health and all its levels does not affect the death anxiety agrees to a certain extent with research findings that did not find a relationship between the mental disorder of individuals and the fear of death, but mainly they find relationship in the subjective sense of the well-being (Iverach et al., 2014; Özgüç et al., 2021; Pradhan et al., 2022). The interpretation of this result, of course, largely depends on the physical health of the patients.

The findings of this research differ a lot from previous surveys despite the fact that this is the first one that took place in Greece and it is about the death anxiety of students and teachers. The main cause of this is related to geographical and cultural factors as well as from social reasons between two sexes that exist in Greek society.

Conclusions and Implications

Thus, it can be concluded that male and female students and teachers differ in their attitude towards death. Female tend to fear the death more than the male. This may happen as female from their nature are more sensitive and anxious. In addition, those male or female who can't control the events that are happening around them have the tend to be more affected from the death of anxiety. Male of female students or teachers who have a high index of self-esteem and a sense of control over events

believe that they can resist the fear of death. The anxiety and not the health affects overall performance on death anxiety.

Based on researches that have been done, it was found that there are contradictory and not significant relationships between the fear of death between individuals and the different aspects of religiosity. A significant positive relationship is evident between death acceptance and belief in God. But there are inverse relationships between the fear of death of other people and religiosity. Thus, there is an inverse relationship between religiosity and specific aspects of fear of death (Malik et al., 2015).

In a study conducted by Wittkowski (2016) on a sample of 186 West German Catholics (93 men and 93 women) it was found that there are no significant correlations between fear of one's own death and religiosity for men aged 45-55 years, while on the contrary there were significant correlations between religiosity and faith in God, communication with other believers and participation in religious organisations. Apparently a positive correlation was found between the acceptance of death, either that which has happened or that which will happen with belief in god. At the same time, there are inverse relationships between fear of the death of others and all aspects of religiosity. Regarding the female sample, the researchers concluded that women who were identified with the moral principles of the Catholic church had a high fear of death for themselves and others, however, negative correlations were observed between individuals' religiosity and fear of their own death, but also of those women who participate in religious activities (Wittkowski, 2016).

Regarding the death anxiety, it is observed that healthy, energetic members of an urban center show an optimistic attitude towards their age and life situation, while old, sick people do not show the fear of death. In general, the idea of death appears to be related to personality and subjective sense of well-being as well as life experiences (Fortner, 2018; Neimeyer & VanBrunt, 2018).

The above research is the first one that took place in Greece and especially, is the first one that is concerned with the male and female students and teachers. This survey is referred to correlations. This age group as well as the teachers of high schools haven't been examined in Greek literature. For this purpose, this survey aimed to fill the gaps existing in Greece in this field. This survey indicates areas for further research which are needed to solve this topic. Consequently, there are restrictions that should be taken into consideration in future research. The most crucial restriction is the fact that this research used only the quantitative method as well as there was no distinction between students of high schools and their teachers.

Limitations of the Study and Suggestions for Future Research

One of the limitations of this research was the small amount of the participants. The participants were people only from the region of Thessaly when Greece has 13 regions. The samples is small and so the finding of significant associations in the data is difficult, as statistical tests usually require a larger sample size to ensure a fair representation. In addition, it is mentioned only to students of 17 years old and not below this age group. Furthermore, despite the adequacy of the variety of variables that were investigated, the inhomogeneous, mainly, geographical distribution of this sample population was the most important limitation of this survey. The educational level of teachers wasn't examined. These limitations can affect the results. The results of this specific research showed the need and desire of teachers and students for further investigation of this subject. Additionally, it is worth mentioning that there is little previous research on this topic.

Therefore, future research which could include other factors, such as the place of residence of the individuals (city-village) or their educational level, which shape attitudes towards the fear of death could be made. In addition, it could be useful to make a similar research after the end of COVID-19 in order to investigate the attitudes of students and teachers after the pandemic. Last but not least, future researchers should use both qualitative and quantitative methods so as to investigate this controversial issue.

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DOI: <https://doi.org/10.57125/FED.2023.12.25.03>

How to cite: Perminova, L., Vasylyuk-Zaitseva, S., Shapka, I. & Savastru, N. (2023). The role of artificial intelligence in improving the quality of education and research. *Futurity Education*, 3(4), 46–59.
<https://doi.org/10.57125/FED.2023.12.25.03>

The Role of Artificial Intelligence in Improving the Quality of Education and Research

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Received: August 4, 2023 | **Accepted:** October 11, 2023 | **Available online:** October 24, 2023

Abstract: The purpose of the study is to determine the role of artificial intelligence in improving the quality of education and research. To achieve this goal, a content analysis was used. Of note is the SWOT analysis method, which was used to identify the positive and negative aspects of the integration of artificial intelligence into scientific and pedagogical life. The results show that the use of artificial intelligence technologies in the field of education is a promising and promising area for further development. The analysis conducted in this context revealed that innovative technologies have become an essential component of modern education. The use of artificial intelligence (AI) is becoming more widespread and. However, for the further development of this area, it is important to improve the level of digital literacy among users. Based on the results of the study, both positive aspects and disadvantages in the use of these technologies can be identified. Among the advantages are the high adaptability of AI, the possibility of individualised learning, accessibility, and a wide range of applications, from primary school to higher education and research. It is important to note that these technologies can be used to achieve learning success regardless of geographical region, making them global in nature. The scientific novelty lies in the consideration of certain shortcomings, among which the issue of security is particularly relevant, especially in the context of global hybrid threats and the overall process of digitalisation. The conclusions note that to overcome the identified negative aspects of the use of AI in research and teaching, it is important to focus on the ethical aspects of using digital tools in general. It is also recommended to consider the possibility of organising additional online courses.

Keywords: artificial intelligence, educational activity, science, digitalisation, prospects, threats.

Introduction

The origins of artificial intelligence (AI) can be traced back to the mid-20th century when the field of computer science began to explore the possibility of creating machines that could simulate human intelligence. The term "artificial intelligence" was coined by John McCarthy in 1956 when he organized the Dartmouth Workshop, which is often considered the birth of AI as a formal field of study. Early AI researchers were primarily focused on developing programs that could mimic human thought processes, such as problem-solving and logical reasoning. The extent to which AI is used varies widely depending on the level of education and geographical region. Access to resources, funding, and infrastructure also play a significant role in determining the extent of AI adoption in different areas.

Modern social demands shape the requirements for specialists of a new level. In particular, the global penetration of digitalisation into all spheres of social life demonstrates the need to find new methods of training specialists in various fields, both natural and humanitarian. The integration of distance education into learning, which occurred as a result of the spread of the COVID-19 pandemic and related quarantine restrictions, has demonstrated the relevance of using the latest technologies. Although the disease has receded globally, the resulting realities demonstrate the need for reflection and further improvement. Among the new tools that are being actively introduced into the educational process are artificial intelligence technologies, which contain considerable innovative potential that is still important for pedagogical science.

Research Problem

Artificial intelligence is a field of scientific and technological developments that deals with the creation of systems that are capable of performing certain tasks that have long required the use of human intelligence (Ridley, 2019). In particular, artificial intelligence includes certain algorithms and models that enable computer systems to analyse, understand, and solve certain tasks using methods

that resemble human thinking (Miller, 2019). Such systems are already quite popular in education today, especially due to their ability to perform tasks, recognise certain images and words, and make independent decisions, organise preliminary planning, or process large amounts of information (Laird et al., 2017). Artificial intelligence is usually used to operate a variety of systems. In general, its potential is important for machine learning, neural networks, linguistics, etc. (Holzinger et al., 2019; Lee & Lee, 2021). However, this system does not have a separate consciousness – its algorithms and programs are created by humans. For this reason, the use of artificial intelligence in education (as well as further vectors of this use) requires special attention from researchers.

Research Focus

Artificial intelligence has become a remarkable force that is changing the way we work, learn, and explore the world around us (Oluniyo, 2020). In this context, it is important to track the role that AI plays in improving the quality of education and research. With the growth of data and the power of computing, this technology has become a key tool in solving complex problems facing education and research. Artificial intelligence helps to improve data analysis, forecasting, recommendation, and task automation, and it is important to identify specific use cases for its application in education and research and to characterise the benefits it brings in improving outcomes and optimising processes. The growing availability of digital tools makes it more accessible for use in a variety of fields, from education to medicine and engineering. It is important to understand how to use these opportunities properly and effectively to achieve maximum results. The focus will also be on the problems of identifying positive and negative episodes in the use of artificial intelligence against the background of its further integration into educational and scientific life and development prospects.

Research Aim and Research Questions

The purpose of the study is to analyse the role of artificial intelligence in improving the quality of education and research. The realisation of this goal involves the disclosure of additional tasks:

1. Determining the current state of AI integration into scientific and pedagogical processes.
2. Analyse the positive and negative elements of its use in scientific, research and educational practice.

Literature Review

In modern literature, the investigated problem is partially presented. However, certain aspects were of interest to many scientists. Modern researchers argue that conceptual elements relevant to learning, such as open science, big data, open data, SMART data, FAIR data, etc. are usually directly related to the use of artificial intelligence (Vasudevan et al., 2019). In particular, the recent evolution of its application (primarily in the period 2017-2022) has demonstrated significant progress and achievements in analytical computational tools and related innovations (Zuroff & Chapados, 2023). This is especially true for the use of those methodologies for which the connection with new areas of artificial intelligence is particularly relevant. The application of machine learning, deep learning, and further work on the development of neural networks have demonstrated certain possibilities for profound transformations of the paradigms of modern learning and science. These achievements range from computer vision (the effect of recognising faces or any other objects), natural language processing (the ability to recognise speech and turn it into texts or translations) to countering cyber fraud (detecting digital intruders and attackers). Other important advances include conversational chatbots, robotic agents, and strategic thinking (Gruson et al., 2019; Pilon, 2023). The functioning of such complex

systems has become possible due to significant improvements in the combination of software algorithms, much greater computing power, more accurate metadata schemes, accessible online datasets, and, most importantly, open repositories and systems with research. It should be noted that in Ukrainian realities, such changes are still hardly noticeable. According to Darwish (2022) artificial Intelligence (AI) has surfaced as a field brimming with advanced methodologies and innovative applications. The swift progression of AI concepts and technologies has given rise to a discernible trend—the integration of interpretability and explainability into this paradigm.

The study by Drach et al. (2023) delves into the theoretical underpinnings of incorporating artificial intelligence (AI) within the realm of higher education. It elucidates how AI, as a strategic technological advancement, bestows numerous advantages upon individuals and society as a whole. Furthermore, it signifies a transformative milestone not only in the history of digital technology but also on a global scale in the evolution of modern civilization. Ceccaroni et al. (2019) offers an insightful overview of the policies formulated by prominent European and global entities, including but not limited to the United Nations Educational, Scientific and Cultural Organisation (UNESCO), the European Union, the Organisation for Economic Cooperation and Development, and the European University Association. These policies pertain to the effective integration of AI into everyday life, with a specific focus on its application within the sphere of education. At the same time, Cohen (2021) researched the issue of the evolution of machine learning. The paper by Yuskovych-Zhukovska et al. (2022) focuses on the application of artificial intelligence in education, shedding light on both opportunities and challenges in the context of sustainable development. It begins by assessing the current state of implementing AI technologies within the educational sphere. These AI technologies are categorized into four main groups: cognitive services, virtual, mixed, and augmented reality, the Internet of Things and peripheral computing, and metacognitive scaffolding (Yuskovych-Zhukovska et al., 2022).

In addition, the article by Pendy (2023) engages in a discussion regarding issues related to the confidentiality and depersonalization of students' data when processed by artificial intelligence during the educational process. It recommends a differentiation of responsibilities concerning access, storage, and utilization of personal and confidential data by educational institutions. Lampou (2023) believed that artificial Intelligence has seamlessly woven itself into the fabric of our daily lives, manifesting in automated systems within vehicles and personalized online advertisements. Within the domain of education, AI holds the potential to elevate the teaching and learning experience. According to Lee and Lee (2021) its objective is not to supplant educators but rather to enrich their role by rendering the learning process more captivating and streamlined. AI systems possess the capacity to offer feedback on students' performance, pinpointing areas for enhancement, and fostering inclusivity, especially for students facing special needs or language barriers. Moreover, AI can automate numerous administrative tasks, affording educators additional time for crafting lesson plans and refining their instructional methods (Ridley, 2019). In summary, the current literature highlights a wide range of aspects related to the development and use of artificial intelligence in education, including technological development, social impact and future prospects.

Research Methodology

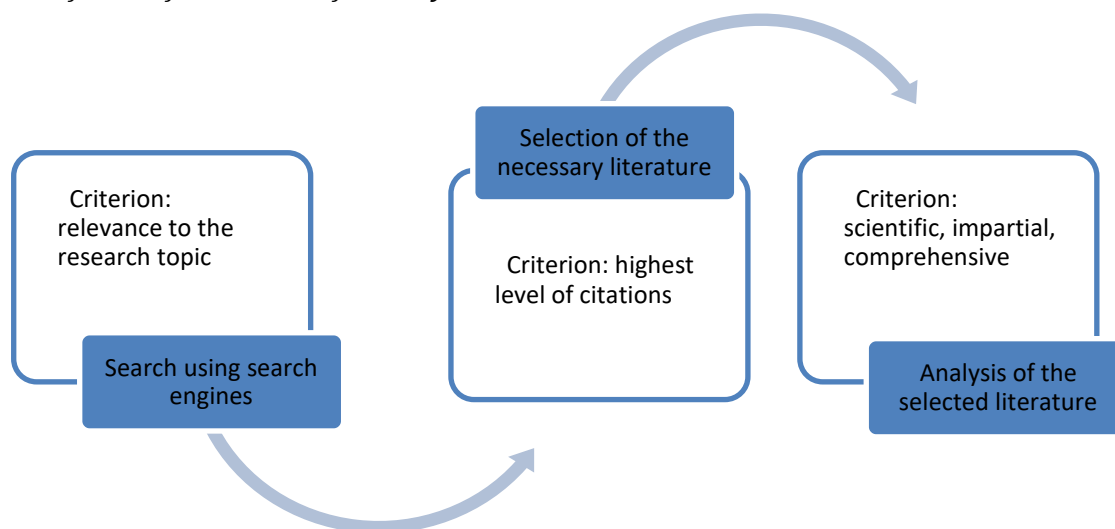
General Background

The method of content analysis was used to study the scientific professional literature that addresses the problem of using AI. Content analysis is the systematic study of textual scientific information in order to identify and analyse patterns, trends, and patterns in a large volume of documents or texts. This method was very useful for studying scientific professional literature, as it allows you to systematise and extract insights from a large number of scientific texts. As a result of the

search using search engines of the texts, more than 140 articles were found on the given topic. In order of appearance of the results, 50 of them were selected (Figure 1).

Figure 1

Selection of Scientific Literature for Analysis



Source: Compiled by the authors.

Based on the study of these publications, the SWOT analysis method was also applied to highlight the prospects for the application of AI in science and education. SWOT analysis is a popular tool in strategic management that helps to assess the current state of affairs and develop a strategy to achieve the set goals. The SWOT acronym reflects four main aspects. Strengths are the internal positive characteristics that define advantages. Weaknesses are also internal factors, but they are negative. Weaknesses indicate limitations, shortcomings, or vulnerabilities. Opportunities - these external factors indicate potential opportunities for the development of AI. Threats - these are also external factors that may have a negative impact in the future. A SWOT analysis helps to identify how AI's strengths can be leveraged to exploit opportunities and reduce the impact of weaknesses and threats in the future. This analysis resulted in recommendations aimed at achieving success and improving the state of affairs. The comparison method was important: it allowed us to compare the data obtained with the results of other researchers. The typological method was used for qualitative processing and grouping of the information obtained. The basics of comparativism were used to compare the strengths and weaknesses of the use of artificial intelligence in education and science.

Data Analysis

The research was conducted in several stages. The first stage involved the collection of materials and content analysis of professional scientific publications. The main search was carried out in computer databases among publications using content analysis, and the most relevant and most cited research studies were selected (50 most relevant and cited works were selected in total). Since they formed the theoretical basis for the study, special attention was paid to this procedure, since the objectivity and impartiality of the coverage of future results depended on the breadth of the sample of materials. By using the methods of analysis and synthesis, the collected material was subjected to critical scrutiny. Certain conclusions were also drawn, which were reflected in the overall findings. The SWOT analysis was used at the third stage of the research to organise and present the collected material, and to identify prospects for further research. At the last stage, the typological method was used to summarise the research.

Research Results

AI Opportunities in Education and Research: The Current State of the Art

Machine learning capabilities using artificial intelligence are also effectively applied due to the pre-training of algorithms and the use of relevant datasets of familiar sizes (Joshi et al., 2021). New opportunities in education have also opened up as a result of a combination of effective research data repositories and the willingness of researchers and educators to share their results and datasets in the open.

This allows educators and researchers to use algorithmic machine learning functions globally, all over the world, justifying their results both by using previous models and by accessing new online research data (Giró Gràcia & Sancho-Gil, 2021; Pendy, 2023). Due to the extensive development of software, huge amounts of images, data, and metadata can be easily and conveniently downloaded, archived, and used for further training of neural networks.

In recent years, many new digital mechanisms have also emerged that make it possible to change the lives of users and students and guarantee convenient work with artificial intelligence products. For example, the world-famous Google Translate service, which allows you to read and translate texts from more than 100 languages, works through any modern browser and automatically provides extremely accurate translations. In addition, digital tools such as Siri and Google Assistant, which allow users to ask questions and receive answers, have become an integral part of smartphones. A tool such as ChatGPT (and similar artificial intelligence programs) has the ability to quickly generate answers to any questions asked, provide justifications, give examples, create poems or narratives, summarise research materials, etc. The possibilities for processing and working with images have also evolved (Xue & Wang, 2022). Visual services based on user-generated texts expressed in natural language are also extremely developed at the current stage of development. Examples of tools that allow you to set textual conditions during training in order to get a realistic image, as result, include Stable Diffusion, Midjourney, or Imagen: Text-to-Image Diffusion Models.

Several types of artificial intelligence can be distinguished (Ouyang & Jiao, 2021). First of all, we are talking about rule-based artificial intelligence and machine-learning artificial intelligence. Rule-based artificial intelligence uses decision-making rules to generate or recommend a proposed solution to a query posed by a learner (Alam, 2021). An example of such a system is intelligent tutoring software that can explain grammar or provide specific feedback to learners. Artificial intelligence based on machine learning is much more powerful because machines (computer-oriented) can actually learn and will likely get much better over time, especially if they are constantly working with large volumes of multi-layered data sets. In education, AI tools based on machine learning are commonly used to solve a variety of problems, including monitoring the activity of students and creating models that accurately predict the consequences of student behaviour.

As part of the further use of artificial intelligence in education, there is another subfield - natural language processing, i.e., the use of software that will allow to understand, predict, translate, and record the textual content of voice commands (Chen et al., 2020). Researchers continue to study methods of using voice artificial intelligence to improve the ability to diagnose reading or other academic and pedagogical work. In particular, the use of machine artificial intelligence in the field of education can now be considered quite commonplace (Malik, 2021). Some testing companies (e.g., Pearson) use natural language processing in the assessment of students' written work. Obviously, the further development of such technologies has considerable scientific and pedagogical potential for further evolution.

Advantages and disadvantages of using AI

Using the SWOT analysis method of professional scientific literature, it is possible to identify the main advantages and disadvantages of using AI in education and research processes. This comparison will allow us to characterise the main prospects for the future use of this digital tool in education and research. In general, researchers positively assess the possibilities of using artificial intelligence in education (Luan et al., 2020), highlighting the following advantages when actively used in pedagogical experience (See Table 1).

Table 1

Advantages of Using AI in Education and Science

Advantages	Characteristics
Fast adaptation	Artificial intelligence systems are able to adapt to the individual learning needs of each student, to achieve learning goals in accordance with the identification of their strengths and weaknesses.
Technological progress	Already at the current stage, artificial intelligence systems are able to analyse and observe the current progress and learning style of the student, their abilities, and inclinations, providing a certain customised template to support learning in the future. Artificial intelligence can systematically track the progress of students by collecting data on their achievements and mistakes. This allows teachers and students to receive feedback on task performance and identify areas that require additional attention.
A variety of functions	Artificial intelligence systems have the ability to evaluate not only closed answers efficiently and quickly (presented in the format of answers to test tasks) but also descriptive answers, which is an important help for teachers today. Through this process, students do not hesitate to make mistakes (because mistakes are part of any real learning) and subsequently receive real-time feedback to apply the necessary corrections
Convenience	Artificial intelligence models offer a gradual transition from simple to complex processes: adaptive learning is applied to students at the first levels, followed by a gradual transition to the next stages with the mandatory completion of the previous one.
Inclusion	AI can make education more accessible to people with disabilities, regardless of physical or cognitive limitations. It can provide adapted materials, support, and tools to help expand learning opportunities for all learners. For example, artificial intelligence can provide learners with access to education according to their needs, by providing text-to-speech for the visually impaired.
Versatility	Artificial intelligence can be used in a dosed manner even in pre-school education (in particular, in the form of special interactive games that teach and develop the necessary basic skills in children). There are opportunities for creating educational content using artificial intelligence: researchers believe that apps that can convert voice to text are already in demand.

Increasing opportunities

Artificial intelligence can provide access to a wealth of information and resources that enhance learning opportunities. It can provide access to up-to-date data, online courses, interactive materials, and other resources to help learners deepen their knowledge.

Source: Compiled by the authors based on Baker et al. (2019), Bilanych and Bokotei (2013), Casas-Ortiz et al. (2023), Darwish (2022), Górriz et al. (2020), Panigrahi (2020).

There are already significant benefits to using AI for the education and science of the future, but these benefits could be transformed and expanded further by the rapid development of this technology. For example, in the future, AI may become a learning partner that can adapt learning material to the individual needs of each student. This will make it possible to more effectively take into account the level of knowledge, learning style, and other personal characteristics of each student (Balat & Bahşi, 2023). Virtual assistants, online courses, and other AI applications can provide access to learning and scientific information to a wider audience. In the field of science, AI can significantly contribute to the automation of research processes. From literature searches to data analysis, AI can perform many routine tasks, freeing up researchers for more creative work. The processes of solving complex tasks and problems may increase significantly. This is especially important in science, where some research can take a lot of time and resources. This will be based on machine learning and data analytics, which can help predict and analyse scientific and educational trends. They can identify patterns that would not always be visible using traditional methods of analysis. Additionally, AI can provide ideas for new research and teaching approaches (Cohen, 2021). Algorithms that are able to generate ideas and solve problems can inspire innovation in science and education (Hosny & Aerts, 2019). Overall, the benefits of using AI in education and science may be transformed in the future due to the continuous development of technology and the new opportunities it will bring. This can contribute to more intelligent, efficient, and accessible learning and research.

At the same time, based on the content analysis of other researchers' studies, we can identify the most common disadvantages of using AI (Table 2). They are being actively discussed, and tentative ways to overcome them are also proposed, although a broader discussion is needed to finally resolve these issues (Hutson, 2018; Joshi, 2019).

Table 2

Disadvantages of Using AI in Education and Science

Disadvantages	Characteristics
Limited ability to understand the context	AI may have limited ability to understand complex contexts, especially when it comes to deep or intuitive aspects of learning and research. It can generate answers to questions but is not always able to adequately interpret or analyse more complex concepts.
Impact on data privacy and security	The use of AI requires a large amount of data, including personal and sensitive data. This can lead to data privacy and security breaches if appropriate protection measures are not taken.
Focus on specific tasks	AI is often developed to solve specific tasks and may be inefficient or incapable of performing other types of tasks. This can limit its versatility and applicability across industries

Support for technical staff	Introducing AI into education and research processes can require significant effort and resources to train and support technical staff with the necessary skills. Also, the development and implementation of AI systems can be expensive, and this can make it difficult for all educational and research institutions to access these technologies
The risk of addiction	Relying on AI can lead to a loss of human competence in certain areas. If the AI system breaks down or receives incorrect information, this can lead to serious problems.
Ethical issues	The use of AI in education and research raises ethical issues such as transparency, equity, and fairness. For example, AI systems may reflect stereotypes or be used to manipulate information

Source: Compiled by the authors based on Ceccaroni et al. (2019), Drach et al. (2023), Knox (2020), Mohammed and 'Nell' Watson (2019), Silva and Janes (2023).

The risks associated with the utilization of artificial intelligence (AI) in education and research are subject to evolution and change in the future, owing to the continuous advancement of this technology and shifts in the socio-cultural and ethical landscape. As AI becomes more prevalent, the volume of personal data collected and processed is likely to expand. This heightened data exposure may elevate the risks of privacy breaches and the potential for misuse, necessitating more robust security and compliance measures. Simultaneously, the emergence of increasingly sophisticated and autonomous AI systems in the future could introduce new uncertainties, as these systems make decisions based on their own analyses. This may give rise to novel risks associated with the unpredictability of such AI behavior in educational and research contexts.

Furthermore, there is a risk of anthropomorphization, where individuals start perceiving digital systems as if they were human (Li et al., 2020). This can result in incorrect expectations and interactions with these systems. Ethical concerns related to AI's usage are expected to intensify or emerge in the future, including debates about its ethical application in scientific research, its impact on the development of intellectual morality, and the responsibility of AI systems, among other issues.

Additionally, AI's influence on the labor market will be profound. The evolution of AI may lead to changes in job roles, potentially automating certain tasks and causing job displacement for some workers. This shift can engender social and economic risks, as professions such as education or science may face the possibility of obsolescence (Vilim & Ibarra, 2022). Therefore, a thorough examination of the advantages and challenges of AI adoption necessitates further discussion, as the perspectives of scholars often diverge on key points. In light of these considerations, there is a need for ongoing dialogue to assess and determine the future prospects of deploying this digital tool.

Discussion

Data storage and the capabilities of digital scholarly systems support the academic cycle of research, knowledge development, and discovery. Data is accessible through the capabilities of networked communication systems and content control tools. We can agree with researchers that this exchange between researchers on a global level contributes to transparency in guaranteeing the knowledge gained (Shrivastava, 2023; Yuskovych-Zhukovska et al., 2022). Artificial intelligence, as Nguyen et al. (2022) rightly point out, has a direct connection with open science. This is especially noticeable when working with large amounts of data, SMART data, and FAIR information, as AI systems and services are able to quickly process, find, analyse, and compare them (Ajami & Karimi, 2023). Its

use is important only as an element of digitalisation. These actions contribute to the further development of artificial intelligence services and systems and better reproduction of results according to the set algorithms. Artificial intelligence is thus becoming a reliable assistant to teachers, providing opportunities to complement the formation of individual learning paths and the ability to provide quick feedback to students. However, certain possibilities of this potential can be harmful (Sadiku et al., 2021; Shi et al., 2021). Among these possible negative consequences of using artificial intelligence in education are the risk of reducing the role of the teacher, increasing negative creativity and uncritical thinking of students (opportunities for cheating and passing off AI work as their own achievements), and the risk of widening the gap between students with different socioeconomic status. In fact, the element of integrity in the use of AI capabilities is much less emphasised (Renz et al., 2020; Taddeo et al., 2021). In general, academic integrity is a core component of academic culture and guarantees high-quality education and research, maintains trust in the academic environment, and promotes the development of science and education. Obviously, this aspect will require further development. Adherence to ethical norms and standards in research and education today requires researchers to be cautious about human experimentation, data confidentiality, and other ethical principles. All this forms the elements of trust in the activities of educational and research institutions.

The current importance of trust in teaching and research is often underestimated as results take centre stage (Lampou, 2023; Schiff, 2020). At the same time, the very mechanics of AI functioning pose threats to trust (Koos, 2018). To be successful, AI must also use only reliable data to draw the right conclusions at the end of a query. If incorrect information is included in the overall dataset, it can lead to incorrect results. In fact, there is no such thing as absolutely objective information, and some digital algorithms can even make information even more subjective. For this reason, it is important to develop digital competence among teachers and researchers, which would allow them to use truly proven capabilities and be able to distinguish between false or biased information, which can be used in AI algorithmic work, among other things. Therefore, actualising the development of digital competencies among teachers, researchers, and students will make it possible to use the potential of AI to its fullest, to counter hybrid threats and other challenges related to the functioning of digital information sources. In order to actively implement such systems, it is proposed to set up a system of free online courses, during which experts will introduce students to the basics of information hygiene and work with the capabilities of the digital environment. As the courses offered will be made publicly available, this will allow us to reach the maximum interested audience, highlight and emphasise the importance of working with AI algorithms and further improve it, bringing it to a new level of efficiency.

Conclusions and Implications

The analysis has shown that innovative technologies have become an indispensable companion to teaching in modern circumstances, AI is used very often, and motivation for learning activities is growing. However, further use of AI requires improvement of digital literacy. Based on the results of the study, the main advantages and disadvantages of using these technologies were identified. Among the advantages are high adaptability, the possibility of forming an individual learning path, accessibility, and a wide range of applications (from primary school to university education, research, etc.). As a result, it is also pointed out, that there is tangible progress in learning that does not depend on the geographical region, i.e., is global in nature. There are also shortcomings, including an important security challenge, which is especially relevant in times of global hybrid threats against the backdrop of the global spread of digitalisation. To overcome the negative effects of AI in research and teaching, it is proposed to emphasise the importance of ethical views on the use of the potential of digital tools in general. The organisation of additional online courses that would form the basis for the development of digital competencies is recommended for use in the near future.

Suggestions for Future Research

An important aspect for further research is to address the formation of new ethics of teachers, students, and researchers, which would be aimed at taking due account of the role of digitalization in modern educational and scientific processes. The development of technologies, including AI capabilities, indicates that constant updating of the “moral codes” of teaching and research, etc. is necessary to meet the challenges of our time. It is important to explore the ethical implications of using AI in education. It is important to address issues such as data privacy, AI algorithm bias, and the ethical use of student data, with a focus on developing guidelines and policies to ensure the responsible implementation of AI in education. At the same time, we consider the study of the relationship between the use of artificial intelligence and the development of education during life to be a separate important aspect. The following studies should be devoted to analyzing the potential of AI to support lifelong learning. For example, it is important to investigate how AI-powered platforms can help people of all ages learn new skills and knowledge throughout their lives. In addition, the use of AI should be reflected in regulations. As the further integration of this tool into public life is evident, there is a need to develop norms for its regulation. An important problem for further research is the integration of the capabilities of artificial intelligence into the training of humanitarian education students. Therefore, this problem of studying the features of using artificial intelligence in the education system will continue to be relevant and will require a thorough research, especially considering modern digitization trends.

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How to cite: Eustache, B. N.-A.-N., & Jonathan, E. M. (2023). A Comparative Study of Academic Performance Between Students of Divorced and Intact Parents. *Futurity Education*. 3(4). 60-72.
<https://doi.org/10.57125/FED.2023.12.25.04>

A Comparative Study of Academic Performance Between Students of Divorced and Intact Parents

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Received: August 8, 2023 | **Accepted:** October 13, 2023 | **Available online:** October 24, 2023

Abstract: This study is part of a series of studies assessing the effects of divorce on children's mental health. In particular, it focuses on school health through the grades of pupils in a number of schools in the city of Kinshasa. The aim is to compare the school performance of children of separated parents with that of children whose parents live together. The aim of this comparison is to identify the nature of the effect of divorce on pupils' academic success. To achieve this objective, a survey (using a questionnaire to identify the children of separated parents and documentary techniques) was carried out among 241 pupils in the final year of secondary education at two schools in the city of Kinshasa (Groupe Scolaire du Mont-Amba and Collège Saint Barthelemy). The results of the study revealed that 47.7% of the subjects surveyed had experienced their parents' divorce. This divorce had considerably affected their academic success, as their school marks were significantly lower than those of subjects whose parents had not separated. This negative effect of divorce calls for specific measures at family and school level to enable children to regain their academic equilibrium by achieving good grades. This study has the particularity of having results from a representative sample compared with other studies carried out in the DRC. It also documented the impact of parental separation on school performance,

using a comparative approach instead of opinion questionnaires. We suggest that parents put their children's interests first in all their vital decisions. They should also ensure the quality and nature of educational follow-up in the event of divorce. In view of our results, it would be desirable to extend the study to other provinces of the DRC, in order to get a general picture of the effects of divorce on pupils' academic success.

Keywords: parental divorce, parental separation, educational success, children, high schools.

Introduction

The main mission of school education is to transform people through the knowledge imparted in schools. Indeed, it is seen as a tool enabling the world's countries to considerably improve the quality of life of their citizens and to develop. In the Democratic Republic of Congo (DRC), the State has assigned the Congolese school the mission of ensuring the harmonious, high-quality training of Congolese man, making him a responsible citizen, endowed with high civic sensitivity, useful to himself and to society, capable of assimilating his culture and the requirements of a democratic state to promote the country's development (Enguta Mwenzi, 2020; Direction des Programmes scolaires et Matériel didactique, 2011).

In order to evaluate the achievement of these objectives, the education authorities have introduced internal and external school assessments (National Primary School Leaving Test and State Examination). These assessments give rise to two possible outcomes for students: academic success and academic failure. Academic success is the successful completion of a course of study, justified by the achievement of learning objectives in a given school system. As a general rule, academic success is characterised by mastery of knowledge. The academic failure, on the other hand, is a situation in which educational objectives are not achieved. It is therefore the gap between expected and achieved results (Enguta Mwenzi & Bayenga Ndibeyang, 2023).

The academic failure, like the academic success, is influenced by two types of factors. There are endogenous and exogenous factors. Factors internal to the learner include cognitive, socio-affective and conative factors (Enguta et al., 2022b; Enguta Mwenzi & Bayenga Ndibeyang, 2023; Enguta Mwenzi & Andia Moyamani, 2023). Cognitive factors refer to intelligence, cognitive development, initial representations, attention, memorisation, metacognitive ability and so on. Socio-affective factors, on the other hand, refer to emotions and personal and social values. Finally, conative factors refer to motivation, cognitive styles, learning styles etc. (Enguta et al., 2022a; Bofula Lobebe et al., 2023).

The classroom context, teaching characteristics, family and societal context illustrate the environmental factors that influence school performance. With regard to external factors, research has shown that family context plays a very important role in academic success or failure compared to another external factor (Alokpo, 2021; 2023). Within this family context, studies have shown that the socioeconomic status, cultural capital, family social capital, parental practices and relationship with the written word are factors that particularly determine students' academic performance (Graovac, 2022; Augustijn, 2023). The school situation becomes more complicated when parents' divorce. In other words, parental divorce can have a considerable impact on children's school life. Several studies carried out outside the DRC have attempted to demonstrate the damaging effects of divorce on children's academic well-being.

In the DRC, studies assessing the effects of divorce on children's school life are very rare. For this reason, the present study sets out to fill this gap in the literature by seeking to specify the nature of the repercussions of divorce on children's success at school. Such a study is important because it enables parents to understand the dangers that await their children in the event of divorce. It can therefore

contribute to parents' awareness of the psychological consequences of divorce on children, and lead them to appropriate psychological follow-up in such circumstances.

Research Problem

In the DRC, marriage is generally considered to be a union between two people of the opposite sex, who also swear fidelity and love to each other for the rest of their lives. Thus, the two spouses are called upon to love, support and live together until death do them part. However, not all marriages reach this level, and many turn sour even before death intervenes. Indeed, many marriages do not stand up to the vagaries of everyday life and are destined to break up. This breakdown, known as divorce, it demonstrates the flaws in the educational and family system. Indeed, in our society, divorce has become just as real and central an institution as marriage. The figures bear irrefutable witness to this: 1 in 3 marriages ends in divorce, and 40% of remarriages end in divorce (Le Forner, 2022).

In addition to its worldwide scope, the divorce is a highly complex phenomenon, since it can inaugurate a variety of trajectories, cause break-ups and serious harm, as well as providing examples of resilience. While the immediate post-divorce period is often marked by major disruptions for children (linked in particular to the reorganisation of the pace and conditions of living and housing, persistent tensions between the parents, the problem of conflicting loyalties, impoverishment of the household, etc.), the long term is likely to enable family relationships to stabilise and heal (Martin, 2007; Le Forner, 2022). In this respect, several studies cited by Haux and Platt (2020) point to the great diversity of children's reactions to their parents' divorce. Some children are able to cope with the separation process, while others experience a period of distress before regaining their equilibrium after two or three years. Others suffer long-term consequences. In short, parental conflict is a risk factor for children that must be taken into account in terms of their health and development (Keller & Lafont, 2020). Separations can have long-term effects on children's health. Of all the aspects of child health affected by divorce, we look at school well-being.

Studies assessing the effects of divorce on children's educational well-being do not produce convergent results. Some studies conclude that separation has no effect on the educational success of children of divorced parents (Haux & Platt, 2021; Raley & Sweeney, 2020; Sassler & Lichter, 2020), or only a very slight effect (Einiö et al., 2022). Other studies, on the other hand, find a negative effect of parental separation on professional and educational success (Arat et al., 2022; Le Forner, 2022). In this regard, Archambault cited by van Dijk et al. (2022) asserts that regardless of social background, the break-up of the parental couple influences children's school life in one way or another. Indeed, the divorce is associated with lower academic achievement in children. Parental separation before the child reaches the age of majority reduces the duration of his or her studies from six months to over a year on average. The educational advantage of growing up in a culturally and socially advantaged family seems to be greatly diminished in the event of family disunion (van Dijk et al., 2022). These authors also point out that young people faced with separation and divorce leave the parental home earlier, one to two years earlier, and form couples earlier (which may explain the potential fragility of these early couples).

On the other hand, they do not experience significantly greater difficulties in finding employment than other members of their age group (especially girls). Clearly, intergenerational conflicts play a very important role in these earlier exits from the parental household (especially in cases of family reorganization). Archambault, citing van Dijk et al. (2022), also shows that the desire for early independence is a key factor in the decision to stop studying. "Wanting to earn a living" is the decisive reason for leaving school for 66% of the low-graduation population. On the other hand, very few of them cite their "disrupted" family trajectory to explain their school career (5% in single-parent families and

10% in blended families). However, Paul Archambault does not overlook the effects of economic insecurity. He also points out that nearly 40% of the lower academic performance at baccalaureate level of children from dissociated families could be attributable to the reduced economic transfer between generations (pocket money, support for book purchases, etc.).

The results of Sun et al. (2020) are in line with those of Archambault. Indeed, Sun et al. (2020) confirm that the marital break-up negatively affects school performance, but add that the differences are often already visible in the years preceding the actual break-up. For these authors, the divorce is associated with a lower probability of obtaining a high school diploma for girls born in wedlock. In the same vein, Zhao et al. (2022) support the previous authors' point of view, reporting that adolescents who experience a divorce experience a significant drop in grade point average and an increase in the number of failed courses in the same year.

Fadaei-kenarsary et al. (2023) reached a different conclusion, finding that the transition from a married to a single-parent family was not associated with a decline in adolescents' level of school engagement in the same year. In the DRC, studies highlighting the impact of divorce on school life are rare. In most cases, they are based on opinion questionnaires without adopting a comparative approach (Kitumba & Enguta, 2022). What's more, these studies do not produce convergent results. For this reason, the present study sets out to fill this gap in the literature by comparing the school marks of children from divorced families with those of pupils from non-divorced families. To this end, two schools in Kinshasa were targeted. These are Groupe Scolaire du Mont-Amba and Collège Saint Barthelemy. In this way, the study will reveal which of the trends identified in previous studies is true in the Congolese context.

Research Aim and Research Questions

The aim of this study was to assess the nature of the effect of parental divorce on the academic success of children enrolled in some schools in the city of Kinshasa. This general objective gave rise to the following question: Faced with this question, the following hypothesis was put forward: the divorce would have a negative effect on the academic success of children enrolled in some schools in the city of Kinshasa. In other words, the children of separated parents would perform less well at school than those living with their parents.

Research Methodology

General Background

The survey method in order to collect the study data in the target schools was used. This method was supported by a questionnaire to identify the children of divorced parents, which were administered to pupils in the target schools. This method was also supported by the documentary technique. The documentary technique enabled obtaining the academic results of the pupils in the schools targeted in the study. The school performances taken into account in this study were those relating to the results of the first semester of the 2021-2022 school year.

Sample / Participants / Group

The study focused on the population of students in the final year of secondary education at the two schools targeted in the study (Groupe Scolaire du Mont-Amba and Collège Saint Barthelemy). Specifically, these were 5th and 6th grade humanities students from these two schools enrolled for the 2021–2022 school year, with a total enrolment of around 482 subjects. Groupe Scolaire du Mont-Amba is an application school of the University of Kinshasa. It is located on the premises of the University of

Kinshasa in the commune of Lemba. It provides education at three levels (nursery, primary and secondary). At secondary level, it organises the following streams: Commercial and Management, Literary (Latin-philo), Scientific (Chemistry-Biology and Math-Physics) and Pedagogical (General Pedagogy). The Collège Saint Barthelemy is located within the Saint Barthelemy parish in the commune of Masina. It is a private Catholic school offering the following courses of study: Scientific (Chemistry-Biology), Technical (Business & IT) and Literary (Latin-Philosophy).

In terms of the study population, there were 286 pupils in the Groupe Scolaire du Mont-Amba (144 in the 5th year of the humanities and 142 in the 6th year of the humanities). At Collège Saint Barthelemy, there were 196 pupils, divided into 94 for the 5th year of the humanities and 102 for the 6th year of the humanities. From this population, a representative (simple random) sample of 241 subjects was drawn. The number of 241 was determined by our concern to have at least 50% of the population in the sample, due to the small size of the subjects concerned by the study. The drawing of lots using the ballot box technique was based on two modalities of our sample (school and level of education). Our sample varied according to the following socio-demographic variables: (1) school, (2) level of education or class, (3) gender and (4) age. At school level, we have 143 subjects from Groupe Scolaire du Mont-Amba versus 98 from Collège Saint Barthelemy. In terms of grade level, there were 119 students in the 5th year of humanities versus 122 in the 6th year of humanities. In terms of gender, our sample was made up of 130 boys versus 111 girls. Finally, in terms of age, there were 91 subjects aged 14–15 and 150 aged 16–18.

Instrument and Procedures

Two techniques were used in order to collect the study data. These were the questionnaire to identify the children of divorced parents and the documentary technique.

The questionnaire to identify children of divorced parents. The purpose of the questionnaire was to identify the children of divorced parents and to enable the division in the sub-study students according to whether or not their parents were divorced. To this end, the questionnaire consisted of two parts. The first part concerned the students' identity. The second part related to the single question identifying the children of divorced parents. The question was worded as follows: Are your parents divorced? Yes or No.

Documentary technique. The documentary technique was used to obtain the school grades of the pupils targeted in the study in the first semester of the 2021-2022 school year through the points charts.

Data Analysis

Three statistical tests were used to process the study data. These were the Kolmogorov Smirnov test, Student's t-test and chi-square. The Kolmogorov Smirnov test was used to study the shape of the distribution of academic achievement scores. The Student's t-test was used to compare the school grades of students whose parents are divorced with those of students whose parents live together. It was also used to study the effect of socio-demographic variables on the school grades of the subjects surveyed.

Research Results

Overall study results

The following tables present the results of the study according to two study modalities: (1) school grades and (2) student enrolment of divorced parents.

Table 1

Results related to subjects' academic performance

Statistical indices	School performances
Mean	70,45
Standard error of the mean	0,69
Median	65,00
Mode	64,20
Deviation	8,13
Variance	66,16

Source: author 's own development.

To make easier the reading of the results recorded in Table 1, one referred to Ngub'Usim Mpey-Nka et al. (2016) classification of the quality of success in school assessments. Thus, three categories of pass quality were obtained: (1) category 1 (best quality pass): school marks with at least 60% of points; (2) category 2 (medium quality pass): school marks located in the interval 55 to 59%; (3) category 3 (low quality pass): school marks located in the interval 50 to 54% of points.

A reading of the data recorded in Table 1 revealed that the average of the subjects surveyed in the school assessments is 70.45. If situating this average within the Ngub'Usim Mpey-Nka et al. (2016) the scale for interpreting the quality of achievement, it is possible to deduce that it falls within the 60%+ range corresponding to higher-quality academic achievement. In other words, it can be assumed that students in sub study schools do better on assessments. From this success, it was deduced that the objectives set by teachers for these two years of study (5th and 6th years of the humanities) were achieved without difficulty.

Table 2

Identification of students with divorced parents

Statistical indices	Frequency(f)	Percentage (%)
Divorce of parents		
Yes	115	47,7
No	126	52,3
Total	241	100,0

Source: author 's own development

The results in Table 2 show that students whose parents are divorced are less represented in the sample than those whose parents are in a couple. Specifically, students whose parents are divorced represent 47.7% of the sample, compared with 52.3% of subjects whose parents are in a couple.

Table 3*Students of divorced parents by school*

Divorce of parents	GSMA	CSB	Total	
			f	%
Yes	65	50	115	47,7
No	78	48	126	52,3
Total	143	98	241	100,0

Legend: GSMA: Groupe Scolaire du Mont-Amba, CSB: Collège Saint Barthelemy

Source: author 's own development

Table 3 shows that there are more subjects whose parents are divorced at Collège Saint Barthelemy (51% or 50/98 subjects) than at Groupe Scolaire du Mont Amba (45.5% or 65/143 subjects).

Table 4*Students of divorced parents by level of education*

Divorce of parents	5th year	6th year	Total	
			F	%
Yes	62	53	115	47,7
No	57	69	126	52,3
Total	119	122	241	100,0

Source: author 's own development

Table 4 shows that there are more subjects whose parents are divorced in the fifth year of the humanities (52.1% or 62/119 subjects) than in the sixth year of the humanities (43.4% or 53/122 subjects).

Study of the normality of the distribution of school results

It is recommended that any researcher using metric data in his study should test the normality of the distributions relating to the results of the study. This test is very important, as the choice and type of statistical tests to be used in differential analysis depend on the shape or normality of the distributions of the results. Several tests can be used to test the hypothesis of distribution normality. These include: the chi-square test, the asymmetry technique, the voussure test, the Kolmogorov Smirnov test, etc. In the case of the presented work, the Kolmogorov Smirnov test was chosen for its practicality and ease of interpretation. The related indices are shown in the following table.

Table 5*Study of the normality of the study distribution (p.0.05)*

Statistical indices	School performances
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Kolmogorov Smirnov z	1,19
Sig. (associated probability)	0,03
Decision	Normal

Source: author 's own development

Table 5 shows that the probability associated with the distribution of school results (0.03) is statistically higher than the critical probability (0.05). Therefore, the null hypothesis was accepted that there was no difference between this distribution and a theoretically normal distribution. Thus, it can be concluded that the distribution of school grades was normal. This situation calls for the use of parametric tests in the differential analysis of results.

Differential analysis of results

The aim of this section was to assess the effect of socio-demographic variables on the study results. This analysis was carried out at the level of school grades only. To do this, Student's t-test was used.

Table 6

Effect of sociodemographic variables on school grades

Variables	Statistical indices		
	T	Sig	Decision
School	0,35	0,45	Non significative
Class	0,36	0,52	Non significative
Sex	0,25	0,09	Non significative
Age	0,31	0,08	Non significative

Legend: t: Student's t-test, sig: significance

Source: author 's own development

Table 6 shows that the study's socio-demographic variables (school, class, gender and age) had no influence on the school grades of the subjects surveyed ($p > 0.05$).

The influence of divorce on academic success

In this part of the work, the concern is to assess the impact of the divorce on the academic achievement of the students involved in the study. For this reason, the academic results of subjects whose parents are divorced with those of students whose parents are still in a relationship were used. This comparison was preceded by the presence of school results according to the presence or absence of divorce.

Table 7

School results according to parents' divorce

Divorce of parents	Statistical indices	
	Mean	Deviation
Yes	59,84	4,91
No	81,16	3,02

Table 7 shows that subjects whose parents are divorced perform less well at school than those whose parents are still in a relationship. These differences are also observed when situating these scores on the Ngub'Usim Mpey-Nka et al. (2016) scale for interpreting school grades. Specifically, the grades of subjects whose parents are divorced fall within the 55-59% range corresponding to good academic achievement. On the other hand, the marks of subjects whose parents are in a relationship fall into the 60%+ range corresponding to better quality achievement. From this reading of the results, it can be concluded that the divorce has a negative impact on students' academic performance. To be valid, this numerical difference must be statistically confirmed. This is why the results of these two groups were statistically compared in the following lines. As normality is observed in the distribution of school grades, Student's t-test was used to compare the school results of these two groups (students of divorced parents and students of parents in a couple). Indeed, the choice of this test is justified by the fact that it is currently considered a test that can be applied to both small and large samples (Dancey, & Reidy, 2023).

Table 8

Influence of divorce on school grades

t-test for equality of means	
t	Sig.
6,32	0,00

Table 8 also shows that the associated probability (0.00), obtained by comparing the school marks of students whose parents are divorced with those of students whose parents are living together, is statistically lower than the critical probability (0.05). It can be therefore concluded that divorce has a negative effect on students' academic success, as students whose parents live together achieve better grades than those whose parents are divorced.

Discussion

The results of the study reveal that in the sample, 47.7% of students have divorced parents. This proportion is very worrying and demonstrates the extent of the phenomenon. Moreover, our results go hand in hand with Le Forner's (2022) conclusion regarding the significant increase in the proportion of individuals whose parents are separated. For this author, nearly four million children have separated parents. These results go hand in hand with those of Gastebois (2012), who found that over 30% of marriages in France often end in divorce. They are also in line with those of Ngonzo and Enguta Mwenzi (2022), who found that over 40% of children in some schools in the DRC were divorced. The unavailability of statistics in the DRC does not allow relating this divorce rate among the study subjects to the rate for the entire Congolese population.

As far as our study hypothesis is concerned, it's clear that the divorce is a scourge that threatens many households. It is not without consequences for children's school careers. Indeed, when comparing the school marks of pupils of divorced parents with those of children whose parents are in a relationship, it can be found that pupils whose parents are in a relationship perform very well compared with those whose parents are divorced. In other words, students whose parents are divorced perform less well at school than those whose parents are in a relationship.

These results go hand in hand with those of several studies (Le Forner, 2022; Arat et al., 2022) where it was found that the breakdown of a marriage negatively affects children's school performance. Indeed, whatever the reason for parental separation, this situation is not without consequences for pupils' school health, for the simple reason that it considerably affects the children's psyche. As a result,

these children's psychological state is affected, and it's only natural that they should be unable to mobilise their school skills, since good mental health is a determining factor in mastering school activities. These results confirm our first hypothesis.

These results call into question those of Fadaei-kenarsary et al. (2023), who found that the transition from a married to a single-parent family was not associated with a decline in adolescents' level of school engagement in the same year. They also call into question the results of several studies (Haux & Platt, 2021; Raley & Sweeney, 2020; Sassler & Lichter, 2020) where no effect of parental separation was found in terms of children's academic achievement. The discrepancy between these results and ours can be explained by the quality of psychological care offered to children of divorced parents in the USA compared with the DRC. In the USA, there are several psychological structures offering psychosocial support to children separated from their parents (Alliance for Child Protection in Humanitarian Action, 2021). These structures are also present in schools, whereas in the DRC, there are no psychological structures providing care for separated children.

As for the confirmation of the negative effect of divorce on children's school performance observed in the study, there are several possible reasons for this. Firstly, the divorce means that the child loses a parent who, in the systemic approach, is essential to his or her psychological equilibrium and optimal development. With this balance disrupted, it's perfectly normal for the child to have trouble concentrating and paying attention. In this context, he becomes very pensive and lost in thought. With his attention disturbed, his performance is bound to decline.

Another explanation is linked to the loss of a parent who used to provide educational support for the family. If the child is in his father's care, he loses his mother, who in the Congolese educational context is an important player in the educational follow-up process. The mother's move can only affect the quality of the educational follow-up, and put the child in difficult situations linked to the ineffectiveness of the maternal substitute in terms of educational follow-up. The most logical consequence is a drop in the child's school grades. This argument is also raised by Harkness et al. (2020).

In a context where the child is under the care of his mother, he loses an important player who, in the Congolese context, is responsible for taking care of all the family's needs. Moreover, taking care of the family's father allows the mother to have enough time for educational follow-up. With the father having moved away, the mother is forced to fend for herself or work to ensure her independence and care for her children. As a result, she no longer has enough time for the children's education. As a result, the children's performance at school is affected. This problem of parental involvement in educational follow-up after separation was also raised by Le Forner (2022).

When controlling for the influence of sociodemographic variables (gender, age, year of study and school), it was found that no moderating variable had a significant influence on the academic grades of the study subjects. With regard to the lack of influence of gender, our results refuting the influence of gender on school grades are in line with the results of Enguta Mwenzi and Bayenga Ndibeyang (2023), where there was no difference between girls and boys in terms of academic achievement. The lack of age influence, grade and school on school grades supports the conclusion of Bofula Lobebe et al. (2023) that these variables are determinants of school success.

Conclusions and Implications

Parental separation is a situation that disturbs children's psychology, and can have varying impacts on their school performance. With a view to specifying the nature of the effect of parental separation on children's school performance, an attempt was made in order to compare the school

performance of children of separated parents with that of children of non-separated parents. Two secondary schools in the city of Kinshasa for this study were targeted. These were Groupe Scolaire du Mont-Amba and Collège Saint Barthelemy. Specifically, an identification questionnaire to 241 students in the final year of secondary education at the two above-mentioned schools were administered.

The results of the study revealed a prevalence rate of parental separation of 47.7% in the sample. This rate demonstrated the sheer scale of the phenomenon of parental separation. Comparing the school results of pupils of separated parents with those of pupils of non-separated parents, it was found that pupils of separated parents performed poorly at school compared with other children. These results clearly demonstrate the negative effect of divorce on children's academic success. In view of these results, it was suggested that parents first of all always put their children's interests first in all their various life decisions. Secondly, that they pay close attention to the quality and nature of educational follow-up in the event of divorce, as poor educational follow-up can exasperate the negative effects of separation on children's school life. Parents can also consult psychologists to monitor their children's progress in the event of divorce. Finally, it was suggested that Congolese schools effectively organise a school psychology service to provide psychological support for pupils whose parents have separated. This support is important to reduce the negative effects of divorce.

Suggestions for Future Research

Unlike studies on the effects of divorce on children's school life carried out in the DRC (Ngonzo & Enguta Mwenzi, 2022), the present study was based on a representative sample. In addition, this study made it possible to document the effects of divorce on educational success in the school context, using a comparative approach instead of opinion questionnaires. Moreover, in studies carried out in the Congolese context, the concern to identify the divorce rate in samples is not present. The presented study has attempted to fill this gap by providing indicators of the divorce rate of parents based on samples of their schoolchildren. This rate can be an important estimate for understanding the scale of this scourge.

This study had several limitations linked to the study population, which took into account only two secondary schools in the city of Kinshasa. In this context, it would be interesting to extend the population to several schools in the city of Kinshasa in order to fully understand the effects of divorce on students' academic success. In addition, one focused on the overall trend in school grades, without taking into account areas of study (languages, mathematics, etc.). It would be interesting for future studies to be based on the academic success of children of separated parents in these two areas, in order to identify the area of learning most affected by divorce. There is also the possibility of extending the study to the various provinces of the DRC, as this study was limited to the context of the capital city of Kinshasa. Indeed, it would be possible to obtain different results if focused on the educational success of children of separated parents in remote areas of the DRC.

Finally, in this study, the focus solely on educational success was chosen, whereas the divorce can affect several antecedents of educational success. It would be desirable for future studies to look at other factors in children's schooling that may be affected by parental separation. Examples include school motivation, school engagement, school well-being, educational follow-up, etc.

Acknowledgements

The authors would like to thank the authorities of Groupe Scolaire du Mont-Amba and Collège Saint Barthelemy for the facilities provided during the surveys.

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How to cite: Peni, N. R. N., & Dewi, D. A. K. (2023). Development Research Framework for Designing Functions Class Using Desmos. *Futurity Education*. 3(4). 73-93.
<https://doi.org/10.57125/FED.2023.12.25.05>

Development Research Framework for Designing Functions Class Using Desmos

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Received: September 16, 2023 | **Accepted:** October 24, 2023 | **Available online:** November 2, 2023

Abstract: Technology-enhanced learning aids are playing a more and bigger role in the constantly changing world of mathematics education. This paper introduced a comprehensive research framework aiming to revolutionise the design of functions classes through innovative Desmos application. The main goal was to develop research framework for Functions classes utilising Desmos as a tool. To actively involve students in the learning process of the framework, creative approaches for incorporating this technology tool into the curriculum were offered. Its interactive and dynamic characteristics were specifically highlighted. The framework was built on the ideas of design-based research and included iterative planning, design, implementation, and evaluation procedures. In the given investigation, the challenges faced by educators in teaching Functions, including the need for increased student engagement and the difficulty in visualising abstract mathematical concepts were uncovered. Significant findings from this study reveal that the integration of Desmos into Functions classes significantly improves student engagement, fosters a deeper understanding of mathematical concepts, and promotes problem-solving skills. Moreover, educators reported increased enthusiasm among students and a more

enjoyable learning experience. The implications of this study are profound for the future of mathematics education. By harnessing the potential of Desmos, educators can design dynamic, captivating, and productive functions classes that align closely with curriculum objectives. Our findings demonstrated that Desmos can be a catalyst for more engaging and effective mathematics instruction, thereby shaping a brighter future for students and educators alike.

Keywords: Desmos, Development Research Framework, Functions, Technology-Enhanced Learning

Introduction

Technology has become integral to teaching and learning in mathematics education. The use of technology in mathematics classrooms can enhance students' learning experiences by providing dynamic and interactive environments for exploring mathematical concepts and visualising graphs of functions. Desmos is an online graphing calculator and math learning platform that has recently gained popularity as a tool for teaching and learning mathematics. It is free, accessible, and offers a range of features and tools that can help students to explore and understand mathematical concepts. Despite the potential benefits of using Desmos in mathematics classrooms, research-based frameworks and guidelines must be developed for designing function classes using Desmos. Many teachers need to be fully aware of the capabilities of Desmos and may need to effectively gain the necessary skills to use it. In addition, integrating technology in mathematics classrooms can be challenging, and there is a need for research-based frameworks that can guide mathematics educators in designing and implementing effective mathematics classes using Desmos. One of the mathematics concepts the students need help with is function. The significance of this research lies in its response to several critical issues within the domain of mathematics education: (1) Engagement and Visualisation: Teaching functions has often been plagued by the challenge of engaging students and helping them visualise abstract mathematical concepts. Recent educational research has underscored the importance of active engagement and visualisation in promoting deep mathematical understanding (Svitek et al., 2022; Tokanov et al., 2023); (2) Technology Integration: With advancements in technology, there is a growing need to effectively integrate digital tools into the mathematics curriculum. However, the integration should not be superficial but rather transformative, aiming to enhance the learning experience and outcomes (Long & Bouck, 2022); (3) Design-Based Research: Contemporary educational research increasingly emphasises the importance of design-based research methodologies that allow for iterative development, implementation, and evaluation of innovative teaching approaches (Lim & Nguyen, 2022)

Research Problem

In the ever-evolving landscape of mathematics education, one critical challenge has persisted over the years - how to make learning functions an engaging, comprehensible, and productive experience for students (Gavin et al., 2009; Lundin, 2012). The abstract introduces a research problem of paramount importance, which revolves around the need to transform the conventional approach to teaching functions by harnessing the potential of technology-enhanced learning tools, specifically the Desmos application. Traditional instruction of functions has often been marred by abstract concepts that students struggle to grasp, resulting in disengagement and hindered learning outcomes. Teachers grapple with the dual challenge of cultivating student interest and bridging the gap between mathematical theory and practical understanding (Thompson, 1984; Chamberlin & Powers, 2010; Park et al., 2016). This research problem recognises these hurdles and seeks to address them through a well-structured development research framework.

Besides, some of the difficulties of the students understanding the concept of a function is that many of them need help understanding the abstract concept of a function, which is the relationship between two variables where each input has only one output. In their work, they found that students often need help understanding the concept of a function and identifying the independent and dependent variables. In addition to this, students also struggle with graphing functions accurately and interpreting the graphs. Students may need help graphing functions accurately and understanding the relationship between the graph and the function. Besides that students have difficulty manipulating and solving functions algebraically, including factoring, solving equations, finding inverse functions, and in the end, the students struggle to connect the algebraic and graphical representations of functions as well as the verbal representations of functions. Applying functions to real-world problems also becomes a problem for students when they need help connecting and understanding the practical applications of functions. In response to these challenges, our research framework adopts a design-based research approach, informed by the most recent scholarship in mathematics education and educational technology. By systematically designing, implementing, and evaluating functions classes that leverage the full potential of Desmos, the aim was to provide educators with a roadmap for the development of dynamic, interactive, and effective teaching and learning experiences.

The crux of the problem lies in reimagining mathematics instruction. It is essential to find innovative ways to integrate Desmos as a dynamic, interactive tool into the curriculum, making the learning of functions not just effective but also enjoyable. The research problem emphasises the need to design and implement a comprehensive framework based on design-based research principles that can lead to a reinvigorated, student-centric approach to teaching functions. Ultimately, this research problem serves as a call to action, highlighting the imperative to bridge the gap between conventional teaching methods and the digital era's potential. It seeks to provide a solution that significantly improves students' learning outcomes in functions classes, setting a new standard for mathematics education in the future.

Research Focus

Based on the several mentioned issues, this study explored possibilities framework to design functions classes using Desmos. The primary focus of this research was to investigate how Desmos, as a dynamic online graphing calculator, can be strategically integrated into the design and delivery of functions classes to address the pressing challenges in contemporary mathematics education. The developed framework can be grounded in educational research and best practices and adaptable to different contexts. The research framework will help mathematics educators to design and implement functions classes that engage students in meaningful learning experiences and support the development of their mathematical understanding.

Research Aim and Research Questions

This paper aimed to develop research framework for Functions classes utilising Desmos as a tool. The framework contained iterative processes for planning, design, implementation, and evaluation and was founded on the concepts of design-based research. The following research question to address the aim is "How can a development research framework leveraging Desmos as a technology-enhanced learning tool be designed and implemented to address the multifaceted challenges students face in understanding and learning functions in mathematics education?"

Expected outcomes based on the aim of this paper were:

1. **A Comprehensive Research Framework:** the research was expected to produce a well-structured development research framework that could serve as a model for mathematics educators to design and implement functions classes effectively using Desmos;
2. **Improved Learning Outcomes:** the implementation of the framework was expected to lead to improved learning outcomes, including increased student engagement, deeper understanding of mathematical concepts, and better problem-solving skills in functions;
3. **Recommendations for Effective Integration:** the research was expected to provide actionable recommendations for educators on how to integrate Desmos into functions classes to maximise its potential for enhancing teaching and learning;
4. **Insightful Analysis:** the research will yield insightful analysis about the impact of technology-enhanced learning on mathematics education, specifically in the context of functions. It will shed light on how mathematics instruction can evolve in the future.

In addition to this, the broader impact of this research lies in its potential to reshape mathematics education. By addressing the challenges students face in learning functions and providing educators with a practical framework for leveraging technology, the research has the potential to:

1. **To enhance mathematics education:** the research can contribute to the ongoing improvement of mathematics education by offering innovative strategies for teaching functions, making it more engaging and accessible to a wider range of students;
2. **To empower educators:** educators will benefit from the research findings and recommendations, as they can better integrate technology tools like Desmos into their teaching practices to improve instruction;
3. **A benefit for students:** The research has the potential to positively impact students by making the learning of functions more enjoyable, comprehensible, and aligned with real-world applications;
4. **To inform educational policy:** Findings from this research can inform educational policies and curriculum development, encouraging the adoption of technology-enhanced learning tools to enhance mathematics education. In summary, this research seeks to create a transformative framework for teaching functions, with the potential to improve both student learning outcomes and the overall landscape of mathematics education.

Research Methodology

General Background

The scope of literature review for this methodology focused on three key areas:

1. **Development Research Frameworks in Mathematics Education:** existing development research frameworks in the field of mathematics education, with a specific focus on those that have been used to enhance the teaching and learning of mathematical concepts were investigated. Then one explored how these frameworks have been designed and implemented and assess their impact on student learning outcomes.
2. **Technology-Enhanced Learning in Mathematics:** the literature related to the integration of technology, such as Desmos, into mathematics education was examined. Examine studies and research that highlight the effectiveness of technology-enhanced learning tools in improving students' understanding of mathematical concepts, engagement, and overall learning experiences.
3. **Challenges in Teaching and Learning Functions:** the existing body of literature that discusses the common challenges students face when learning functions in mathematics; include

research on conceptual difficulties, graphing challenges, algebraic manipulations, and the integration of algebraic, graphical, and verbal representations of functions were explored. When we indexing the literature for the methodology section, we organize it into subsections that align with the scope areas mentioned above:

1. Development Research Frameworks in Mathematics Education:
 - a. Define development research frameworks in the context of mathematics education.
 - b. Review relevant studies that have used development research methodologies to improve mathematics instruction.
 - c. Analyse the key components of successful development research frameworks.
 - d. Discuss the role of design-based research principles in the development of effective frameworks.
 - e. Identify gaps or limitations in the existing literature related to development research in mathematics education.
2. Technology-Enhanced Learning in Mathematics:
 - a. Discuss the significance of technology-enhanced learning tools in mathematics education.
 - b. Present evidence from the literature regarding the impact of technology, specifically Desmos, on mathematics instruction.
 - c. Examine studies that highlight the benefits of technology-enhanced learning in terms of student engagement, understanding, and problem-solving skills.
 - d. Explore best practices for integrating technology tools into mathematics curriculum.
 - e. Identify any emerging trends or innovations in technology-enhanced mathematics education.
3. Challenges in Teaching and Learning Functions:
 - a. Summarise the common difficulties students encounter when learning functions in mathematics.
 - b. Reference studies that have investigated these challenges, including those related to conceptual understanding, graphing, algebraic manipulations, and connecting different representations of functions.
 - c. Analyse the implications of these challenges for mathematics education and curriculum development.
 - d. Identify areas where technology-enhanced learning tools like Desmos can potentially address these challenges.
 - e. Discuss the need for a comprehensive development research framework to tackle these issues effectively.

Based on the scope and indexing above, the integration of Desmos into the development of functions classes, aligning with the overarching goal of enhancing mathematics education comprehensively were investigated. By doing so, a design-based research proposed by Reeves (2006) was chosen. This facilitated the iterative planning, implementation, and evaluation. The research begun with an extensive literature review spanning the last decade to identify current trends, best practices, and scholarly insights related to the integration of technology, particularly Desmos, in mathematics education. This review informed the approach and ensures that our research builds upon and contributes to the existing body of knowledge (Lesh et al., 2000). A review of the literature on the use of technology in mathematics education (Reeves, 2006), an analysis of best practices in designing functions classes, and a study of the efficiency of using Desmos in functions classes were included in the research framework for designing functions classes using Desmos. Technology's potential to improve mathematics instruction and student learning outcomes was examined in the literature study. The benefits and difficulties of using technology in math courses were examined. Desmos was used to

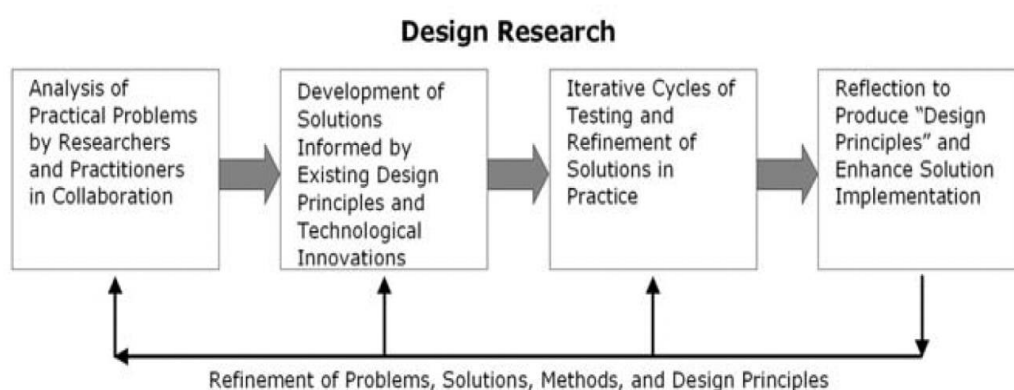
determine important characteristics of successful function classes and analyse best practices in function class design. Clear learning objectives, well-designed exercises, efficient scaffolding, and chances for students to participate in collaborative learning were some of these aspects. The framework was founded on the tenets of effective mathematics teaching (Goldin, 1998) and served as a manual for creating and implementing functional classes that engaged students in meaningful learning experiences. Then Goldin framework was used and modified based on this research aim addressing the challenges in teaching and learning functions.

Research Results

The framework contains iterative processes for planning, design, implementation, and evaluation and is founded on the concepts of design-based research. Design research approaches in educational technology steps proposed by Reeves (2006) reflect a dynamic and expanding field at the crossroads of instructional design, technological integration, and pedagogical innovation. This approach aims to bridge the gap between theory and practise by emphasising the systematic and iterative development of educational interventions, tools, and environments. At its foundation, design research in educational technology is guided by a dedication to tackling real-world educational difficulties (Molina et al., 2007; McKenney & Reeves, 2012). The design research differs from traditional research paradigms in that it prioritises the immediate relevance and impact of research findings. Design research approach often emphasise the significance of design principles and theoretical frameworks (see Fig. 1). Researchers use known theories of learning, cognition, and human-computer interaction to influence design decisions, ensuring that educational technology interventions are anchored in strong pedagogy. In essence, educational technology design research serves as a catalyst for educational innovation. It uses technology to produce more effective, interesting, and learner-centred educational experiences while also contributing to the larger discussion on the integration of technology in education. Design research seeks to impact the future of teaching and learning in an increasingly digital environment through rigorous design, collaboration, and continuing reflection.

Figure 1

Design research Approaches in Educational Technology



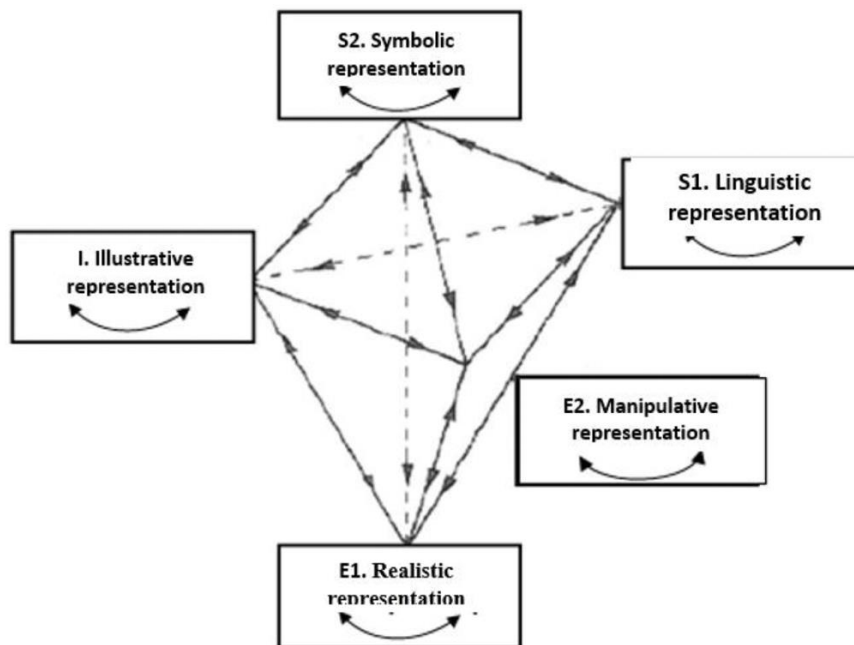
Source: Reeves (2006).

Works with it, to strengthen the framework, the main focus to overcome the issue of students' difficulty in learning is put emphasize on representation. Five modes of representation mentioned by Goldin (1998) are being used to explain the final proposed framework of this study: (1) Realistic representation is depictions of actual conditions and objects; (2) Manipulative representation:

artificially created representations to enhance the dynamic activity of things; (3) Illustrative representation: representations that use illustrations, figures or graphs; (4) Linguistic representation: representations in everyday languages, and the last one; (5) Symbolic representation: representations used in mathematical notations. Goldin's mode divides the enactive representation into two which are realistic representation and manipulative representation, while for the written symbol are distinct as linguistic and symbolic representation (Tan et al., 2023).

Figure 2

Goldin's Representational Systems in Mathematics' Education



Source: Goldin (1998)

Planning

The planning stage holds immense significance as it lays the foundation for effective instruction. Reeves (2006), in his works on design research from the perspective of technology, emphasise collaboration between researchers and practitioners; in this sense, teachers prepare and explore the real teaching and problems given. In this study, to overcome the difficulties of function, Desmos is proposed. Eight activities (Figure 3) could be used to teach function (<https://www.desmos.com/>). The initial two activities which are introduce the function serve as the scaffolding upon which the entire lesson is constructed. Research in mathematics education has consistently emphasized the importance of establishing clear conceptual understanding before delving into procedural fluency (Hiebert & Grouws, 2017). These first two activities could be considered as building conceptual foundations. For the assessment of conceptual understanding, the subsequent three activities, which involve differentiating between functions and non-functions, serve a dual purpose. Firstly, they serve as formative assessments to gauge students' comprehension of the newly introduced concept. This aligns with the principles of assessment for learning, where ongoing assessment is used to inform instructional decisions (Black & Wiliam, 1998). Secondly, these activities foster critical thinking and metacognition, as students must analyze the characteristics of functions to distinguish them from other mathematical relationships. The final three activities, focusing on domain and range within functions, represent a natural progression in the instructional sequence. Once students grasp the fundamental concept of

functions, they can explore the essential elements that define a function: its input values (domain) and output values (range). By dedicating a segment of the instruction to these aspects, we are not only deepening students' understanding but also aligning with research highlighting the significance of domain and range in function comprehension (Fries et al., 2020).

Figure 3

Desmos Activities for Function

The screenshot shows the Desmos Classroom interface. On the left is a sidebar with a search bar and navigation links: Home, Collections, Featured Collections by D..., Functions (selected), Turtle Crossing, Graphing Stories, Guess My Rule, Commuting Times, Card Sort: Functions, Domain and Range Introduction, Free-Range Functions, and Marbleslides: Lines. The main content area is titled 'Functions' and lists several activities:

- Introducing Functions**: Graphs of position over time help introduce the idea that functions have a single output for each value of the input.
- Turtle Crossing**: In this lesson, students make connections between several turtle-crossing scenarios and the graphs that represent these scenarios.
- Graphing Stories**: This activity will help students make the transition from one-variable representations (e.g., number lines) to the TWO-variable representation of the coordinate plane. Students will watch 15-second videos and translate them into graphs with your help.
- Functions and Not Functions**: Not everything you can graph is a function; how can we tell the difference?
- Guess My Rule**: Students are introduced to the concept of a function by using input-output pairs in a table. They explore different rules, some of which are functions and some of which are not. Some rules are numeric, while others involve letters and words.
- Commuting Times**: This activity illustrates the relationship between a dataset (which is usually not a function) and a model of the data (which—in algebra—is a function).
- Card Sort: Functions**: In this activity, students sort graphs, equations, and contexts according to whether each one represents a function.
- Domain and Range**: The domain of a function is the set of all possible inputs; the range of a function is the set of all possible outputs. Restricting the domain or range of a function is sometimes a useful mathematical technique.
- Domain and Range Introduction**: In this activity, students practice finding the domain and range of piecewise functions. They begin with an informal exploration of domain and range using a graph, and build up to representing the domain and range of piecewise functions using inequalities.
- Free-Range Functions**: This activity challenges students to strengthen their ideas about range. Many students who can correctly indicate the range of, say, $y = x^2$ using formal mathematical notation may still cling to some mistaken ideas. For example, students commonly say that π is not in the range of $y = x^2$ because they cannot think of a number that, when squared, gives π .
- Marbleslides: Lines**: In this delightful and challenging activity, students will transform lines so that the marbles go through the stars. Students will test their ideas by launching the marbles and will have a chance to revise before trying the next challenge.

Source: <https://www.desmos.com/>

To enhance the effectiveness of this instructional plan, it may be advantageous to include real-world applications of functions throughout the activities. Research indicates that contextualized mathematics instruction can improve students' motivation and transfer of learning (Lesh et al., 2000). This can be achieved by presenting functions in contexts that resonate with students' experiences, such as modelling real-world scenarios or exploring functions in fields like physics or economics.

While planning this sequence of activities, it is crucial to consider the diverse learning needs of students. Research on differentiated instruction suggests that adapting teaching methods to accommodate various learning styles and abilities can lead to improved student outcomes (Tomlinson, 2014). Thus, the planning stage should include strategies for differentiation, such as providing additional support for struggling learners and offering enrichment opportunities for those who grasp concepts quickly. In conclusion, the planning phase in mathematics instruction is a critical juncture that demands meticulous consideration. The proposed sequence of activities, starting with the introduction of the function concept and culminating in domain and range exploration, aligns with established principles of mathematics education and assessment. To enhance its effectiveness, integrating real-world contexts and incorporating differentiation strategies can further enrich the learning experience. Ultimately, a well-designed plan sets the stage for successful teaching and learning, ensuring that students develop a solid grasp of the concept of functions and its related components.

Design

Designing the classroom using Desmos in order to teach function provides students with an interactive and dynamic environment for exploring the concepts. It allows creating graphs of functions in real-time, making it easy for students to visualise the relationships between variables and understand the behaviour of functions. In the process of designing a classroom environment for teaching functions using Desmos, we embark on a pedagogical journey that combines technological innovation with sound instructional design principles. This stage of "design" is pivotal as it determines the structure and flow of the learning experience, aligning with the research findings that underscore the potential of Desmos to foster interactive and dynamic learning environments. The utilization of Desmos as a central tool in the classroom design transforms the traditional static learning environment into an interactive and responsive space. Research in educational technology highlights the importance of creating interactive learning environments that engage students actively in the learning process (Abykanova et al., 2016). By integrating Desmos an environment where students can actively explore and experiment with mathematical concepts, leading to deeper comprehension was created.

One of the defining features of Desmos is its capability to generate graphs of functions in real-time. This dynamic functionality aligns with the principles of constructivism, where learners actively build their understanding through hands-on exploration (Piaget, 1972). In the context of teaching functions, this means that students can instantly visualize the impact of different variables on function behaviour, fostering a more intuitive and experiential grasp of mathematical concepts. The design of the classroom with Desmos at its core is driven by the goal of enhancing students' conceptual understanding of functions. Research indicates that visualization and interactive tools can support students in developing a more profound and flexible understanding of mathematical concepts (Etyarisky, & Marsigit, 2022). By allowing students to see and manipulate graphs in real-time, Desmos facilitates the exploration of key function attributes, such as transformations, domain, and range, leading to richer conceptual development.

Incorporating Desmos into the classroom design also opens avenues for collaborative learning. Students can work together in real-time, sharing graphs, discussing observations, and jointly solving

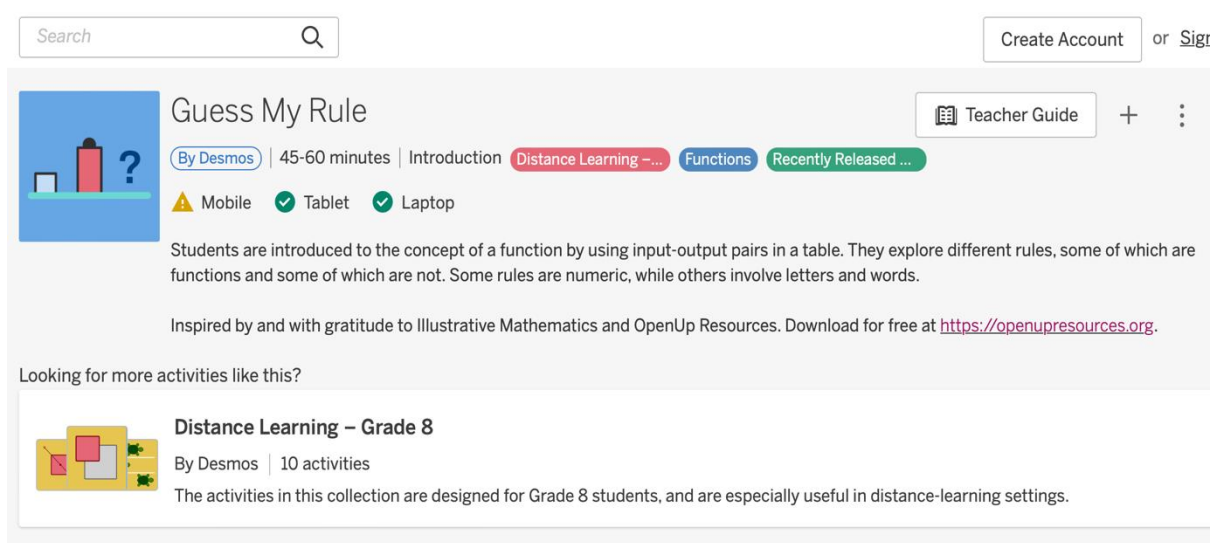
problems. Collaborative learning has been shown to enhance student engagement and promote deeper understanding through peer interaction (Johnson & Johnson, 2009). The classroom design encourages cooperative exploration of functions, further reinforcing learning outcomes. Rose & Meyer (2002) stated that an essential aspect of classroom design with Desmos is ensuring accessibility and inclusivity for all students. Research emphasises the importance of designing technology-enhanced learning environments that accommodate diverse learner needs. Therefore, the classroom design should consider accessibility features and provide support for students with varying abilities, ensuring that all learners can benefit from the interactive and dynamic environment. Desmos also provides a range of tools and features, such as sliders, tables, and data plots, that can help students to explore and manipulate mathematical concepts. When designing function classes using Desmos, it is important to define learning objectives and design tasks aligning with them. Tasks should be designed to promote the development of mathematical thinking and reasoning and should provide opportunities for students to engage in problem-solving and sense-making activities. Based on the eight activities in Desmos (Fig. 3), the activity that is most suitable for introducing functions is an activity entitled Guess My Rule. In conclusion, the design of a Desmos-integrated classroom for teaching functions is a deliberate and research-informed process. It leverages the power of technology to create an interactive and dynamic learning space that promotes deeper conceptual understanding, collaboration, and inclusivity. This design aligns with contemporary educational research, highlighting the transformative potential of technology in enhancing mathematics education. By designing classrooms that embrace Desmos, we pave the way for a more engaging and effective learning experience for students as they explore the intricacies of mathematical functions.

Implementation

Through the Guess My Rule activities, Desmos analogises the basic concept of function to an animation illustration of a working machine (Desmos.com., n. d). Guess My Rule in Desmos has eleven stages within 60 minutes, where the students are required to explore the rule to determine whether it is a function.

Figure 4

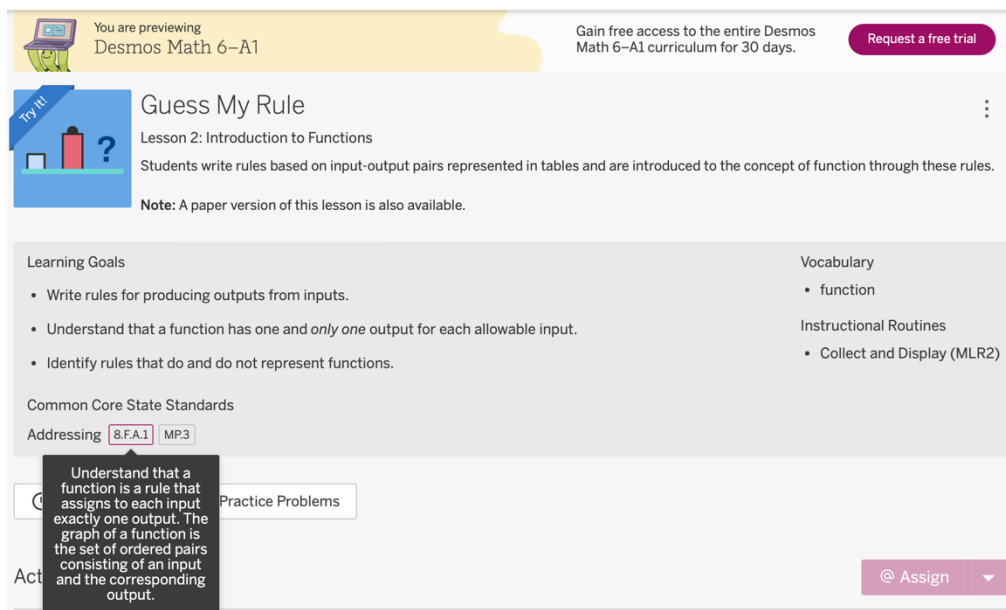
Desmos Activities for Function Guess my Rule in Teacher Guide Page



Source: <https://www.desmos.com/>

Figure 5

Desmos Activities for Function Guess my Rule in Students' Page

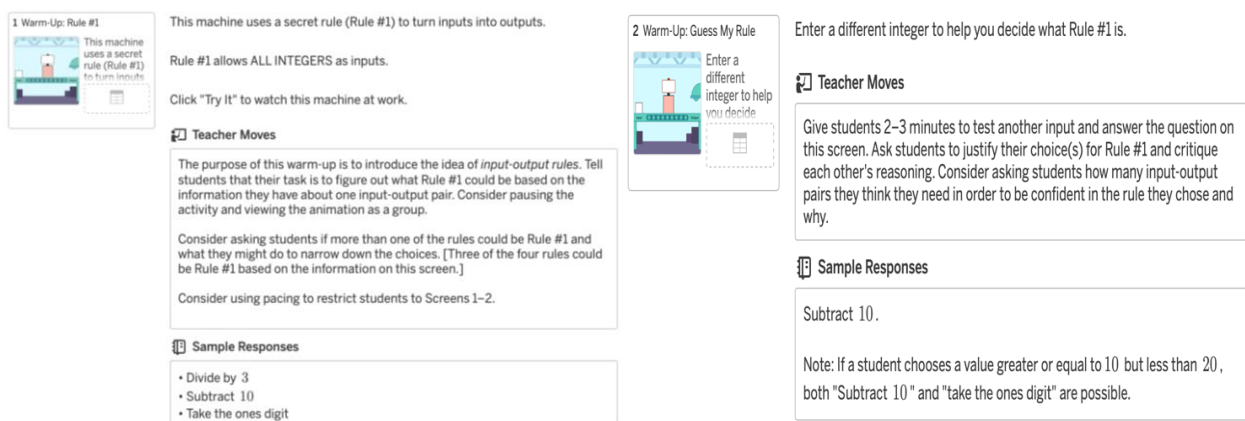


Source: <https://www.desmos.com/>

Figure 5, shows the activity addressing students understand about the rule that a function has one and only one output for each allowable input. In the first stage, the students are introduced to input-output rules through the animation. Students are asked to guess the rule from the input, which is processed into output (Fig. 6). In this stage, the students learn how to make connections using input-output rules.

Figure 6

Desmos Activities for Function Guess my Rule#1



Source: <https://www.desmos.com/>

The first and second stage are belonged to the rule#1 where the students were asked to guess my rule. The second stage is the confirmation of students' answers in the first stage, where require the students enter the number in the input by themselves. In the second stage, students experiment with numbers to verify their answers. As shown from our previous work in implement this activity (Dewi &

Peni, 2023), the students demonstrate two indicators of critical thinking skills: Focus and Reason. Dewi and Peni (2023) stated that the visualisation is crucial for success, as it triggers critical thinking in students. Addition to this, Goldin (1998) stressed the importance of presenting representations in an optimal order that allowed students to build up their ideas gradually. Students will find the image of how the machine works and this skill is linked to enhance their illustrative representation.

The third and eighth stages show three different conditions that might happen in a machine process which are rule#2 (Fig. 7), rule#3(Fig. 8), and rule#4(Fig. 9). In other words, these stages explain examples and non-example of function and lead students to construct their understanding of the meaning of function in the ninth stage.

Figure 7

Desmos Activities for Function Guess my Rule#2

3 Rule #2: Test Some Inputs

Here is a new rule called Rule #2.

Rule #2 allows ALL NUMBERS as inputs.

Test several inputs to see how Rule #2 works.

When you think you know the rule, go to the next screen.

Teacher Moves

The purpose of Screens 3 through 8 is for students to experience rules where only one output is possible for each input and rules where multiple outputs are possible for each input.

Arrange students into pairs. Tell students that their job in this activity is to guess each mystery rule by testing different inputs and looking for patterns.

Let them know that each rule has different allowable inputs and that it may take a different amount of inputs to be confident about each rule.

Consider using pacing to restrict students to Screens 3–8.

4 Rule #2: Guess My Rule

Here are some inputs and outputs from your classmates.

If you input 6, what do you think the output will be?

Teacher Moves

Use the teacher view in the teacher dashboard to identify students who may need additional support. Consider asking students how they think the machine created the outputs.

Sample Responses

7

Responses vary.

If you input 6, the output should be 7 because this rule outputs the number 7 no matter what the input is.

Source: <https://www.desmos.com/>

Figure 8

Desmos Activities for Function Guess my Rule#3

5 Rule #3: Test Some Inputs

Rule #3 allows SINGLE WORDS as inputs.

Test several inputs to see how Rule #3 works.

When you think you know the rule, discuss it with someone you are not currently working with.

Teacher Moves

Screens 5 and 6 are similar to Screens 3 and 4 with a more challenging rule. This rule takes words (technically any string of letters and spaces) as inputs and returns a single letter—the next letter in the alphabet of the last letter of the word.

For example, the word "hello" becomes "P" because "o" is the last letter of the word, and the next letter in the alphabet is "P."

For students struggling to find a rule, consider encouraging them to try more inputs. You might suggest that they enter a letter, like "a" or "l."

Remind students that when they think they know the rule, they should find a classmate who they are not currently working with and discuss their rules together before moving on to the next screen.

6 Rule #3: Guess My Rule

Here are some inputs and outputs from your classmates.

Put your rule to the test with some new words below.

Then press "Try It" to see what the machine will do.

Teacher Moves

Give students one minute of quiet think-time. Then invite them to discuss their output predictions with a partner. Consider holding a whole-class discussion and displaying the student view of the dashboard. Ask students to justify their output predictions for the four words and critique each other's reasoning.

In the second table, the word "friend" appears twice as an input. Consider highlighting that for this machine, when you use the same input, you expect the same output.

Sample Responses

- friend → E
- wallet → U
- friend → E
- party → Z

Source: <https://www.desmos.com/>

Figure 9

Desmos Activities for Function Guess my Rule#4

7 Rule #4: Test Some Inputs

Rule #4 allows SINGLE LETTERS (like "A") as inputs.

Test several inputs to see how Rule #4 works.

Then go to the next screen.

Teacher Moves

Screens 7 and 8 explore a rule that is not a function. The purpose of this screen is for students to notice that sometimes the same input will lead to different outputs.

Rule #4 takes single letters as inputs and returns a name beginning with that letter. For example, the letter "J" might output "Jada" or "Jacy" or "Jaleel."

Consider encouraging students to test the same input more than once and to focus less on the rule and more on any patterns they notice (e.g., that different outputs are created from the same input).

8 Rule #4: Guess My Rule

Here are some inputs and outputs from your classmates.

If you input "A" into this rule, explain what you think the output will be and why.

Then compare your response to your classmates'.

Teacher Moves

Give students one minute of quiet think-time. Then invite them to discuss with a partner how their response was similar to other students' responses and why they believe that occurred. Highlight unique answers to show the class.

Consider asking students, "How is Rule #4 different from the other rules we have seen today?"

Sample Responses

Responses vary.

- If you input "A," the output should be some name starting with "A," but I'm not sure what.
- The output will be "Alan" or "Adrian" if the input is "A" because I noticed that the first letter of the name is always the input.

Source: <https://www.desmos.com/>

At the stage 9 (Fig. 10), students have just been introduced to the term function. Activity in this stage, engage students in the process achieving the critical thinking process, distinguishing facts from assumptions, re-examining arguments, and forming conclusions to answer questions (Dewi & Peni, 2023).

Figure 10

Desmos Activities for Function Stage 9

9 What Is a Function?

Input	Output	Input	Output
10	20	10	20
100	110	100	110
1000	1100	1000	1100
10000	11000	10000	11000

Rules #1, #2, and #3 are called FUNCTIONS.

Rule #4 is NOT a function.

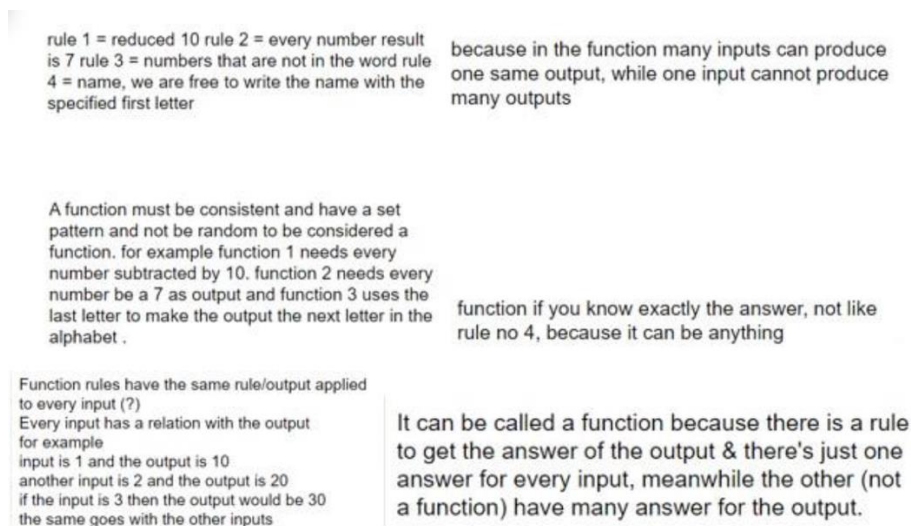
What do you think makes a rule a function?

Source: <https://www.desmos.com/>

Based on the students respond, the summary of responses reveals that there are students who are able to articulate their ideas clearly, there are students who are unable to do so, and there are also students who continue to appear perplexed as to why Rule 4 is stated as not a function.

Figure 11

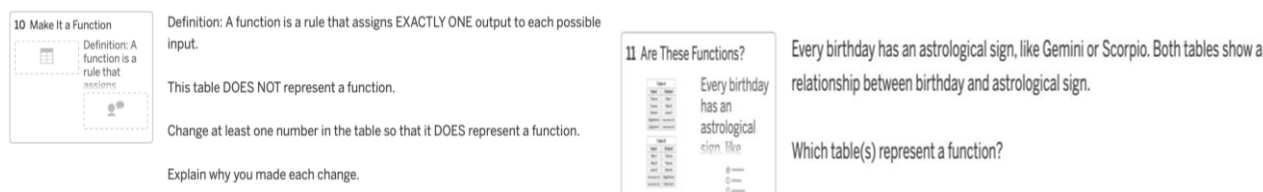
Srudents' Respond to Stage 9



Stage nine exercises enhance students' understanding of function by rephrasing the question "What is function?" to "What do you think makes a rule a function?", encouraging critical thinking and decision-making in the learning process. The tenth stage and eleventh stages are the confirmation stage for students' understanding of basic function concepts. The students were given the real situation related to function and being asked whether it can represent the function concept.

Figure 12

Desmos Activities for Function Stage 10 and 11



Source: <https://www.desmos.com/>

Evaluation

Table 1 shows the proposed framework based on the learning objectives, well-designed exercises, efficient support, and chances for students to participate in collaborative learning within a mathematics classroom using Desmos. The research journey advances to the evaluation stage, where we rigorously assess the effectiveness of the proposed framework designed to enrich mathematics classrooms through the integration of Desmos. This comprehensive framework, rooted in learning objectives, well-designed exercises, scaffolding, and collaborative opportunities, represents a holistic approach to fostering mathematical understanding and engagement. The evaluation phase involves scrutinising various facets of the framework to determine its impact on students' learning experiences.

Table 1

Proposed Design Framework for Function Classroom

Representation Model	Class Design using Desmos	Indicator for Function
Realistic representational mode	Virtual experiment (guess the rule)	Understanding the concept of function

Manipulative representational mode	Virtual experiment (try to submit input to get an output - confirm the rule).	- Understanding the concept of function - Graphic function
Illustrative representational mode	Virtual experiment of a machine and how it works.	Manipulating and solving function
Linguistic representational mode	The keyword such as input, output, and rule in the virtual experiment.	Translating between representations
Symbolic representational mode	Comparison the real problem (try to compare and determine which problem represent function)	Applying function to real-world problems

Source: author 's own development.

The alignment between a realistic representational mode, class design utilizing Desmos for virtual experiments, and the understanding of the concept of functions is profoundly significant. Realistic representational modes, such as graphical representations in Desmos, provide students with tangible and relatable visuals that bridge the gap between abstract mathematical concepts and real-world applications. When integrated into class design, Desmos allows students to engage in virtual experiments, providing them with opportunities to explore, manipulate, and observe function behaviours in dynamic, interactive settings. This hands-on approach fosters a deeper understanding of functions as students actively experiment and make connections between mathematical abstractions and real-world phenomena. Consequently, this synergy empowers students to grasp complex function concepts more intuitively, ultimately enhancing their mathematical comprehension and problem-solving skills. The convergence of manipulative representational modes, Desmos-driven class design for virtual experiments, and a deep understanding of function concepts, complemented by graphical visualization, creates a comprehensive learning ecosystem. This synergy fosters a multi-dimensional approach to function comprehension, empowering students to navigate the abstract world of mathematics through hands-on exploration, dynamic visualization, and real-world connections.

The interplay between an illustrative representational mode, Desmos-based class design with virtual machine experiments, and manipulating/solving functions represents a cohesive approach. It enables students to explore functions in the context of real-world machinery, enhancing their problem-solving skills by applying mathematical concepts to practical scenarios, thereby strengthening their understanding of functions in a tangible and engaging manner. The convergence of linguistic representational mode, Desmos-centred class design focused on rule exploration within virtual experiments, and the skill of translating between representations creates a comprehensive learning framework. This approach not only deepens students' understanding of mathematical rules but also enhances their ability to articulate and apply these rules across various mathematical contexts, promoting mathematical fluency and problem-solving skills. In the last row of the table 1 show the alignment of symbolic representational mode, Desmos-driven class design for real problem comparisons to discern functions, and the application of functions to real-world scenarios creates a cohesive pedagogical approach. This fosters a deep understanding of functions as students actively analyse and apply them to practical challenges, enhancing their problem-solving abilities and reinforcing the real-world relevance of mathematical concepts.

Discussion

The planning stage is the first stage of the design-based research proposed by Reeves (2006) and modified by the authors and refers to the Goldin (1984) framework in order to get the table 1 as the

proposed framework. Technology has been touted as a powerful tool for enhancing mathematics education (Ruiz-Ramos & Kinkead-Clark, 2022; Abu & Kribushi, 2022; Kanandjebo & Lampen, 2022). It has the potential to transform the traditional mathematics classroom by providing students with dynamic and interactive environments for exploring mathematical concepts and visualising graphs of functions. Technology can help students to connect mathematics to real-world problems (Abidin, et.al., 2020), support the development of mathematical thinking and reasoning (Francisco, 2013), and provide opportunities for collaborative learning (Goos et al., 2003; Shechtman et al., 2010). The use of technology in mathematics classrooms can also support differentiated instruction, where teachers can tailor learning experiences in order to meet the needs of individual students (Reeves, 2006). In this case, Desmos can provide students with immediate feedback, adapt to their level of understanding, and create personalized learning paths. Furthermore, Desmos can help to promote equity in mathematics education by providing access to tools and resources that may be otherwise unavailable to students in disadvantaged communities.

After the planning for the class, the tasks should be designed in order to be accessible to students with different levels of mathematical understanding and should provide appropriate scaffolding and feedback. The learning trajectory of learning functions starts from the introduction of concepts. In this case, introducing the function can't be directly done by explaining that "function explanation is something". The activity of the 'Guess My Rule' contains iconic representation (Goldin, 1984), which can bridge children's thinking processes from concrete to abstract things. In using the Guess My Rule activity, the teacher still has a role as a facilitator who can bridge and strengthen each stage of the activity (Leatham & Peterson, 2010; Bell, et al., 2010).

In the implementation stage of the research, an instructional roadmap comprising 11 stages was meticulously devised. These stages were thoughtfully designed to guide students through a progressive and scaffolded learning experience aimed at enhancing their understanding of the concept of functions. Central to this approach is the strategic use of representational systems, which play a pivotal role in shaping students' conceptual development. When employing representational systems, it is recommended that students start with realistic representations, such as illustrated and linguistic ones, and then go on to symbolic representations at the end of their classes (Moskofoglou Chionidou & Vamvouli, 2019) as shown in Figure 6.

The recommendation to commence with realistic representations, such as illustrated and linguistic modes, and eventually transition to symbolic representations, signifies a pedagogical choice that aligns with well-established principles of cognitive development and learning theory. Research in mathematics education underscores the importance of providing learners with concrete and tangible entry points into abstract concepts (Vygotsky, 1978). Realistic representations offer this bridge, enabling students to relate to and visualise mathematical ideas in a way that mirrors their everyday experiences. Beginning with realistic representations allows students to build strong conceptual foundations. These representations provide a concrete context for exploring the behaviour of functions, fostering intuitive connections between mathematical concepts and real-world scenarios. As students' progress through the stages, they gradually internalise and generalise their understanding, moving from the tangible to the abstract. The staged approach is underpinned by the principle of scaffolding, where instructional support is provided and gradually reduced as students gain proficiency (Wood et al., 1976). Starting with realistic representations offers a scaffolded entry point into function concepts, providing learners with the necessary support and guidance to navigate the complexities of functions.

By deferring the introduction of symbolic representations to later stages, one aimed to optimise student engagement and retention. Research indicates that students may struggle to grasp abstract

symbols without a solid conceptual foundation (Nesher & Teubal, 1975). By first engaging with realistic representations, students are more likely to approach symbolic representations with greater confidence and comprehension. In conclusion, the implementation approach, characterised by a sequential progression from realistic to symbolic representations, is founded on research-informed principles of cognitive development and pedagogy. This carefully scaffolded journey empowers students to embark on a guided exploration of function concepts, ensuring that they not only grasp abstract mathematical ideas but also develop a profound and enduring understanding of functions that extends to real-world applications.

The evaluation stage where the framework developed, three aspects need to be consider based on the result are representation model, class design using Desmos and the indicator of the Function topic. The proposed framework is able to overcome difficulty in functions for the students. Some common difficulties include understanding the concept of a function, where many students needed help understanding the abstract concept of a function (Tall & Bakar, 1992; Elia et al., 2007), which is the relationship between two variables where each input has only one output that the activity could overcome by Guess my rule in Desmos. Graphing functions also could be taught to the students through virtual experiments, and this activity helps the students accurately understand the relationship between the graph and the function. Manipulating and solving function problems could be overcome when the students practice their representation model in manipulative and illustrative representational modes within the classroom activity. In line with the work of Chandrasegaran et al. (2008) and Bock et al. (2015) that multiple types of representation help students deepen their understanding. Using the linguistic representational mode, the activity designed to determine the keyword helps the students translate between algebraic, graphical, and verbal representations of functions. Leveraging the linguistic representational mode as an instructional strategy is instrumental in facilitating the translation between various mathematical representations of functions (Bossé et al., 2014). By employing activities that focus on determining keywords within mathematical contexts, students are encouraged to discern essential information and establish connections between algebraic, graphical, and verbal representations. This process enhances their ability to bridge the gap between symbolic notation and real-world meaning, aligning with principles of mathematical literacy and relevance which related to the last one is when the students can have a representation model of symbolism, and then they can apply the concept of functions to real-world problems. As students progressively acquire a representation model that encompasses symbolism, they are better equipped to apply the concept of functions to practical, real-world problem-solving scenarios. This holistic approach fosters a deeper understanding of functions while developing the essential skill of transferring mathematical knowledge into meaningful, real-life applications, ultimately empowering students as mathematically proficient problem solvers.

Desmos is a powerful tool for teaching functions in mathematics, but it has its limitations. First, while Desmos excels at graphing functions, it may not fully address the conceptual difficulties that some students encounter when learning functions. Understanding abstract concepts like domain, range, and the nature of functions may still require traditional instruction and clarification. Second, Desmos primarily focuses on graphical representations of functions. It may not adequately support students in mastering the algebraic aspects of functions, such as solving equations, factoring, or working with complex expressions. This limitation means that educators must complement Desmos with other instructional methods to ensure a comprehensive understanding of functions. Third, the effectiveness of Desmos in teaching functions depends on access to technology and a reliable internet connection. Not all students and schools have equal access to such resources, potentially creating disparities in learning opportunities. Lastly, successful integration of Desmos into the curriculum requires proper training and

ongoing support for teachers. Without adequate preparation, educators may not fully harness the tool's potential, leading to underutilisation or ineffective implementation. In conclusion, while Desmos is a valuable resource for teaching functions, it should be used alongside other instructional methods to address its limitations and ensure a well-rounded learning experience for students.

Conclusions and Implications

In conclusion, developing a research framework for designing function classes using Desmos is an important step towards enhancing the quality of mathematics education. The integration of Desmos into mathematics classrooms can provide students with dynamic and interactive environments for exploring mathematical concepts and visualising graphs of functions. The research framework for designing functions classes using Desmos will provide mathematics educators with a practical, flexible, and adaptable guide for integrating Desmos into their teaching practices. The resulting framework will enhance student's learning experiences and support the development of their mathematical understanding. As this framework takes root, it promises to not only enrich students' learning encounters but also cater to the diverse needs of educators, ensuring flexibility and adaptability in its application. The outcome of this undertaking is poised to transcend the traditional boundaries of mathematical education, fostering an environment that nurtures heightened comprehension and intellectual growth. Therefore, embracing this research framework signifies a commitment to fostering innovative learning experiences, promoting mathematical prowess, and sculpting a brighter educational landscape for both students and instructors alike.

The findings of this study demonstrated the versatility and applicability of the developed framework for teaching functions with Desmos in various educational settings. Through the systematic design and implementation of the research framework, it was established that its principles and strategies can be effectively adapted to diverse contexts, including different grade levels, educational systems, and cultural backgrounds. This adaptability signified the framework's potential to have a profound and far-reaching impact on mathematics education. By providing educators with a flexible roadmap that incorporates technology-enhanced learning tools like Desmos, one empowered them to address the common challenges in teaching functions across a wide spectrum of environments. As a result, this research not only contributed to the improvement of learning outcomes for students but also promised to enhance the quality of mathematics education on a broader scale. The transferability of the framework underscored its significance as a model for reshaping mathematics instruction, making it more engaging, accessible, and effective in various educational settings worldwide. As educators embrace these principles and strategies, the ripple effect on mathematics education will extend far beyond the confines of the proposed study, ultimately benefiting a diverse and global community of learners.

Suggestions for Future Research

The main prospects for further research on the top are related to the comparative analysis of teaching approaches: to conduct a comparative study that will evaluate the effectiveness of the research framework in designing functions classes using Desmos against traditional teaching methods. This could involve measuring student engagement, comprehension, and overall learning outcomes. Besides, student attitudes and motivation could also be examined in terms of the implementation of Desmos in function classes influences students' attitudes towards mathematics and their motivation to engage with mathematical concepts. This could involve surveys, interviews, and observation of classroom dynamics.

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DOI: <https://doi.org/10.57125/FED.2023.12.25.06>

How to cite: Shevchuk, I., Filippova, L., Krasnova, A., & Bazyl, O. (2023). Virtual Pedagogy: Scenarios for Future Learning with VR and AR Technologies. *Futurity Education*. 3(4). 95-117.
<https://doi.org/10.57125/FED.2023.12.25.06>

Virtual Pedagogy: Scenarios for Future Learning with VR and AR Technologies

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Received: August 14, 2023 | **Accepted:** October 22, 2023 | **Available online:** November 5, 2023

Abstract: Modern education and science are at the stage of active practical implementation of digital technologies aimed at improving the efficiency of the educational process. The fourth wave of industrial development offers digital and technological solutions that enhance the practical learning experience through the use of immersive technologies such as augmented and virtual reality. The purpose of this study is to assess the possibilities of using currently available Virtual Reality /

Augmented Reality (VR/AR) technologies and to develop specific recommendations for improving the quality of the educational process, as well as to explore promising areas for the development of immersive education. The study used methods of criterion-based selection of the optimal tool for creating educational virtual content. This selection was made among the research nomenclature of currently available relevant digital platforms based on the calculation of specialised metrics for assessing the focal technical and technological capabilities of the studied cloud resources. Based on the results of this study, the optimal and currently available means of creating educational content has been identified, which provides users with the opportunity to use VR/AR technologies without acquiring special skills and abilities. Pedagogical scenarios that have already been immersed and can be adapted to different sectors of education are proposed. Probable vectors for the further development of educational VR/AR technologies are considered, and a hypothesis is formed about the need to use real experience in implementing immersive and virtualised educational processes to adjust and moderate the future development of global education in the context of the and Education 4.0 paradigms. The results of this study indicate the dynamic development of the field of immersive and virtualised educational space, formulate practical recommendations for using currently available tools for creating virtual educational content, and also point to the problem of low scientific support for the development of the studied field, which requires a systematic approach and a generally accepted strategy in the transformational processes of civilisational evolution. According to the results of the study, it is recommended to actively introduce available cloud-based platforms for creating virtual educational content into educational processes, as well as to use a nomenclature of pedagogical scenarios that have already been adapted and transformed to the use of VR/AR technologies in educational processes. It is necessary to constantly monitor and moderate the processes of involving immersive and virtualisation tools in the educational space.

Keywords: virtualisation, virtual educational content, immersive educational space, immersion, interactivity, scientific support, pedagogical scenario, transformation, cloud solutions, digital platforms

Introduction

Modern education, like modern science, is at the stage of intensive practical testing, which leads to the search for transformational tools to increase the practical component in the educational process. Digital and technological solutions of the fourth industrial age provide an opportunity to increase the practical experience of the educational process by using immersive technologies such as augmented and virtual reality (AR and VR). The majority of students (about 97%) want to start their education using VR/AR technologies (ZipDo, 2023; Raturi, 2023). On average, 68% to 72% of teachers want to incorporate virtual immersive tools into their courses, and about 54% already use virtualisation tools in education (VictoryXR, n. d.; ZipDo, 2023). Students who have studied in immersive learning environments demonstrate greater motivation to learn and a significant increase in academic performance compared to similar results in typical educational processes (Clegg, 2023; ZipDo, 2023).

The immersive nature of the educational space has been the subject of numerous research papers and publications (Al-Ansi et al., 2023; Gómez-Rios et al., 2023; Rojas-Sánchez et al., 2023). A large number of review publications on the implementation of VR/AR technologies in the field of education, its possible applications and further development vectors only show the problems that are typical for this dynamic environment, namely the low number of relevant scientific papers on the practical application of the technology under study at the present time (Pathania et al., 2023; Fitria, 2023; Yenioglu et al., 2023).

Immersive experience in the educational process means the use of virtual and augmented reality technologies to create a favourable environment where students can immerse themselves in the learning material and actively interact with its elements. This increases the level of student engagement and interest, helps them to understand complex concepts, and provides an opportunity to apply the knowledge they have gained in practice. This approach can be used in a variety of disciplines, such as history, art, science and technology, languages, and others (Lion-Bailey et al., 2023; Lock & MacDowell, 2023; Dengel et al., 2023).

One of the key aspects of VR and AR's impact on education is the ability to make complex concepts more accessible and understandable to students. The immersive nature of these technologies allows for the visualisation of abstract concepts, which contributes to their better absorption. For example, in science and mathematics, VR can help solve complex problems and understand difficult mathematical concepts (Fakih, 2023; Sun et al., 2023; van Dinther et al., 2023).

VR and AR create immersive learning environments that capture students' attention and increase engagement. The interactive capabilities of these technologies allow students to learn the material not as passive observers, but to actively interact with it, which contributes to better learning and understanding of the educational material (Fernandes et al., 2023; Jia & Qi, 2023; Aguayo & Eames, 2023).

In addition, VR and AR allow for individualised learning, in particular by creating individual tasks and content for each student. This helps to take into account differences in students' knowledge levels and interests, improving the quality of learning. It is also worth noting that VR and AR allow for interactive simulations and virtual tours, which facilitates the teaching of practical skills and allows students to explore places and events that would otherwise be inaccessible due to physical limitations (Hwang, 2023; Almurbati, 2021; Garcia et al., 2023).

Thus, the use of VR and AR in education helps to improve the understanding of complex concepts, increases student engagement, individualises learning, facilitates the learning of practical skills, and expands access to quality education. These technologies are becoming an important tool for improving the quality of the educational process.

Research Problem

Despite the numerous scientific papers and relevant publications on the educational context of VR/AR technologies, the studied array is still a review and does not allow to reliably determine the vectors of future development of immersive educational processes. Moreover, a large number of review publications only form the phenomenon of “white noise” around the studied issues, and practical recommendations for the implementation of currently available means of creating virtual educational content contain only a small number of relevant scientific papers. Nevertheless, the experience of integrating VR/AR technologies into the educational environment is crucial in shaping trends and vectors of future development, as it forms the basic factual background on which experts adapt immersive technologies to educational purposes.

Research Focus

The identified problems of research and scientometric support of the process of integrating immersive tools into the educational sector direct the focus of the current study to identify models, methods, and recommendations for the practical application of VR/AR technologies in the formation of the educational process at the already achieved level of technical and technological development of

virtual learning environment tools. This focus of the study allows us to include this publication in the scientific works that form the basis for the balanced development and deep implementation of VR/AR technologies in the educational space, forming the necessary practical experience in testing and verifying theoretical developments and assumptions.

Research Aim and Research Questions

The purpose of the study is to develop practical recommendations for the use of currently available VR/AR technologies in order to improve the quality of the educational process and identify promising areas for further development of the immersive education.

Objectives of the study:

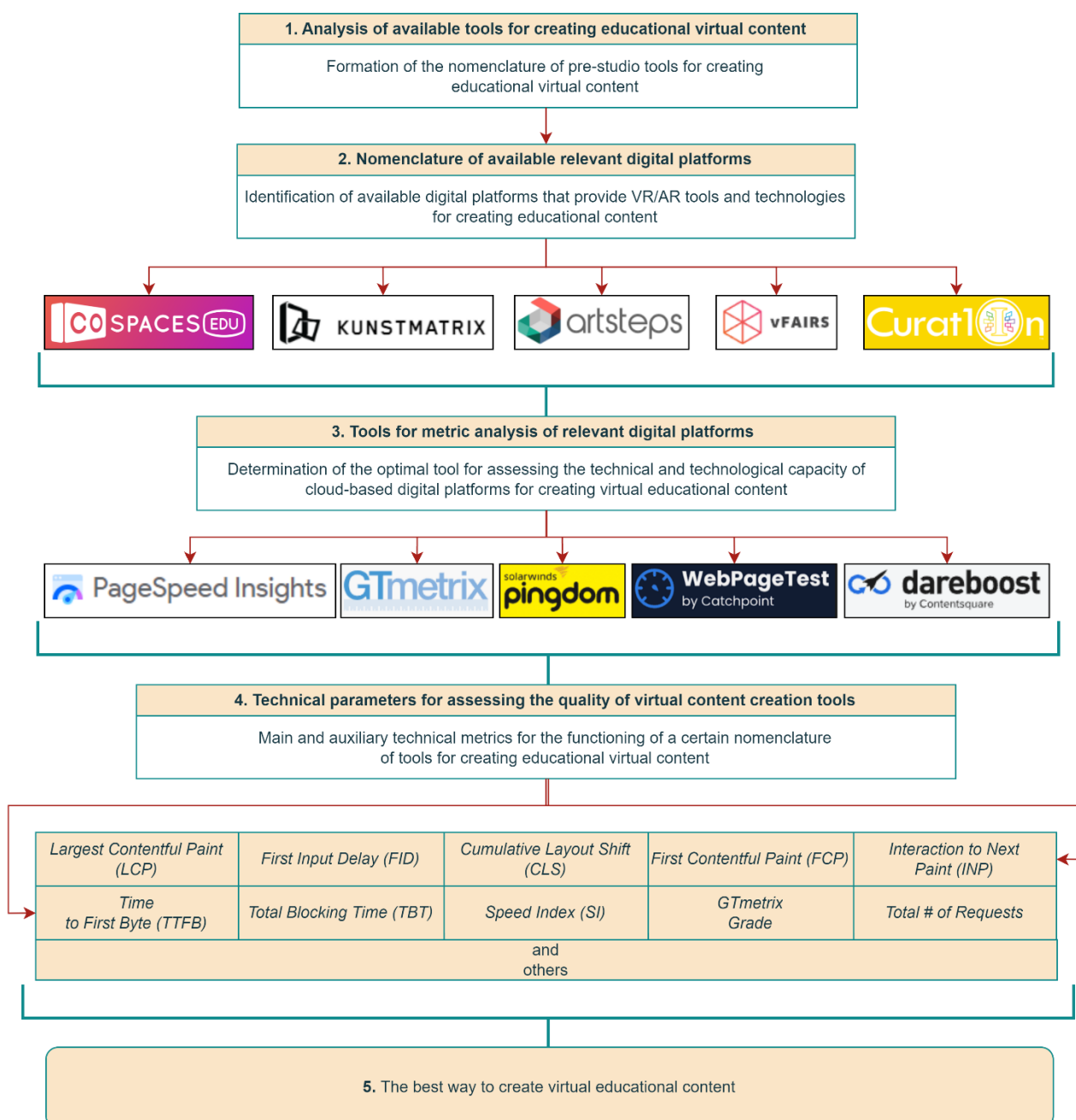
1. Establish the nomenclature of currently available tools for creating virtual educational content.
2. Identify tools that can be used to test virtual educational content creation tools.
3. To develop a system of criteria for choosing the optimal means of creating virtual educational content.
4. Conduct testing and determine the appropriate means of creating educational content using elements of VR/AR technologies.

Research Methodology

The general research procedure involves several iterations to determine the optimal solution for the immediate integration of VR/AR technologies into educational processes (Figure 1).

Figure 1

General Research Procedure



Source: author own development.

The appropriate tool for analysing the technical and technological capability of available digital platforms for developing virtual educational content is determined on the basis of the indicator of applicability, as evidenced by the relevant trend parameter over the past five years, which is determined using the *Google Trends* tool (<https://trends.google.com/trends/>).

Since the focus of the study is to determine the optimal educational platform currently available, which will allow for the effective development of relevant educational content without the need for the teacher to acquire special skills, the relevant VR/AR technology tools should meet the general “Ready to use” paradigm. In the process of searching for the described tools for creating virtual educational content, the following digital platforms were considered. The concept of “Ready to use” is based on the formation of such functionality on platforms for the creation of virtual educational material, which does not require special skills or knowledge in the field of programming and site creation (Table 1).

Table 1

Research Nomenclature of Digital Platforms for Creating Virtual Educational Content

Name of the digital platform	Brief description and links
<i>CoSpaces Edu</i>	<i>CoSpaces Edu</i> is a web-based platform for creating interactive virtual environments with augmented reality elements, which is intended for use in education. The resource allows users to create virtual exhibitions that can be interacted with using virtual and augmented reality (https://www.cospaces.io/).
<i>Kunstmatrix</i>	<i>Kunstmatrix</i> is an online platform for creating virtual galleries and art exhibitions. With <i>Kunstmatrix</i> , you can create and publish virtual exhibitions that can include augmented reality elements. In addition, the platform allows users to create interactive exhibition tours and use audio and video materials to enhance the visitor experience (https://www.kunstmatrix.com/en).
<i>Artsteps</i>	<i>Artsteps</i> is a platform for creating virtual exhibitions and galleries using augmented reality. Users can create their own exhibitions, add paintings, photos, videos, and other objects, and place them in a virtual space. In addition, the platform allows users to add sound effects, animation, and other elements to make the exhibition more interactive and engaging for viewers. <i>Artsteps</i> also has the ability to add augmented reality to enhance the experience of exhibition visitors (https://www.artsteps.com/).
<i>vFairs</i>	<i>vFairs</i> is a platform for creating virtual exhibitions and events. It provides the ability to create virtual exhibitions using augmented reality, which allows you to create a more immersive experience for visitors. In addition, the platform provides ample opportunities for interactivity and communication with event participants (https://www.vfairs.com/event-management-platform/virtual-exhibition/).
<i>Curat10n</i>	<i>Curat10n</i> is a platform for creating virtual exhibitions with augmented and virtual reality elements. With this tool, users can create their own exhibitions, add audio and video materials, text descriptions and 3D models that allow visitors to experience the virtual exhibition in the most immersive and convenient way. The platform also offers the possibility of using video conferencing to organise online tours and interact with visitors (https://curat10n.com/).

Source: author's own development.

Given that the above digital platforms are cloud solutions, it is advisable to use the following cloud metrics analysers as tools for analysing the technical and technological capability of these resources (Table 2).

Table 2

Research Nomenclature of Tools for Analysing Digital Platforms for Creating Virtual Educational Content

Tools for analysing digital platforms	Brief description and links
<i>PageSpeed Insights</i>	<i>PageSpeed Insights</i> is a free online tool from Google that analyses the speed and performance of web pages on mobile and desktop devices. It helps you understand how a page loads and what components affect its speed. It provides recommendations on how to optimise web pages and information on speed metrics that affect the user experience and search engine rankings. <i>PageSpeed Insights</i> analyses page load speed based on several metrics,

Tools for analysing digital platforms	Brief description and links
	including <i>Largest Contentful Paint</i> , <i>First Contentful Paint</i> , <i>Time to First Byte</i> , and others (https://pagespeed.web.dev/).
<i>GTmetrix</i>	<i>GTmetrix</i> is a free web service that allows you to measure the speed of website pages and analyse their performance. The service offers a detailed analysis of web page performance using a variety of metrics such as load time, page size, image optimisation, caching, and others. In addition, <i>GTmetrix</i> provides recommendations on how to improve page performance to help reduce page load times and improve performance (https://gtmetrix.com/).
<i>Pingdom Website Speed Test</i>	<i>Pingdom Website Speed Test</i> is an online tool for measuring the loading speed of a web page and getting detailed information about its performance. The tool is used to determine the time it takes to send a request to the server and the time it takes for the server to respond, calculate the time it takes for a web page to load, and analyse the speed of loading individual resources (images, CSS styles, scripts). <i>Pingdom</i> also provides detailed reports on web page load speed, including recommendations for improving performance and reducing load times (https://tools.pingdom.com/).
<i>WebPageTest</i>	<i>WebPageTest</i> is a free tool for testing web page loading speed. This resource allows you to determine the page load time, number of requests, page size, as well as other performance indicators such as <i>Time to First Byte (TTFB)</i> , <i>Speed Index</i> , and <i>Time to Interactive (TTI)</i> . With <i>WebPageTest</i> , you can test from different locations around the world using different browsers and devices. In addition, the resource has the ability to visualise page load, which helps to find and fix problems that affect the performance of web pages (https://www.webpagetest.org/).
<i>DareBoost</i>	<i>DareBoost</i> is an online service for analysing web page loading speed and performance. This resource offers a wide range of tools that allow you to identify problem areas on your website and make recommendations on how to solve them. The service analyses a variety of parameters, including page load time, image size, and other resources, and offers various approaches to optimise them. <i>DareBoost</i> can be used to improve website performance and ensure a high quality user experience (https://www.dareboost.com/en).

Source: author's own development.

Given that the digital platforms that can be used to create virtual educational content are cloud technologies (Table 1), the most appropriate means for the purpose is determined by comparing the relevant technical parameters, the most important of which are shown in Table 3.

Table 3

Characteristics of Analytical Metrics for Determining the Technical and Technological Capacity of Digital Platforms for Creating Virtual Educational Content

Parameter.	Brief description
<i>Largest Contentful Paint (LCP)</i>	<i>Largest Contentful Paint (LCP)</i> is a web performance metric that measures the time it takes for a browser to load and display the largest content on a page, such as an image, video, or block of text. <i>LCP</i> helps determine how quickly users can view important content on a page and whether it is being pushed to the far side of the screen or delayed until later. The less time it takes to load <i>LCP</i> , the better the user experience and the more likely they are to stay on the site.
<i>First Input Delay (FID)</i>	<i>First Input Delay (FID)</i> is a web performance metric that measures how quickly users can interact with a web page. It is determined by the time that

Parameter.	Brief description
	elapses between the first user interaction with the page, such as clicking on a link or button, and the moment when the response from the server is returned with sufficient speed for the user to perceive the response. This allows you to understand how quickly a page responds to user actions and can help reduce wait times on pages with a lot of interactivity. The lower the FID value, the better, as it means that the page responds to user actions quickly and efficiently.
Cumulative Layout Shift (CLS)	<i>Cumulative Layout Shift (CLS)</i> is a metric that reflects the degree of stability of a page's visual layout as it loads. It measures the total change in the layout of a page from the moment it starts to load to the moment it is fully loaded. This parameter is important for users because a large change in layout during page loading can lead to users not being able to find the information they need or perform the desired actions. The ideal <i>CLS value</i> should be less than 0.1. The lower the <i>CLS value</i> , the more stable the visual layout of the page.
First Contentful Paint (FCP)	<i>First Contentful Paint (FCP)</i> is a web performance metric that measures the time it takes for a browser to render the first content on a page. The content can be text, an image, or another element. <i>FCP is reflected</i> in the <i>Core Web Vitals</i> metric, which is important for assessing the user experience of a website. Quickly displaying the first content can have a positive impact on website visitors, reduce bounce rates, and increase engagement.
Interaction to Next Paint (INP)	<i>Interaction to Next Paint (INP)</i> is a metric that measures how quickly a user can interact with the content of a page after it loads. This is measured by the response time to the first active element (such as a button or link) after the page loads. This parameter allows you to evaluate the speed of the page's response to user interaction and determine how quickly a user can start interacting with the page after it loads. The ideal <i>INP</i> speed is considered to be less than 100 ms. The shorter the response time, the better the page meets the needs of users and the higher its ranking in search results.
Time to First Byte (TTFB)	<i>The Time to First Byte (TTFB)</i> parameter indicates the time it takes for the server to respond to a browser request for the first time. This parameter is measured from the moment the request is sent until the first part of the response is received from the server. The lower the TTFB, the faster the browser receives a response from the server. A slow server response can lead to delays in page loading and a poor user experience.
Total Blocking Time (TBT)	<i>TBT (Total Blocking Time)</i> is a website performance metric that measures the time a web page is blocked from responding to user actions. This means that users may be forced to wait for a page to load, which can affect their satisfaction with the site. The lower the <i>TBT</i> value, the less likely it is that users will experience unfair delays and blockages when interacting with the website.
Speed Index (SI)	<i>Speed Index (SI)</i> is a parameter that measures the speed of page loading. It shows how quickly users receive visual content on a page. The lower the value of the parameter, the faster the page will be displayed. Page load speed can affect users, which can affect their interaction with the site, as well as search engine rankings.
GTmetrix Grade	<i>GTmetrix Grade</i> is a performance metric that evaluates the performance of a web page based on testing its loading speed and resource optimisation. The grading is based on a scale of A-F, where A stands for the best performance and F for the worst. The score takes into account various factors such as loading speed, image and script optimisation, caching, code minification, page size, and much more. The higher the <i>GTmetrix Grade score</i> , the faster the page loads and the more efficiently it uses server resources.

Parameter.	Brief description
<i>Total # of Requests</i>	<i>The Total # of Requests</i> parameter indicates the total number of requests that were made during the loading of a website page. These can be requests for resources such as images, CSS styles, JavaScript scripts, fonts, and others. A higher number of requests can lead to a longer page load time, so it is an important factor in measuring website load speed. When measuring website page load speed, the optimal number of requests depends on the type of website and its functionality.

Source: author's own development.

The given metrics make it possible to determine the performance of cloud-based solutions for setting up platforms for creating virtual educational content. Platforms with higher performance will have correspondingly better metrics, indicating the ability to identify the optimal digital medium for creating immersive learning materials from a selected nomenclature of relevant cloud solutions.

The above nomenclature of metrics (Table 3) is not exhaustive; other parameters are also used to determine the technical characteristics of cloud resources, which make it possible to determine the optimal digital platform for creating virtual educational content.

The optimal tool from the nomenclature of available digital platforms, selected on the principle of "Ready to use", has been identified, which will allow teachers to create educational content with elements of VR/AR technologies without additional special training. This has far-reaching results in terms of a well-grounded (based on real-world implementation experience) definition of the future of pedagogy in the general concept of Education 4.0.

The developed methodology is limited by time frames, because over time both the nomenclature of relevant educational cloud platforms and the nomenclature of tools for testing these platforms may change, forming other optimal solutions in the future.

The results of this study allow educators to obtain information about the optimal cloud solution for the development and implementation of the principles of virtual education in educational processes at the time of writing. And the methodology will allow a similar study to be conducted for another set of relevant platforms and testing tools that have the potential to emerge in the future.

Research Results

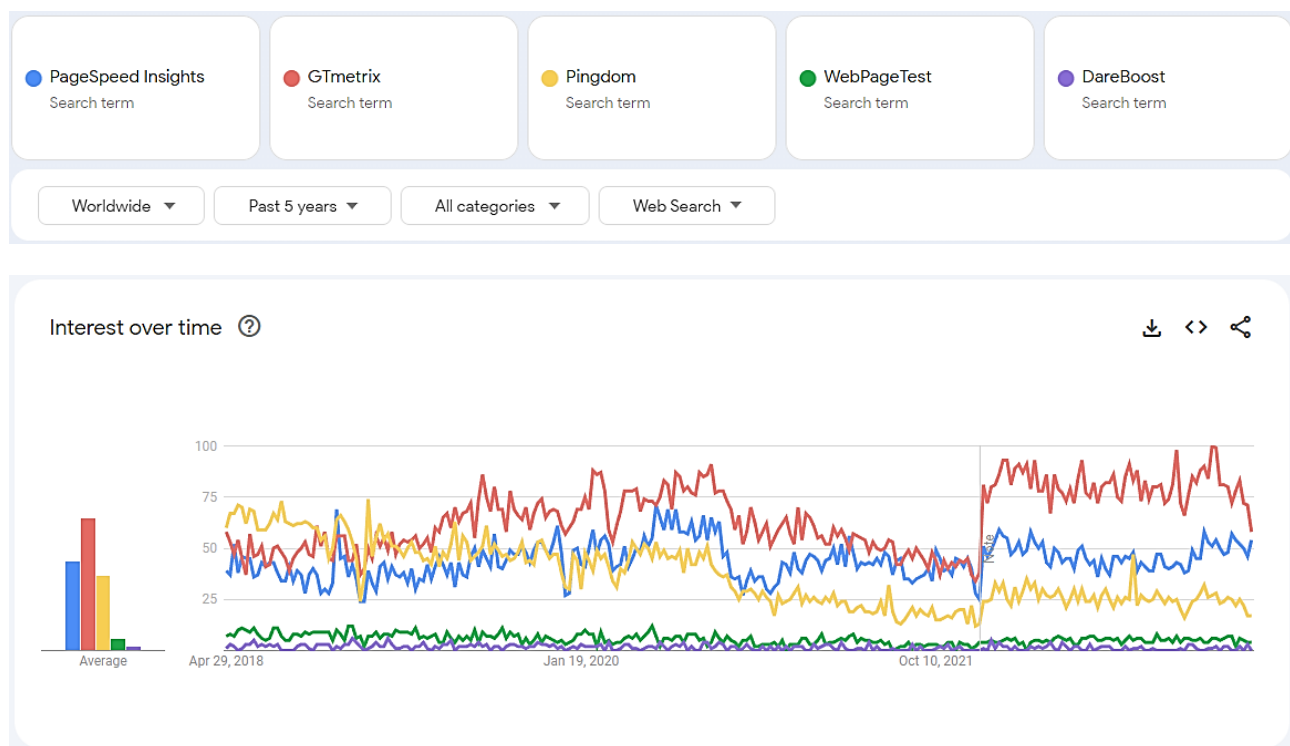
In accordance with the proposed methodology, we define a tool for assessing the technical and technological capabilities of available digital platforms for creating educational content with elements of VR/AR technologies (Table 1), which is adequate to the purpose of the study, and which can be installed among the possible services for material analysis of cloud solutions (Table 2). *Google Trends* (<https://trends.google.com/trends/>) was identified as an arbitration tool, the trendiness parameter of which indicates the frequency of use, and, accordingly, the suitability for use of certain metric monitors (Figure 2).

The use of Google Trends for the selection of tools for testing platforms for the creation of virtual educational content is appropriate in connection with the use of current, broad and relevant databases by the specified resource, regarding the applicability of each of the comprehensive solutions selected in the experimental nomenclature. Applicability is determined by tendency, that is, a more adaptive and stable digital solution is used more actively by the global community. And that's why Google Trends can point to such a tool.

The use of Google Trends to select tools for testing platforms for creating virtual educational content has its limitations. Google Trends provides only general information about the popularity of queries in the Google search engine, and this information may be limited by regional specificities and Google users. It is important to consider that Google Trends does not provide detailed data on specific testing tools and their capabilities. Additionally, the popularity of tools may change over time, and the analysis results may only be relevant for a specific moment. Therefore, for a comprehensive and objective selection of testing tools for platforms for creating virtual educational content, it is necessary to combine data from Google Trends with other sources of information and research.

Figure 2

Identification of an Appropriate Tool for Analysing the Technical and Technological Capabilities of Available Digital Platforms for Creating Virtual Educational Content



Source: created by the author on *Google Trends* (<https://trends.google.com/trends/>).

According to the results of the analysis of the applicability parameter (Figure 2) (based on the trendiness of queries in *Google Trends*), it was found that the leading tools for metric analysis of cloud solutions are Pingdom Website Speed Test, PageSpeed Insights, and GTmetrix. However, the *GTmetrix* monitoring service is the most trendy, so we accept it as the main tool for metric analysis of the range of available digital platforms with the ability to use VR/AR technologies to create educational materials and immersive environments (Table 1).

Parameters such as Largest Contentful Paint (LCP), First Input Delay (FID), Cumulative Layout Shift (CLS), First Contentful Paint (FCP), Interaction to Next Paint (INP), Time to First Byte (TTFB), Total Blocking Time (TBT), Speed Index (SI), GTmetrix Grade, and Total # of Requests (Table 3) play an important role in determining the performance of cloud-based digital platforms for creating virtual educational content. Each of these parameters affects the quality and performance of a digital platform that delivers virtual educational experiences. Largest Contentful Paint (LCP) determines the load time of the largest content on a page. This parameter is important for virtual educational content because it

affects the loading speed and accessibility of the main material. The lower the LCP, the faster the user gets access to important educational content. First Input Delay (FID) measures the delay between the first interaction on a page and the platform's response to that interaction. It is important for users interacting with virtual learning materials, as a short delay helps to improve engagement and usability. Cumulative Layout Shift (CLS) determines the stability of the page layout during loading. It's important for virtual learning platforms because it ensures that content doesn't move around during the learning experience, which can be annoying for users. First Contentful Paint (FCP) indicates the time when the first content becomes visible on the page. This is important for virtual education content because a fast FCP can improve the user experience and reduce wait times. Interaction to Next Paint (INP) shows the delay between user interaction and the next page refresh. This is important for virtual learning materials because a short delay helps to create a comfortable and continuous learning experience. Time to First Byte (TTFB) measures the time it takes for the server to respond to a user request. It is important for the speed of downloading virtual materials. Total Blocking Time (TBT) indicates the time when a user cannot interact with content due to blocking resources. This is important for ensuring continuous learning. Speed Index (SI) measures how quickly a page becomes visible to the user. This is important for improving usability and engagement. GTmetrix Grade and Total # of Requests are also important for the overall performance of a digital platform for creating virtual educational content, as they indicate overall performance and download speed.

Thus, each of these key metrics affects the effectiveness of a cloud-based digital platform for creating virtual educational content, improving the quality and productivity of learning. Therefore, optimising these parameters is an important task for creating a high-quality virtual educational experience.

Using the most trendy tool for analysing the technical and technological capabilities of available digital platforms for creating virtual educational content - *GTmetrix* (Figure 2), we obtained not only the above-described performance metrics of cloud solutions but also additional parameters that allowed us to determine the optimal available means of immersing educational processes - Table 4.

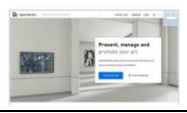
Table 4

Calculation of Metrics of Available Digital Platforms for Immersive Educational Processes

Parameter.	Results of calculating metrics for available cloud solutions				
	 <i>CoSpaces Edu</i>	 <i>Kunstmatrix</i>	 <i>Artsteps</i>	 <i>vFairs</i>	 <i>Curat10n</i>
Key metrics					
GTmetrix Grade	A (96%)	B (87%)	D (65%)	D (69%)	E (58%)
Performance Score	100%	92%-8%	57%-43%	68%-32%	49%-51%
Structure Score	85%	74%-11%	85%	70%-15%	78%-7%
Largest Contentful Paint	559ms	1.4s-887ms	3.5s+2.9s	2.2s-1.6s	3.2s+2.7s
Total Blocking Time	78ms	0ms-78ms	162ms+83ms	178ms+99ms	26ms-52ms
Cumulative Layout Shift	0	0.05-0.05	0.07-0.07	0.08+0.08	0.46+0.46
Total Page Size	5.82MB	2.75MB-308MB	2.81MB-3.02MB	4.65MB-1.17MB	3.88MB-1.94MB
Total # of Requests	100	69-31	57-43	165+65	102+2
Auxiliary metrics of content engagement					

Parameter.	Results of calculating metrics for available cloud solutions				
					
	<i>CoSpaces Edu</i>	<i>Kunstmatrix</i>	<i>Artsteps</i>	<i>vFairs</i>	<i>Curat10n</i>
Cumulative Layout Shift	0.01	0.05	0.24	0.06	0.4
First Contentful Paint	410ms	1.2s	2.7s	1.5s	1.2s
Largest Contentful Paint	628ms	1.6s	3.5s	1.7s	1.5s
Speed Index	1.1s	1.6s	4.1s	2.7s	2.9s
Time to Interactive	595ms	1.6s	3.6s	3.2s	1.5s
Total Blocking Time	0ms	0ms	111ms	131ms	22ms
Redirect Duration	N/A	N/A	N/A	N/A	N/A
Connect Duration	170ms	459ms	327ms	56ms	478ms
Backend Duration	43ms	293ms	160ms	742ms	158ms
Time to First Byte	213ms	752ms	487ms	798ms	636ms
First Paint	410ms	1.2s	1.7s	1.5s	1.2s
DOM Loaded	596ms	1.6s	2.7s	1.8s	1.5s
DOM Interactive	554ms	1.6s	2.7s	1.7s	1.5s
Onload Time	1.0s	3.2s	3.9s	3.2s	1.5s
Fully Loaded Time	3.0s	4.0s	5.1s	13.9s	5.3s
Auxiliary metrics of structure performance					
Allow back/forward cache restoration	(100)	(100)	(100)	(93)	(100)
Avoid an excessive DOM size	(100)	(97)	(89)	(63)	(96)
Avoid chaining critical requests	(100)	(99)	(98)	(99)	(97)
Avoid CSS @import	(100)	(100)	(100)	(100)	(100)
Avoid document.write()	(100)	(100)	(100)	(100)	(100)
Avoid enormous network payloads	(40)	(90)	(91)	(82)	(60)
Avoid large layout shifts	N/A	(100)	(82)	(99)	(72)
Avoid long main-thread tasks	(100)	(100)	(94)	(92)	(100)
Avoid multiple-page redirects	(100)	(100)	(100)	(100)	(100)
Avoid non-composed animations	(100)	(100)	(100)	(100)	(100)
Combine images using CSS sprites	(100)	(100)	(100)	(100)	(100)
Defer offscreen images	(100)	(100)	(100)	(100)	(100)
Don't lazily load Largest Contentful Paint image	(100)	(70)	(100)	(100)	(100)
Efficiently encode images	(100)	(100)	(100)	(100)	(76)

Parameter.	Results of calculating metrics for available cloud solutions				
					
	<i>CoSpaces Edu</i>	<i>Kunstmatrix</i>	<i>Artsteps</i>	<i>vFairs</i>	<i>Curat10n</i>
Eliminate render-blocking resources	N/A	(97)	(67)	(99)	(93)
Enable Keep-Alive	(100)	(100)	(100)	(100)	(100)
Enable text compression	(100)	(84)	(100)	(100)	(100)
Ensure text remains visible during webfont loading	(100)	(98)	(100)	(99)	(100)
Lazy load of third-party resources with facades	(100)	(100)	(100)	(100)	(85)
Minify CSS	(100)	(100)	(100)	(100)	(100)
Minify JavaScript	(100)	(100)	(100)	(100)	(100)
Preconnect to required origins	(100)	(100)	(92)	(100)	(100)
Preload key requests	(100)	(100)	(100)	(100)	(100)
Preload Largest Contentful Paint image	(100)	(100)	(100)	(100)	(100)
Properly size images	(100)	(100)	(100)	(100)	(100)
Reduce initial server response time	N/A	(100)	(100)	(30)	(100)
Reduce JavaScript execution time	(100)	N/A	(94)	(90)	(100)
Reduce unused CSS	(100)	(97)	(99)	(100)	(97)
Reduce unused JavaScript	(100)	(97)	(97)	(99)	(97)
Remove duplicate modules in JavaScript bundles	(100)	(100)	(100)	(100)	(100)
Serve images in next-gen formats	(100)	(100)	(100)	(100)	(96)
Serve static assets with an efficient cache policy	(72)	(77)	(72)	(74)	(94)
Use a <meta name="viewport"> tag with width or initial-scale	(100)	(100)	(100)	(100)	(100)
Use a Content Delivery Network (CDN)	(100)	(75)	(94)	(95)	(76)
Use explicit width and height on image elements	(70)	(70)	(70)	(70)	(100)

Parameter.	Results of calculating metrics for available cloud solutions				
	 <i>CoSpaces Edu</i>	 <i>Kunstmatrix</i>	 <i>Artsteps</i>	 <i>vFairs</i>	 <i>Curat10n</i>
Use HTTP/2 for all resources	(100)	(100)	(100)	(100)	(100)
Use passive listeners to improve scrolling performance	(93)	(100)	(100)	(100)	(100)
Use video formats for animated content	(100)	(100)	(100)	(100)	(100)

Source: created by the authors on the GTmetrix resource (<https://gtmetrix.com/>).

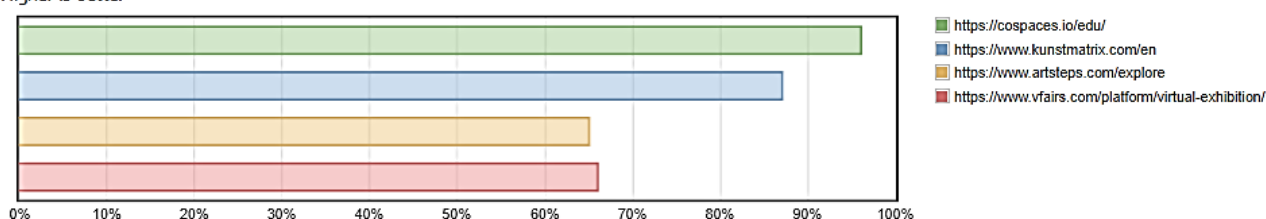
GTmetrix's internal tools allow for a comparative and correlative analysis of the results (Table 4) according to the main metrics for assessing the effectiveness of available digital platforms for creating educational content with elements of virtual and augmented reality (Figure 3).

Figure 3

Determining an Appropriate Tool for Analysing the Technical and Technological Capabilities of Available Digital Platforms for Creating Virtual Educational Content

GTmetrix Grade

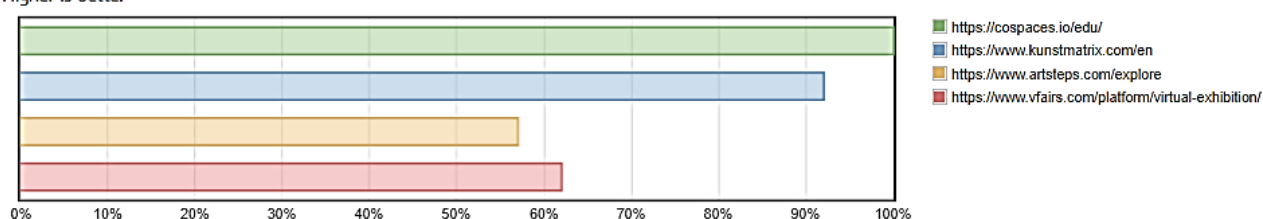
Higher is better



a. GTmetrix Grade: the best - CoSpaces Edu

Performance Scores

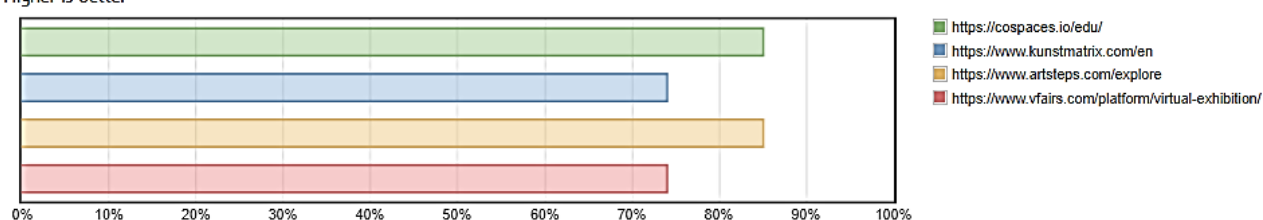
Higher is better



b. Performance Scores: the best - CoSpaces Edu

Structure Scores

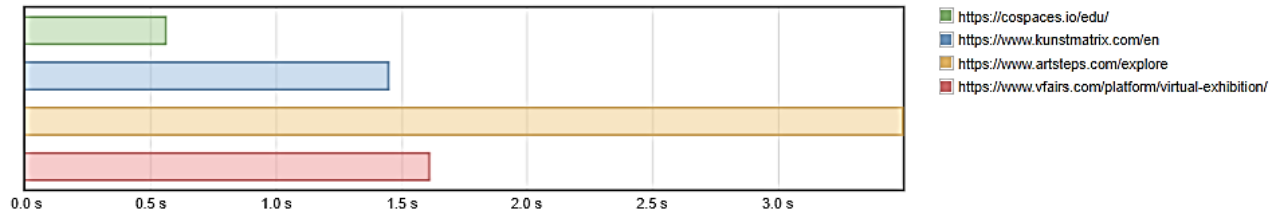
Higher is better



c. Structure Scores: the best - CoSpaces Edu

Largest Contentful Paint

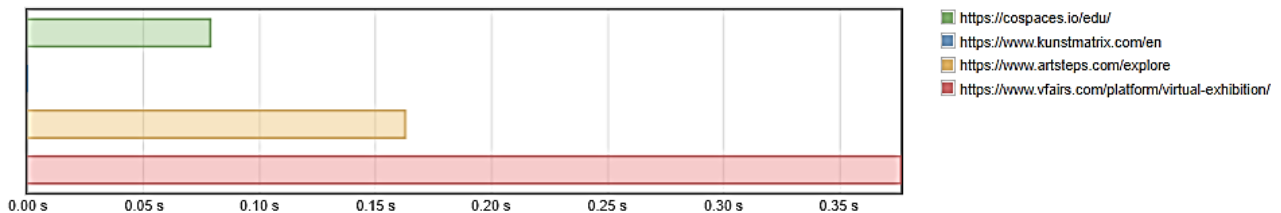
Lower is better



d. Largest Contentful Paint: the best - CoSpaces Edu

Total Blocking Time

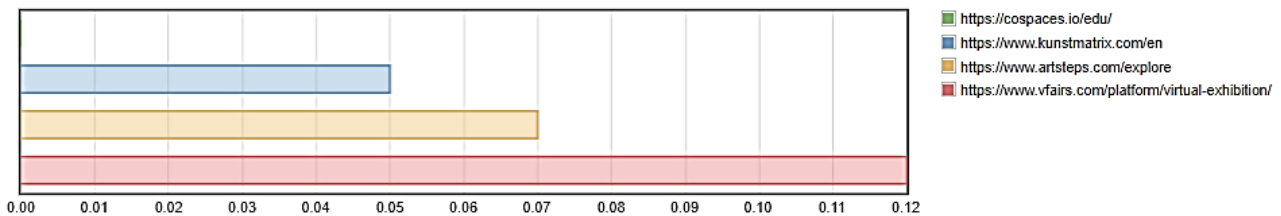
Lower is better



e. Total Blocking Time: the best - CoSpaces Edu

Cumulative Layout Shift

Lower is better



f. Cumulative Layout Shift: the best - CoSpaces Edu

Page Sizes

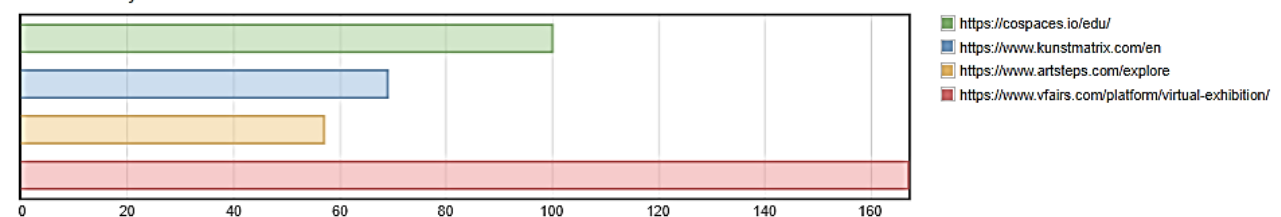
Lower is usually better



g. Page Sizes: the best Kunstmatrix

Request Counts

Lower is usually better



h. Request Counts: the best Artsteps

Source: created by the authors on the *GTmetrix* resource (<https://gtmetrix.com/>).

According to the results of the general metric analysis by *GTmetrix* (Table 4) and comparative and correlative evaluation (Figure 3), the digital platform *CoSpaces Edu* prevails in most of the parameters of cloud solutions' efficiency (inferior to others only in *Page Sizes* and *Request Counts*), which received a *GTmetrix Grade* of A. Other resources that can be used as immersive learning environments include *Kunstmatrix* (which is optimal in terms of *Page Sizes*) and *Artsteps* (which is optimal in terms of *Request Counts*).

The contextual analysis also points to the advantage of *CoSpaces Edu*, as this resource contains a wide range of tools and instruments for creating VR/AR educational content. The introduction of virtual reality and augmented reality into the educational process significantly transforms traditional educational approaches. VR allows creating immersive learning environments where students can interact with virtual objects and scenarios. AR complements the real world with digital elements, providing an opportunity for extended interaction with physical objects. Let's consider the possibilities of immersing the modern educational space that have already been achieved and are available to a wide range of teachers, in particular on the currently optimal CoSpaces Edu resource (Table 5).

Table 5

Pedagogical Characteristics of Educational Processes, Methods and Tools Transformed by Immersive and Virtualisation Technologies

Educational process, method and tool	Brief pedagogical description
Virtual exhibitions	Virtual exhibitions allow students to explore art and cultural heritage in immersive virtual galleries and museums. They can interact with art, look at details and explore art history in realistic environments.
Virtual tours	VR allows you to create virtual journeys to historical and geographical locations that may be out of reach for students. This expands the possibilities of geographical learning and allows you to study historical events at their places of origin.
Guided tours with augmented reality elements	AR adds interactivity to physical tours by expanding students' knowledge through information layers overlaid on the real world during tours.
Dialogues with reconstructed personalities	With VR, students can interact with virtual reconstructions of historical or scientific figures, learning from them about their achievements and contributions to their fields.
Interactive immersive environments	Creating virtual interactive worlds for learning and research. This allows students to explore scientific concepts, historical events, or solve problems in immersive scenarios.
Interactive laboratories and simulations of various professional areas	Virtual laboratories allow students to conduct virtual experiments and research in various fields of science, including physics, chemistry, biology, and others.
Interactive conceptual visualisations of abstract mathematical and natural concepts	VR/AR makes it possible to visualise complex mathematical and scientific concepts, helping students to understand abstract ideas.
Interactive historical and cultural exhibitions	VR allows you to create virtual exhibitions where students can learn about history and cultural heritage through interactive scenarios.
Interactive biological and therapeutic expositions	Virtual expositions in biology and medicine allow students to acquire practical skills, learn about biological processes and treatment methods.

Source: author's own development.

The use of VR/AR technologies expands learning opportunities, making it more interactive, immersive, and interesting for students in various fields of education. The use of the listed and described pedagogical processes, methods, and tools (Table 4) already allows teachers to transform their approach to teaching and improve the quality of education.

The contextual analysis allows us to determine the likely nature of the future development of educational VR/AR technologies, which include a number of promising areas. First of all, it is expected that these technologies will be integrated into the general educational system at the level of educational institutions, which will ensure their accessibility to a wide range of students and facilitate further development. The development of content and curricula involves the creation of new pedagogical methods and virtual learning materials aimed at supporting learning in various fields of knowledge, including STEM. The main trend is the individualisation of learning, which allows for the creation of personalised learning paths for students, taking into account their needs, level of knowledge, and individual learning style.

It also envisages the development of communities and collaboration through the creation of virtual learning environments that allow students and teachers to interact and share learning experiences. The development of applications and platforms for learning in VR/AR environments is an important component of future development, with the aim of facilitating learning and expanding educational opportunities in various fields. The assessment and measurement of student performance in virtual learning environments will evolve in parallel with the development of technologies that take into account the specifics of learning in these environments.

The use of VR/AR technologies is not limited to education and can be used in other fields such as medicine, business, engineering, art, and many others, which will help expand opportunities for education and training in these areas. The increasing availability and decreasing cost of VR/AR equipment is also an important trend that will provide greater access to these technologies for different social groups and reduce barriers to their use in education.

Thus, it has been found that currently available digital platforms and tools (in particular, the optimal *CoSpaces Edu* resource identified in this study) already allow teachers and other stakeholders to transform the content of educational processes, increasing the immersiveness and interactivity of the educational space, which contributes to increasing student interest and improving the quality of learning. The experience of introducing VR/AR technologies into the processes of education and professional training of students will allow us to form a convincing array of data that will determine the fundamental vectors of the future development of pedagogy and global education.

Discussion

Based on the results of this study, the following aspects have been identified for discussion:

- The author notes that the current scientific support for the immersive nature of educational processes contains a small number of practical recommendations for the transformation of learning and pedagogy using VR/AR technologies;
- the hypothesis is formed that the currently available digital platforms for the development of virtual educational content provide an opportunity to transform the approach, tools, and methods to the processes of education and professional training of students;
- the nomenclature of relevant and accessible digital platforms that already allow integrating elements of virtualisation and immersive learning into the educational space is formed and reviewed;
- A system of criteria for assessing the technical and technological capabilities of digital platforms for creating virtual educational content was developed;
- an appropriate metric monitor has been identified, based on the results of a criterion-based assessment, which identifies the optimal digital platform that can already be used by teachers to immerse and improve the quality of education;

- pedagogical scenarios that have undergone a transformation process involving VR/AR technologies and that can already be used by teachers and other stakeholders are considered and characterised, which confirms the hypothesis of the current study;
- based on the results of the contextual analysis, the article reveals probable vectors for the future development of educational VR/AR technologies, and forms a hypothesis for further research based on the use of a reliable data set of experience in implementing immersive and virtualisation tools to adjust and moderate the further development of global education in the general Education 4.0 paradigm.

Alam and Mohanty (2023) emphasise the importance of virtual online laboratory learning in computer science and engineering, especially during the COVID-19 pandemic. The results showed that the Software Engineering Virtual Lab (SE VLab) is more effective than traditional laboratories, which is manifested by an increase in student achievement. Virtual online laboratory learning allows for increased student engagement and facilitates objective assessment of performance, emphasising its significant advantages in software engineering education. The results of Alam and Mohanty (2023) confirm the hypothesis of this study regarding the potential of existing digital platforms for the development of virtual educational content to transform the context of educational processes, but the authors use a limited data set (based on the analysis of one resource), which makes the current study more objective.

The team of authors de Moraes Rossetto et al. (2023) developed their own tool for immersive educational processes, which includes a virtual and augmented reality module. The authors also conducted an empirical test of the effectiveness of the developed pedagogical tool, according to which a significant improvement in academic performance among students was found. The results of the study by de Moraes Rossetto et al. (2023) confirm the findings of the current study but create the false impression that teachers need to have special skills to modernise educational processes using VR/AR technologies. At the same time, this study proves that the use of immersive and virtualisation tools is already available to every teacher without any special skills.

AlGerafi et al. (2023) identify the potential of augmented reality (AR) and virtual reality (VR) in education, focusing on their impact on student motivation, learning outcomes, and the overall learning experience. The authors carefully consider how AR and VR can enhance learning, knowledge retention, and skill development, especially in the context of distance education. AlGerafi et al. (2023) also explores the role of software tools and relevant digital platforms in creating immersive and interactive learning environments, promoting active learning and critical thinking through simulations and interactive experiences. Although the results of the described publication correlate with the findings of the current study, AlGerafi et al. (2023) did not conduct empirical research, and practical recommendations are limited due to the lack of specificity of the studied tools for virtualisation and immersive education.

Ivanova et al. (2023) confirm that the use of virtual and augmented reality technologies in the mechanical engineering education process facilitates and increases the effectiveness of learning by increasing student engagement. The applications reviewed by Ivanova et al. (2023) for learning in 3D environments create interactive opportunities for mastering skills related to the operation of grinding devices for sharpening cutting tools. The authors also confirm that learning in virtual and augmented reality environments is as effective as learning in a real laboratory and contributes to improving the learning experience of students. The results of this publication fully confirm the conclusions and hypotheses of the current study, but are limited to only one educational sector and need to be extended to other educational spaces.

Raja and Priya (2023) confirm that the use of augmented reality (AR) and virtual reality (VR) in the educational process encourages students to actively learn and seek knowledge. The authors note that the introduction of these technologies (in the form of digital platforms and applications) is an effective tool for improving the educational process by creating immersive learning environments with various sensory elements. However, the researchers also point out the existing limitations and challenges of implementing AR and VR in the education sector. Unlike the current study, the described publication is a review and does not contain an empirical component. And although the findings of Raja and Priya (2023) confirm the results of this study, the application of the recommendations formulated by these researchers is limited.

Thus, the analysis of the data set of scientific support for the immersive transformation of global education from the above and similar publications indicates a number of limitations, including a large number of review papers that make a limited contribution to the research vector, narrowly focused conclusions that require scaling and wider verification, and other obstacles. These limitations create obstacles to the perception of relevant scientific information and create an urgent need to develop a general research strategy and practical recommendations that will be available to a wide range of teachers and stakeholders. However, this situation only points to the fact that the field of virtualisation and immersive learning is in a dynamic stage of development and requires further validation of research results, in particular through empirical verification in a real learning environment.

The study has several potential limitations, including selection bias in the choice of digital platforms and potential publication bias if only positive findings were included. The rapidly evolving nature of VR/AR technologies may affect the relevance of the recommendations over time, and resource constraints and pedagogical challenges in adopting these technologies might not be fully addressed. Access and equity issues, privacy concerns, and long-term effects on education are essential considerations. The study might not delve deeply into the user experience, usability, and interdisciplinary collaboration required for successful implementation. Acknowledging these limitations is crucial for a more comprehensive understanding of VR/AR integration in education and the practicality of the provided recommendations.

Conclusions and Implications

The analysis of the results of this study has revealed the following practical aspects. Firstly, it has been determined that there are not enough practical recommendations on the use of VR/AR technologies in the educational process, which creates a lack of information for educators and pedagogical staff. The second important aspect is the confirmation of the hypothesis that modern digital platforms for creating virtual educational content open up opportunities for rethinking learning and pedagogical methods in the educational process. This hypothesis becomes the basis for further research. The third important aspect is the analysis of available digital platforms that allow the integration of immersive elements into the educational environment. This analysis provides information about the potential opportunities and limitations of such platforms.

The study developed a system of criteria for assessing the technical and technological efficiency of digital platforms for creating virtual educational content. This system of criteria can serve as a guideline for choosing the optimal means of creating virtual educational content based on the use of cloud services and resources. An important step is to define a metric monitor that helps determine the optimal digital platform for use in the educational process.

According to the results of testing based on a defined set of metrics and contextual analysis, it was established that currently the optimal cloud solution for the development of virtual educational content is *CoSpaces Edu*.

The study also includes an analysis of pedagogical scenarios that have already been transformed using VR/AR technologies and can be used by teachers and other participants in the educational process. The final stage is to identify possible areas for further development of educational VR/AR technologies based on contextual analysis and experience in implementing these technologies.

The practical significance of this study is that it identified key aspects of the use of VR/AR technologies in the educational process and provided practical recommendations for educators and teachers. The scientific novelty of the study is that it examines the relevant aspects of using digital platforms to create virtual educational content and provides a systematic approach to evaluating their effectiveness.

The results of this study should be implemented by teachers and stakeholders, as the availability of immersive and virtualisation technologies for educational processes has been proven. At the same time, the experience of implementing VR/AR technologies and modernising educational processes is the basis for moderating and adjusting the future development of pedagogy and global education.

Suggestions for Future Research

For future studies, it is important to consider the main prospects for further research on the research problem. First of all, it is recommended to develop and improve pedagogical strategies for the use of VR/AR technologies in the educational process in order to achieve specific educational goals. Researchers can study effective methods and approaches that will help improve learning outcomes and student motivation. The second area for future research is to assess in more detail the impact of VR/AR technologies on students' academic achievements, motivation, and perception of educational material. This will allow for a better understanding of how these technologies can improve the learning process and the learning experience. For the third area of research, it is important to work on creating more accessible tools for creating virtual educational content. This will help teachers and educational institutions to integrate VR/AR technologies into curricula more easily and quickly and make them more accessible to all stakeholders.

Another area for future research involves studying the impact of VR/AR technologies on distance education and online learning. Particular attention should be paid to how these technologies can improve the quality of distance learning. The next area involves researching innovative solutions and opportunities that VR/AR can open up in education, including interactive games, virtual laboratories, and other forms of immersive learning. Another interesting area for future research is to analyse the costs of introducing VR/AR technologies into education and facilitating access to these technologies for various educational institutions. Equally important is the area of studying the psychological impact of VR/AR technologies on student learning, in particular on motivation, interest, and perception of the learning process. The direction of further research is also worthy of attention, which will include studying the impact of VR/AR technologies on the development of students' interpersonal skills, such as cooperation, communication, and teamwork.

Similar studies should be conducted for other aspects of the introduction of VR/AR technologies in educational processes. In particular, a forward-looking area of research is the development of standards and guidelines for the use of VR/AR technologies in education, which will contribute to greater standardisation and quality of education. Another area of research that could be worth exploring is the analysis of the effectiveness of curricula that use VR/AR technologies compared to traditional teaching methods. Another area could include exploring the possibilities of using VR/AR technologies in specialised educational fields, such as medicine, engineering, or the arts. Equally important is the area

that involves exploring opportunities for cooperation between educational institutions and technology companies to further develop and integrate VR/AR technologies into the educational process.

The impact of virtualisation and immersion of the educational space on the psycho-emotional state of students should also be studied in detail. In particular, a basic research area that may include the study of ethical issues related to the use of VR/AR technologies in education, including student privacy and security. Another important area is the study of the possibilities of integrating VR/AR technologies with other innovative pedagogical approaches, such as gamification or artificial intelligence. The emphasis is on the area of research on the impact of VR/AR technologies on the development of critical thinking and problem-solving. The research area that may include an analysis of the impact of VR/AR technologies on the psychomotor development of students and their skills in solving practical problems is extremely important.

Future research in these areas will contribute to the further development of VR/AR technologies in education and help create more innovative and effective learning environments. In general, future research in the field of VR/AR technologies in education is important for the further development of modern education and the improvement of students' learning opportunities. Future research in the field of VR/AR technologies in education should be aimed at a deeper and more comprehensive understanding of the impact of these technologies on student learning and development, as well as the development of effective pedagogical approaches for their implementation in the educational process.

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DOI: <https://doi.org/10.57125/FED.2023.12.25.07>

How to cite: Musah, E. (2023). Social Spousal Abuse and Emotional Homeostatic Disequilibrium (EHD) Amid Married Secondary Schools Teachers in Rivers State of Nigeria. *Futurity Education*. 3(4). 118-131. <https://doi.org/10.57125/FED.2023.12.25.07>

Social Spousal Abuse and Emotional Homeostatic Disequilibrium (EHD) Amid Married Secondary Schools Teachers in Rivers State of Nigeria

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Received: September 1, 2023 | **Accepted:** October 26, 2023 | **Available online:** November 8, 2023

Abstract: This study aimed to demonstrate the relationship between social spousal abuse and emotional homeostatic disequilibrium (EHD) among married secondary school teachers in Rivers State of Nigeria. The goals of the study were to enlighten the reader about the EHD phenomenon, to find out the relationship between social spousal abuse and EHD as well as to seek for ways to curb it in marriages. The investigation adopted the ex post facto correlation design and also considered the possible moderating influence of gender on the relationship between social spousal abuse and EHD among the subjects of the study. The population comprised all married teachers in secondary schools across Rivers State of Nigeria, about 8,499 out of which 766 (11%) were selected through stratified random sampling technique for the study. Two instruments namely, the Social Spousal Abuse Scale (SSAS) with five items and Emotional Homeostatic Disequilibrium Scale (EHDS) with 15 items were developed by the researcher for collection of data on social spousal abuse behaviours and EHD indicators. Reliability coefficients of $\alpha = .68$ and $\alpha = .99$ for SSAS and EHDS respectively were achieved through Cronbach Alpha. The study was guided by two each of research questions and null hypotheses. The research questions were answered using mean and standard deviation while the null hypotheses were tested with correlation and regression statistics at 0.05 significance level. The statistical package for Social Sciences (SPSS) version 23 was used for data analysis. The results showed that social spousal abuse was significantly related to EHD and that gender was not found to significantly moderate the relationship of social spousal abuse with EHD among subjects of the study. Implications of the study were highlighted among which is that persons in the helping professions should work jointly in order to eliminate EHD

in marriages among married secondary school teachers in Rivers State of Nigeria. Suggestions for further studies were equally made. One of them was that this particular study should be replicated on the same population or another with a larger sample size for greater generalisation.

Keywords: Disequilibrium, Emotion, Gender, Homeostasis, Secondary School, Social Spousal Abuse, Teachers.

Introduction

The phenomenon called emotional homeostatic disequilibrium (EHD) refers to a condition in which a person has lost the ability to proportionately maintain their emotional experiences and expressions in order to be in harmony with self and others around them. In such a situation, the individual finds it difficult to achieve the life goals and aspirations. It is about a person's state of emotional imbalance whereby the individual can no longer maintain a state of emotional well-being and soundness of heart and body (Malik et al., 2021). They further stated that it is a condition in which unpleasant experiences of the individual generate negative emotional attitudes in them that adversely affect their normal everyday functioning. EHD also weakens a person's immune system and makes them vulnerable to contagious emotional viruses and disease invasions.

If an individual experience emotional homeostatic disequilibrium (EHD), they express negative emotions like fear, anger or disgust that throws their brain and body out of balance. When this happens, such a person may no longer be able to adequately utilise the everyday life competencies such as perception, appraisal and precise expression of emotions; access and evoke emotional stimuli when they facilitate cognition; comprehension of emotional messages and use them for emotional information and regulate their own emotions for personal growth and well-being (Malik et al., 2021). The adverse effects of EHD on individuals are quite disheartening, so much that persons who are victims of it exhibit behaviours that suggest mental instability. In other words, such persons behave in maladaptive ways.

However, quite unfortunately, the EHD phenomenon has infiltrated the marriage institution in Nigeria and caused colossal damages in many marriages. Victims of EHD do not have control of their behaviours, hence most of their behavioural reactions are unconsciously expressed and not intentional. Some spouses have inadvertently violated societal laws and got punished in accordance with extant laws of their societies like imprisonment and committal to death. Wessells and Kostelny (2022) opine that spouses under the grip of EHD seldom consider repercussions of their actions. According to them, their rational minds, at this stage, are overwhelmed by their emotional minds. A number of spouses who are under the influence of EHD destroy property, or even murder fellow human beings in extreme cases when they divert attention to things in their environment. There are also those under the EHD influence who do not direct their maladaptive behaviours towards people and things in their environment but on self. These are they who are often depressed, overly afraid and in serious cases, commit suicide.

In marital relationships, social spousal abuse may be a factor responsible for the occurrence of EHD symptoms or behaviours among partners. Social spousal abuse involves isolating the victim from their social networks and support either through disallowing them from relating with friends or family or through oral or physical attacks on them either in public or before others. It may also involve criticising or being suspicious of victim's family and friends, controlling their use of mobiles, phones and internet, and use of the family car, deliberately physically isolating victim in their home or making them

to move away from family and friends, and demanding to know where they are and who they are with at all times. This form of spousal abuse is most effective when an audience is present. It involves misbehaviours like disgracing victim in public, menacing and frightening as well as calumny. Equally, it involves offensive jokes, always barracking or uncomplimentary teasing, and pricking, holding, caressing or other kinds of unsavoury acts that victim has asked their partner to refrain from in public. Social spousal abuse may also include any behaviour designed to upset victim in front of others. The disclosure of confidential information or embarrassing events to co-workers and friends is also a socially abusive behaviour. Gossiping, spreading rumours, and playing mind games are effective means of controlling victim (Abuse Warrior, n. d.; National Domestic and Family Violence Bench Book, 2023).

It is often difficult to detect the socially abusive behaviour. It can be quite subtle and is always denied by the abuser. The abuser masterfully spreads their web of destruction, leaving the victim without recourse unless they want to enter the fray of gossip. When victim eventually leaves the abuser, they must make a fresh start with new friends who are not under the abuser's control. Only then can they be accepted for who they are and be free from the image their abuser had created of them. Social spousal abuse is the most nebulous form of abuse. Defining it is not easy and so may be possibly disregarded except if every incident of abuse is looked into, not separately but in sum (Park & Jeon, 2022). Studies have revealed quite a number of consequences of social spousal abuse. For example, PairedLife (2023) opined that social spousal abuse causes intense emotional, mental and physical damage to the victim. This opinion of PairedLife (2023), according to Tonsing et al. (2021) can be explained from the context of stress. The stress can be thought of as any event that strains or exceeds an individual's ability to cope (Sanchez & Estevez, 2022). The stress is described in The Oxford dictionary of psychology as any mental and physical pressure or anxiety that is created through physical, social, emotional, occupational or economic situations, happenings or experiences that are difficult to manage or endure. Sometimes, the stress is also used to refer to circumstances that threaten or put pressure on people, while pressure describes the stress that arises from threats of negative events (Sanchez & Estevez, 2022). From these definitions, it is noteworthy that social spousal abuse behaviours are socially and emotionally stressful.

A diversity of causes creates stress in people's lives. Frustrations over not being able to satisfy a motive, conflicts arising from mutually incompatible motives, pressures within a marital relationship and unpleasant environmental conditions are all sources of stress. Spencer et al. (2022) explained that "being frustrated in an unhappy relationship produces stress". Some unhappy marriages are sources of pressure because one spouse always seems to displease the other no matter how hard he/she tries to avoid it. The pressure of trying to avoid these negative events can sometimes be more stressful than the negative events themselves.

Married persons react to stress in both psychological and physical ways. Psychological reactions to stress often translate to symptoms of EHD. Under stress, people feel anxious, depressed and irritable (Bhandari, 2023) as well as psychosomatic symptoms such as headache and difficulty in sleeping. Cognitive change occurs as well: spouses have difficulty concentrating, lose their ability to think clearly, and find their thoughts keep returning to the source of stress. It may be interesting to understand that all these are symptoms of EHD. In simple terms, therefore, it means that social spousal abuse behaviours are sources of stress or that they are stressful experiences for the victim. Moreover, the consequences of such stressful experiences may be EHD symptoms like depression, anxiety, sleeping difficulties, irritability and cognitive or mental problems for the individual. According to Sanchez and Estevez (2022)s, when spouses experience considerable amount of stress in their lives, it can lead to depression.

It has been discovered by scholars that marital partners who are overwhelmed by two acute stressors of life are four times more susceptible to mental health eventualities compared to those who had to cope with only one chronic stressor (Seay et al., 2023). Other scholars, Mascolo and Fawbush (2023) opined that the effects of social abuse in an intimate relationship are nearly the same as those of physical abuse on the victim. They further listed psychological stress, loss of motivation, guilt, shame, withdrawal, lowered self-esteem and self-confidence as some of the consequences of social abuse. In addition, Park and Jeon (2022) also discovered in their study that a remarkable percent of women in depression had been socially abused as an adult in a spousal relationship. And that, women in depression were significantly more inclined to have been severely socially abused compared to those not in depression after making adjustments for other considerable socio-demographic variables.

A study conducted by Radell et al. (2021) to examine if social abuse acts as an extra threat to teenage psychopathology when other known significant threats have been controlled for. The authors recruited 100 adolescent volunteers aged 12-18 years directly from 13 high schools. The socially abused adolescents were compared with 100 non-abused adolescents matched for age, gender and race. Identification interrogations as well as assessment of chosen threats to psychopathology were given to the teenagers and their parents, after which multiple regressions were used to test the individual risk introduced by social abuse. The results revealed that social abuse added considerably to other threats in explaining the identification of major depression, dysthymia, conduct disorder, substance and cigarette smoking. This result tends to justify the fact that social abuse creates psychological stress in a victim, which in turn leads them to show EHD symptoms.

In reviewing literature on the prevalence of psychological disorders among women with a history of social abuse in intimate relationships, Chatterji and Heise (2021) revealed a weighted mean prevalence of psychological disorders among them to be 49.3% in 17 studies of depression, 18.6% in 12 studies of low self-esteem and 62.9% in 10 studies of social withdrawal. According to them, weighted mean odd ratios representing associations of these problems with social abuse ranged from 3.55 to 5.62 and were characteristically concordant among studies. Differences in sampling scopes may be the explanation for variability. Dose-response relationships of social abuse to depression and social withdrawal were observed. They also stated that, although, research has not addressed many criteria for causal inferences, the existing research is consistent with the hypothesis that social abuse increases risk for psychological problems. This result is in line with that of Radell et al. (2021).

The gender is also considered in this study. The term "gender", according to Chiniara (2023), non-technically is a synonym for sex. More specifically, especially in feminist psychology, the behavioural, social and cultural attributes associated with sex. Most times, misunderstandings arise from confusing sex with gender. Our biological sex dictates our gender: the characteristics by which people are identified as male or female (Carlton et al., 2020). The sex refers to whether one is biologically male or female and determined at the moment of conception by the type of sperm that fertilises the egg. For instance, a 'Y' sperm produces a male offspring and an 'X' sperm, a female child. Sex differences are therefore biologically based. Examples include differences in the reproductive systems and genitals of males and females or differences in the average height and body proportions of each sex (World Health Organization, n. d.).

In contrast, the gender is socially determined. It is the societal meaning assigned to male and female. The gender is socially defined and enshrined in the social setting and procedure by an organization of limits that assist to assign what is proper or improper for every gender and by self-concepts, values, principles, beliefs and consequences for behaviour (World Health Organization, n. d.). Rather than describing gender as an individual property based on biology, the gender ideologists focus

on how people in their interactions with others come to perceive each other and each other's behaviour as gender appropriate or inappropriate (Canadian Institute of Health Research, 2023). In their opinion, Canadian Institute of Health Research (2023) referred to gender as the distinctions a culture makes in what it considers masculine or feminine. Gender differences, according to them, are socially determined. For example, our culture expects boys to be assertive and noisy, and girls to be helpful and understanding. One is born either male or female, but socialised to be masculine or feminine.

It has been speculated that there are gender differences in emotional expression. However, the research is mixed regarding emotional expression between the two genders. Powerful study results have shown that differences exist in the manner males and females recognize, treat and display emotions. Other research findings reveal that both male and females have more similar emotionality than dissimilarities. Peraica et al. (2023) stated that current study results have revealed significant methods by which both males and females respond to emotional stimuli and understand other people's emotions. They further enumerated their findings as follows: (a) A global study of 55 cultures found that women tend to be more emotional, agreeable, extroverted and conscientious compared to men. (b) Females interpret other person's emotional responses better than men do, in spite of whether or not they obtained such emotional signals orally or by sight. (c) Females indicated experiencing love and anger a little deeper than males did in a different investigation of gender differences in emotional reaction. These women also smiled more when recalling memories of happiness or love. (d) Men and women respond to stress in different ways. Females exhibit more sadness or anxiety compared to males, whereas males display an elevation in their blood pressure and more inclined toward alcohol consumption. (e) Females have greater proclivity for experiencing disgust compared to males when faced with a stimulus that can elicit an emotional response.

It is on this bases that Peraica et al. (2023) asked, 'so are there apparent sex differences in emotion, and how big are those differences (using the d statistics where small differences are $+0.20$, moderate differences $+0.50$, and large differences $+0.80$ and above)?' Probably, the most compelling evidence of gender differences in emotion exists in the domain of unpleasant emotions (Carlton et al., 2020; Spencer et al., 2022).

In another development, Chatterji and Heise (2021) studied sex dissimilarities in experiences and expressivity of emotions. The heart rate (HR) was measured as an index of emotional experience while subjects were made to view 16 video scenes that incite eight kinds of emotions (horror, disgust, sadness, neutrality, anger, amusement, pleasure, surprise). The results indicated that while viewing videos that instigate an emotional reaction, males frequently showed deeper emotional experiences whereas the females displayed greater emotional expression, especially unpleasant emotions. Additionally, it was observed that gender differences were dependent on specific kinds of emotion and not the valence. Ahmadabadi et al. (2021) also undertook a research that compared a meta-analytic survey of gender differences plus moderators of differences in emotional expression at infancy through adolescence. The results revealed a very minor, although significant gender differences altogether, with girls exhibiting more pleasant emotions and internalising emotions (e.g., sadness, anxiety, sympathy) than boys, and boys showing more externalising emotions (e.g., anger) than girls. Prominently, age, interpersonal context and task valence moderated gender differences, promoting the relevance of contextual issues in sex differences. Sex differences in pleasant emotions were greatly displayed with appreciation in age, with girls exhibiting greater pleasant emotions compared to boys in middle childhood and adolescence. Contrarily, boys displayed higher externalising emotions than did girls at toddler/preschool age and middle childhood and lesser externalizing emotions compared to girls in adolescence. Malik et al. (2021) also conducted a study of gender differences in reaction to pleasant an unpleasant slide. They realized that females responded highly negatively to negative slides (e.g., dismembered bodies, physical attacks

and distress or dead animals), a gender difference which was consistent in size from ages 20-81. Givon et al. (2023) also discovered in a similar study that women responded with greater sadness to sad films than did men, and women reacted with more fear-disgust to fearfully-disgusting films than men did. In contrast, men reacted with greater happiness to happy films. Also, in another study by Yang (2022), it was found that women tended to report more negative emotionality than men.

Many of these studies are not comprehensively reviewed due to the lack of space and/or to align with the requirements of the journal. Moreover, it may interest the reader to understand that nearly all studies cited in this work were conducted outside Nigeria, which means that there is a gross lack of literature in this part of the world on this problem. It is therefore within this context of lack of literature that this study becomes imperative to contribute, at least in part, to existing knowledge.

Theoretical Framework

This research work is hinged on James-Lange's feedback theory. It is a theory that was propounded by an American psychologist, William James and a Danish psychologist, Carl Lange when they examined the nature of emotions. They maintained that the important factor in our felt emotions is the feedback from bodily changes that occur in response to an environmental stimulus. James-Lange's theory holds that the emotional stimulus that we feel is routed (by the sensory relay centre known as the thalamus) directly to the limbic system, which produces the body reactions of fear through the hypothalamus and sympathetic division of the autonomic nervous system. In other words, the feedback (repercussion) to the brain from bodily responses produces the conscious experiences of emotion that people feel. The theory seems to put the cart before the horse. "You were afraid because you escaped". The bodily activity (escape) started the emotion of fear, which means that emotional experience comes after bodily reaction to a stimulus. This may seem meaningless to many because our common sense would rather make us believe that it should be the other way around. However, certain situations in life lend credence to James-Lange's theory. For instance, if we are suddenly confronted by a dangerous animal such as a lion, our first reaction will be to run away from the charging lion and thereafter, certain emotional reactions such as increase in heartbeat, rapid breathing, feelings of weakness and so on, will follow. These reactions, which could be viewed as expression of fear, came as a result of physiological arousal that was caused by running (Nickerson, 2023).

According to this theory, different physiological states correspond with different types of emotion. It is therefore believed that a spouse's emotions and feelings constitute the consequences of their emotional behaviour. Hence, spouses do not cry because they feel sad, but that they feel sad because they cry, and also, they feel happy because they smile, and not that they smile because they are happy (Cherry, 2022). In relation to this study, James-Lange's feedback theory therefore holds that spouses feel EHD because they acted, and not that they acted because they feel EHD.

Statement of the Problem

Many marriages in this country, especially among the people of Rivers State, are facing a lot of challenges, amongst which the EHD phenomenon appears to be the most troublesome. It has caused many marriage dissolutions, death of spouses and several other consequences. Social spousal abuse is presumed to instigate EHD in marriages. That is why, the problem that this study seeks to find answer to is: Does social spousal abuse relate with emotional homeostatic disequilibrium amid secondary school teachers who are married in Rivers State, Nigeria?

Research Focus

This study focused on finding proofs about the correlation that exists between social spousal abuse and the phenomenon of EHD amid secondary school teachers who are married in Rivers State, Nigeria.

Research Aim

The aim of this research was to ascertain if a relationship may exist between social spousal abuse and the phenomenon of emotional homeostatic disequilibrium (EHD) amid secondary school teachers who were married in Rivers State of Nigeria, with a view to educate the public about the EHD phenomenon and make necessary recommendations for the betterment of society. In spite of the devastating effects of EHD on individuals, especially spouses, there is serious lack of literature about it in this part of the world. This study was therefore intended to, at least in part, fill that gap.

Research Questions

The following research questions were raised for the study:

1. What relationship exists between social spousal abuse and EHD among married teachers of secondary schools in Rivers State, Nigeria?
2. What is the influence of gender in moderating the relationship of social spousal abuse with EHD among married secondary school teachers in Rivers State, Nigeria?

Hypotheses

H₀₁: A significant relationship does not exist between social spousal abuse and EHD among married teachers of secondary schools in Rivers State, Nigeria.

H₀₂: The gender does not significantly moderate the relationship between social spousal abuse and EHD among married teachers of secondary schools in Rivers State, Nigeria.

Research Methodology

General Background

This study adopted an ex post facto correlation design. In this design, a researcher studies real-life situation where the subjects have experienced what the researcher wanted to investigate. It involved the collection and analysis of data about some variable retrospectively in order to find how any or some of them influence or are related to other variables (Saleh & Kowalczyk, 2022; Tippins, 2023). The population of the research comprised all married teachers of secondary schools in Rivers State, Nigeria, which is 8,499 (4,752 females and 3,747 males).

This investigation into the relationship between social spousal abuse and EHD among married secondary school teachers in Rivers State, Nigeria was imperative in the sense that the EHD phenomenon has caused so many problems in marriages, especially among married couples who were teachers in Rivers State secondary schools.

Sample

Out of 8,499 that was the population, a sample size of 766 (11%) in line with Kabuacha (2021), Nishat (2021), and Australian Bureau of Statistics (2023) who stated that if the population runs in few thousands that 10% of the population should be used as sample size) (324 males and 442 females in 35 secondary schools across the State) was chosen by stratified random sampling procedure on the basis

of senatorial district, LGA, sex and number of schools. The subjects of this study willingly accepted to participate in this investigation.

Instruments and Procedures

A 5-item Social Spousal Abuse Scale (SSAS) and a 15-item Emotional Homeostatic Disequilibrium Scale (EHDS) were constructed by the scholar for data collection. The validation of SSAS and EHDS were done by specialists in Measurement and Evaluation. Reliability coefficients of $\alpha = .68$ and $\alpha = .99$ for SSAS and EHDS respectively achieved by means of Cronbach Alpha. The instruments for data collection were administered on the subjects personally by the researcher and retrieved from the respondents immediately they had attended to the instruments with the help of two research assistants.

Data Analysis

All research questions were answered using mean and standard deviation while correlation and regression statistics was utilised to test the hypotheses at significance level of 0.05. SPSS version 23 was employed for the data analysis.

Research Results

Research question 1: What relationship exists between social spousal abuse and EHD among married teachers of secondary schools in Rivers State, Nigeria?

Table 1

Correlation Analysis of Relationship between Social Spousal Abuse and EHD among Married Teachers of Secondary Schools in Rivers State, Nigeria

N	Mean	SD	r	r²	r²_{adj}
766	32.96	5.91	.58	.34	.34

Note. Independent variable: Social spousal abuse; Dependent variable: Emotional homeostatic disequilibrium.

Table 1 indicates a correlation coefficient of the correlation between social spousal abuse and EHD amid married teachers of secondary schools in Rivers State, Nigeria as .58. This provides an answer to research question one. It means that a certain correlation exists between social spousal abuse and EHD amid married secondary school teachers in Rivers State of Nigeria.

Hypothesis 1: A significant relationship does not exist between social spousal abuse and EHD among married teachers of secondary schools in Rivers State, Nigeria.

Table 2

Regression Analysis of the Relationship between Social Spousal Abuse and EHD among Married Teachers of Secondary Schools in Rivers State, Nigeria

Source	SS	Df	MS	F	B	β	SE	T	P
Regression	9097.218	1	2274.306	98.01	.16	.10	.09	1.86	.06
Residual	17658.36	760	23.204						
Total	26755.58	761							

Note. $P \leq 0.05$ Significance level; $N = 766$.

Table 2 shows the calculated $F = 98.01$; $P \leq 0.05$ significance level. The meaning of this is that, a relationship that is significant exists between social spousal abuse and EHD among married teachers of secondary schools in Rivers State, Nigeria. The beta weight as seen in the table shows that social spousal abuse significantly contributes to EHD among teachers of secondary schools in Rivers State, Nigeria.

Research question 2: What is the influence of gender in moderating the relationship of social spousal abuse and EHD among married teachers of secondary schools in Rivers State, Nigeria?

Table 3

Correlation Analysis of the moderating influence of gender in the relationship of social spousal abuse and EHD among married teachers of secondary schools in Rivers State, Nigeria

N	Variables	Mean	SD	r	r ²	r ^{adjd}
766	Gender	1.62	49	.49	.24	.23
	Social spousal abuse	10.66	3.84			
	EHD	32.96	5.91			

Note. Moderating variable: Gender; Independent variable: Social spousal abuse; Dependent variable: EHD.

The result in table 3 reveals that there is a positive correlation between gender, social spousal abuse and EHD among married teachers of secondary schools in Rivers State, Nigeria ($r = .49$). It therefore shows that research question one is answered in the affirmative. In other words, gender has a moderating influence on the correlation of social spousal abuse with EHD among married teachers of secondary schools in Rivers State, Nigeria.

Hypothesis 2: The gender does not significantly moderate the relationship of social spousal abuse with EHD among married teachers of secondary schools in Rivers State, Nigeria.

Table 4

Regression Analysis of the influence of gender in moderating the relationship of social spousal abuse with EHD among married teachers of secondary schools in Rivers State, Nigeria

Source	SS	Df	MS	F	B	β	SE	T	P
Regression	5814.456	2	1453.614	52.824					.000
Residual	20941.12	761	27.518						
Total	26755.58	76							
Gender					.37	.03	.40	.92	.36
Social spousal abuse					.69	.45	.05	13.93	.00

Note. $P \leq 0.05$ Significance level; $N = 766$.

The correlation model in table 4 shows that the gender does not have a significant moderating impact on the relationship between social spousal abuse and EHD amid married teachers of secondary

schools in Rivers State, Nigeria. This makes the hypothesis as accepted and holds true. The calculated $F = 52.824$; $P \leq 0.05$ significance level. Therefore, gender does not significantly moderate the relationship between social spousal abuse and EHD among married teachers of secondary schools in Rivers State, Nigeria. However, the beta weights of gender ($\beta = .03$) and social spousal abuse ($\beta = .45$) indicate an interaction of gender with social spousal abuse, and this interaction influences EHD among the subjects of the study.

Discussion

Regarding the relationship between social spousal abuse and EHD among the subjects of this study, the result of this investigation revealed the existence of a certain correlation between social spousal abuse and EHD amid married secondary school teachers in Rivers State of Nigeria. In other words, social spousal abuse is significantly related to EHD among the subjects of this study, as indicated in table 2 in which the calculated $F = 98.01$; $P \leq 0.05$ significance level. This discovery suggests that when a spouse is socially abused by their partner, there is a tendency for the abuse victim to experience and/or exhibit symptoms of EHD (Mascolo & Fawbush, 2023). The outcome of this present study confirms the one by Radell et al. (2021) which revealed that social spousal abuse accounts for major depression in victims. Chatterji and Heise (2021) also found out that social spousal abuse was significantly related to depression and social withdrawal. This result is similar to these other ones probably because the consequences of social spousal abuse are the same all over the world.

About the influence of gender in moderating the relationship of social spousal abuse with EHD among the subjects of the study, the result showed no remarkable moderating influence that the gender exerts on the relationship between social spousal abuse and EHD among married teachers of secondary schools in Rivers State, Nigeria. It can be seen in table 4 whereby the calculated $F = 52.824$; $P \leq 0.05$ significance level. This result may be explained from the context of socialization effects. Marriage promotes behaviours that tend to portray decency, maturity and responsibility for both men and women. As such, married persons are not expected to dress indecently but to comport themselves as mature and responsible adults in public or when relating with people within and outside the family circle. Moreover, these behavioural traits of married people are not restricted to a particular race or ethnic group but are globally acknowledged (Gambari, 2023).

This result disagrees with that of Peraica et al (2021) in which it was discovered that women constituted majority of spousal abuse victims. It is also in contrast with Yang (2022) who revealed that women tend to report more negative emotionality than men. Also, in contrast with this result, Park and Jeon (2022) equally discovered that women in depression may have remarkably been exposed to larger doses of social maltreatment in an adult intimate relationship. From the foregoing, this researcher thinks that an aspect of this problem that still needs to be investigated is whether location and socio-economic status play significant roles in the occurrence of EHD in marriages.

Limitations of the Study

This study is limited in terms of generalisation of its results to other contexts or population for the under listed reasons:

1. Rivers State is only one State in Nigeria out of 36 States and the FCT. Its population is not even up to 10 percent of the entire Nigerian population. Besides, it is only a selected number of secondary school teachers that constituted the study participants.
2. This study was conducted with only married secondary school teachers in Rivers State. Therefore, its results can equally not be generalised to married persons in other professions or

economic endeavours. plus, persons in other climes. The implication of this that researchers should replicate this study in other settings with consideration for subject's socio-economic status and see if the results would vary.

Conclusions and Implications

Following the results of this study, these conclusions are made:

- There is a remarkable correlation between social spousal abuse and emotional homeostatic disequilibrium amid secondary school teachers in marital relationship in Rivers State, Nigeria.
- No remarkable moderating influence that the gender exerts on the relationship between social spousal abuse and EHD among married teachers of secondary schools in Rivers State, Nigeria.

The results of this study reveal that social spousal abuse victims are likely to be more vulnerable to EHD symptoms than non-victims and that no particular gender suffers more social spousal abuse than the other. This means that men as well as women could suffer social spousal abuse in marital relationships. The implications of this study therefore are that:

- Persons in the helping professions like counsellors, psychologists, social workers, psychiatrists and even the clergy should work concertedly towards curbing the EHD phenomenon among the subjects of this study.
- Married teachers of secondary schools in Rivers State, Nigeria should understand the adverse effects of social spousal abuse and adopt better ways of settling their marital issues.
- Married secondary school teachers should endeavour to access marital counselling whenever there is a need to do so.

Suggestions for Future Research

This study investigated social spousal abuse and emotional homeostatic disequilibrium (EHD) among married secondary school teachers in Rivers State of Nigeria. It also considered the moderating influence of gender in the relationship between social spousal abuse and emotional homeostatic disequilibrium (EHD) among married secondary school teachers in Rivers State of Nigeria. Based on the foregoing, the following topics have been suggested for further research studies:

1. Relationship between emotional homeostatic disequilibrium (EHD) and academic performance of students. A study on this topic seems quite apt at this time of our nationhood. The country is passing through very difficult times, being faced with a myriad of problems in nearly every aspect such as insecurity, inflation, food scarcity, high cost of education, and many others. A lot of EHD cases of individuals may be attributed to the impact of one or a combination of these national problems on the individual. On the part of the student, when such a problem becomes unbearable, they may likely develop EHD symptoms that might interfere with their academic performance. It is on this premise that this author suggests an investigation that will ascertain whether or not emotional homeostatic disequilibrium (EHD) could have a relationship with students' academic performance.
2. Relationship between socio-economic status or location and EHD among the subjects of this study or any other population. Since emotional homeostatic disequilibrium is a psycho-emotional disease with the potential to destroy an individual's immune system and lead them to untimely death, this author thinks that an investigation into whether or not socio-economic status or location may be related to EHD in a selected population would be worthwhile. Such a study would tremendously benefit humanity by enlightening the public about factors that precipitate or trigger emotional homeostatic disequilibrium (EHD) symptoms in individuals, for the citizens to imbibe and practice precautionary measures against the phenomenon.

3. This study should be replicated on the same population or another with a wider representative sample. The beauty of every research study is its ability to be replicated either on the same population or a different one to promote authenticity and greater generalization of results. Moreover, it also provides an impetus for later scholars to have a good resource base when conducting a study that is related to this particular problem, which is the EHD phenomenon. On the whole, it all serves to provide authentic information about the EHD problem as well as generate a reliable solution to the problem. It is therefore this author's suggestion that a replication of this study is necessary and should be made.

4. An evaluation of emotional health needs of university staff on the verge of retirement and retired staff of Nigerian universities. It is important to conduct a study that recognizes the Nigerian senior citizens especially university staff who are retired as well as those on the verge of retirement as people in a developmental stage with peculiar emotional needs that require Guidance and Counselling services that would enable the retired university staffs and the ones about to retire on how to adjust to post-retirement and pre-retirement life. The study should emphasize participants' need to access Counselling services that would enable them to easily adjust to post-retirement and pre-retirement and aging. It will go a long way in placing the subjects as well-adjusted senior citizens of the country.

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DOI: <https://doi.org/10.57125/FED.2023.12.25.08>

How to cite: Moula, E., & Kouzoukakis, C. (2023). Delving into the impact of location-based games on high school students: Foro Italico vs. The Siege. *Futurity Education*. 3(4). 132-149.
<https://doi.org/10.57125/FED.2023.12.25.08>

Delving into the impact of location-based games on high school students: Foro Italico vs. The Siege

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Received: August 30, 2023 | **Accepted:** October 28, 2023 | **Available online:** November 9, 2023

Abstract: This study presents the research results of the implementation of two location-based educational games in the field of history and cultural heritage, created on Taleblazer to be played by high-school students on smartphones. The games were designed to take place in the city of Rhodes island and were titled: “The Siege of Rhodes by Muhammad the Conqueror (1480 p.C.)”, briefly hereafter, The Siege and “Let’s Discover the Secrets of Foro Italico”, briefly hereafter, Foro. By applying to each of them a different design strategy (gamification versus narrative-driven plot), the prime aim was to understand which features were preferred by different age groups, but also which other, external parameters influenced the reception of the games.

The overarching pedagogical basis under which this research was placed brought together a series of theoretical approaches that cross-fertilised each other: The game-based learning, Cognitive Theory

of Multimedia Learning, Situated learning in combination with approaches that highlight the importance of augmented reality and location-based (digital) games to improve the learning outcome.

The research sample was 58 students, aged 12-18, who participated in both games, and the methodological tool was a questionnaire, distributed to the participants after the completion of both games. The processing and analysis of the data was done in the program SPSS.

The games were created in the context of previous research, with the aim of verifying or differentiating from already recorded results. This research largely confirmed previous research results but also enriched the existing conclusions with new ones, regarding the importance of the age group and previous experience of the participants, as most of the experiments so far did not provide sufficient statistics of quantitative data. Although the learning performance was not verified, the additional findings could prove useful in the future for a more tailored design of similar educational games, in order to optimise the learning process, taking into account factors that influence game reception. However, the need for a larger sample size and for further investigation of how games function as learning resources is undeniable.

Keywords: Augmented reality, city of Rhodes, cultural heritage, gamification, history, location-based games, simulation, storytelling, Taleblazer.

Introduction

Research Problem

Digital environments are the affinity space of the new generation (Gee, 2017). The ubiquity of technology and the amount of student interaction with it affect how students process information and acquire knowledge. Different experiences lead to different thought structures. With the continuous development of digital spaces and tools, new educational and participatory methods and practices have been developed, among which digital games seem to be at the forefront (Koutroumanos & Nikolopoulou, 2010).

Digital natives (Prensky, 2001) also known as i-gen (Twenge et al., 2019) or gamers generation (Beck & Wade, 2005) "do not respond to traditional teaching methods" (Katz, 2000), since the Monopoly of the school in controlling and disseminating knowledge is over. Necessary digital literacy skills and knowledge are primarily social in nature and include the ability to take advantage – among others- of distributed knowledge and collective intelligence, problem-solving, social interaction, negotiating identity, communication through multimedia tools (Gee, 2003; Jenkins, 2006).

Multimedia changes the studentship role by offering them the freedom of individual pace in processing information as well as active and responsible participation in the learning process while maintaining his commitment and attention at high levels. Among all media activities, gaming and indeed mobile gaming is the most popular and widespread among the youth. 79% of under-22s play mobile games, which are primarily aimed at a younger population. Smartphones are their gateway to gaming, so the popularity of mobile gaming among Generation Z is greater than expected. Jesse Schell (2010) summed it up as the trend towards a 'Gamepocalypse' "where every second of your life you are actually playing a game in some way".

On one hand, the popularity of games among young people and on the other hand, the high level of percentage of daily engagement with them has stimulated the educational community's research

interest in their use to achieve learning goals. The observed gap between the daily habits of young people especially in their relationship with mobile technologies, and the conventional, educational practices, triggered even more and accelerated educational research with the aim of optimally utilising technologies and especially games for the achievement of learning objectives.

Due to the universal use of mobile smart devices, there has been exponential growth in the number of mobile applications developed for educational purposes, which mainly adopt a gamification approach (Kumar, 2023), to boost motivation and enhance learning performance (Zainuddin et al., 2020). A step further, game-based learning refers to the innovative learning approach that involves games or other kinds of software applications with educational value (Tang & Hanneghan, 2011). The goal of game-based learning is to bridge the gap between the everyday culture in and out of school of the new generation. By making learning more compelling and engaging, students are motivated to participate and adopt a positive attitude towards knowledge and educational processes.

Thus, the concept of the game-based learning approach and the cognitive theory of multimedia learning are considered in collaboration, as multimedia learning environments often include game-based learning to enhance student motivation. The principle known as the "multimedia principle" states that we learn more deeply from a combination of media than from words alone (Mayer, 2005) and in this context, the application of games is proposed as an alternative solution to reduce the cognitive load that is usually traced to conventional educational practices.

Location-based games (LBGs) are placed at the intersection of the above three theories, which are additionally supported by the theory of situated learning. Situated Learning (SL) argues that meaningful learning only takes place if it is embedded in the social and physical context within which it will be used. According to this approach, students engaged in activities that focus on real problems are asked to use their critical thinking and kinesthetic abilities to construct new knowledge through either analog or digital resources (Wen & Looi, 2019). LBGs are a subcategory of pervasive games (Magerkurth et al., 2005) in which the game evolves and progresses through a player's location and movement. The action takes place in the real world, enhanced by the use of augmented reality technology. Recent literature shows that students can benefit from location-based mechanics in a wide range of learning experiences in various cognitive domains (Quintero et al., 2019). However, there are still many unexplored aspects concerning various factors, which this research aspires to investigate. In this direction, the findings of the present study aim to contribute to the adaptation of educational technology to specific users, in order to improve educational outcomes. Even more, through location-based games, learning can become more tangible, exploratory and relevant to the needs of the new generation.

Research Focus

Location-based augmented reality games (LBGs) offer users new possibilities to discover and interact with the outdoors, the use of GPS, connectivity and mapping technologies, opening up a wide range of research (Cashman & Phelps, 2009; Saker & Evans, 2016). They usually work on mobile devices (smartphones or tablets) and guide users to specific locations. Augmented reality (AR) is used to provide that extra layer with 3D objects, avatars and animations for player interaction. When someone reaches these sites, digital content is activated. Students are asked to complete challenges or assignments, answer quizzes, or interact with virtual objects that enrich their learning experience. Other terms used in research to describe certain types of LBGs include AR games and mixed reality games (Viinikkala et al., 2016). AR and mixed reality games are often spatial awareness games. Regardless of the term used, however, we are witness of a growing market for such location-based games (LBGs) and gamified location experiences that appeal to an ever-increasing number of players. Geocaching, PokémonGo and

Ingress are some representative examples. They create a fusion between physical and digital spaces and support the development of new forms of interactions and experiences in the city space that enhance the sense of place value and place identity.

The basic idea with these games is that players combine knowledge and movement in the real world, especially in places rich in cultural content, such as historic city centers or archaeological sites. Since 2000, many articles have mentioned LBGs as a new trend and recently this seems to be gaining ground. In the following decades, more and more location-based and mobile AR applications were developed (Ribeiro et al., 2021). Their field covers a wide spectrum, from environmental education (Schneider & Schaal, 2018), geography, IT (Lovászová & Palmárová, 2013), science, astronomy (Cecotti, 2022), business (Puja & Parsons, 2011), urban sustainability (Mangnus et al., 2022) history, physical exercise, tourism and various learning activities for the elderly or disabled (Marco et al., 2008).

There are several authoring tools for location-based games, like Taleblazer, ARIS and Unity with Mapbox (Metikaridis & Xinogalos, 2021), among which we selected Talebalzer, as the most appropriate for our purpose.

TaleBlazer is the only the platform that fully supports an all-visual programming language and allows anyone with no programming background creating a game by following the site's very well-edited and built-in step-by-step guide. It has a simulation feature so that a creator can remotely test the functionality of a game before publishing it. What's more, it supports various media formats (text, images, audio) to enhance the gaming experience, is free, and has a friendly, easy-to-navigate user interface. Its main drawback is that it does not support a multiplayer game and does not provide an online discussion space (Batsaras & Xinogalos, 2023).

The field of utilising location-based games to approach history and cultural heritage is on an upward trajectory. Many studies from the last decade demonstrate the growing interest of the scientific community in the specific field. Some outstanding examples of location-based educational games are the following:

- ✚ “The Heraklion Fortification Gates” offers students the opportunity to learn about the history of the Venetians gates of the city of Heraklion, in Crete (Vassilakis et al. 2018).
- ✚ “Doltso: A Traditional District of Kastoria in the Passage of Time” is designed by the Center for Education for the Environment and Sustainability of Kastoria. Its aim is to get students to know the Byzantine and post-Byzantine churches, the imposing mansions, and the historical buildings of the homonymous preserved district (Kleftodimos et al., 2023a).
- ✚ “Once Upon a Time in Dispilio” and “Crime in the Lake Settlement” take place in the same northwestern region of Greece, in the prehistoric remains of the mentioned sites and are created by the same institution (Kleftodimos et al., 2023b).
- ✚ The “Oracle of Delphi” (Ekonomou & Vosinakis, S., 2018) presents students with the great monuments of the most important Greek archaeological site of Delphi and their historical uses.
- ✚ “Viking Ghost Hunt” takes place in important historical locations in Dublin, Ireland. It engages the player in local Viking history (from the years 800–1169) through a ghost-hunting game in a multi-modal experience (Paterson et al., 2013).

- ✚ “O'Munaciedd' is part of the 'Matera Città Narrata' project. It presents the historical, artistic and natural heritage of the Basilicata region in southern Italy (La Guardia et al., 2012).
- ✚ “Explore!” is a treasure hunt designed for the archaeological site of Egnazia, Italy (Costabile et al., 2008), intended for middle school students. Its aim is to help students acquire historical knowledge and concepts while a loose narrative gives it coherence and engages participants in playful activities.
- ✚ “Frequency 1550” (Raessens, 2007; Huizenga, 2009) is a highly acclaimed educational game about medieval Amsterdam, designed to be played in the historic centre of the city.
- ✚ “The Voices of Oakland” (Dow et al., 2005) introduces visitors to the history and architecture of Oakland Cemetery, Atlanta's oldest cemetery.

The above list is not exhaustive or inclusive. Only a few of these games were contented, but significant examples taking place in sites of historical interest and used them as a guide for our own experiment.

Research Aim and Research Questions

For the formulation of the research questions, individual research articles on the use of location-based games for educational purposes were taken into account, as well as research review articles covering long periods of time, from 2010 onwards (Ribeiro et al., 2021; Laato et al., 2019). Individual studies usually check the degree of the positive reception of the game by the participants, the success criteria of the games (competition, collaboration, use of augmented reality, etc.), the emotions elicited by participation (pride, enthusiasm, boredom, indifference), and the game-learning relationship. In the reviews of a large volume of individual research, an attempt is made to answer, through grouping and comparison, more general issues, such as the cognitive subjects-fields of the games, the strategies that are integrated to facilitate learning or to attract students, and stimulate participation, the learning outcomes, the challenges-difficulties of developing similar games and the future prospects of this type of applications. Although the relevant research is rapidly developing, the existing literature falls short in providing answers to the questions we intend to investigate, as the results delivered so far measure percentages of the total participants, without correlation with other variables.

Many of our research questions are placed in the context of the previous research, the results of which they attempt to verify or refute, as follows:

- ✚ Are students excited by participating in spatially sensitive augmented reality games? Do they prefer competitiveness? Do they enjoy collaboration? Do they think such games have educational value? Do they gain new knowledge? Do they have previous experience with similar games? Do they find navigating digital maps easy? Do they single out any feature of the games as their advantage?

In addition, it was sought to cross and correlate the above data with other nominal variables, such as age group, gender, previous experience, and preferred game.

To sum it up, taking as a null hypothesis the absence of a relationship between the following variables, it was investigate whether this was true. If the null hypothesis is not verified, then it will mean that there is a relationship between the crossing variables in the following questions.

- ✚ Is the age group a factor influencing the game reception (enthusiasm, desire for future participation, knowledge acquisition, collaboration, competitiveness, ease of navigation)?
- ✚ Is the age group a factor that affects the preference for the type of game and its corresponding game mechanics?
- ✚ Equally, is the gender, a factor influencing game reception (enthusiasm, desire for future participation, knowledge acquisition, collaboration, competitiveness, ease of navigation)?
- ✚ Is the gender a factor that affects the preference for the type of game and its corresponding game mechanics?
- ✚ Even more, is previous experience, a factor influencing the game reception (enthusiasm, desire for future participation, knowledge acquisition, collaboration, competitiveness, ease of navigation)?
- ✚ Is the previous experience a factor that affects the preference for the type of game and its corresponding game mechanics?

Research Methodology

General Background

In most of the applied examples referred to above, the way to collect data was to fill in a questionnaire, the conclusions of which are presented descriptively. As there were no studies in the relevant literature that highlighted the complex relationships of data and how they interact, the contribution of the present research was a better and in-depth understanding of how various factors interact and influence the reception of the games as well as the learning process embedded in games.

Sample

The research sample was 58 students from high schools at the city of Rhodes, aged 12-18, who participated in both games and the methodological tool that was a questionnaire, distributed to the participants after the completion of the games. The selection was deliberately random so that there would be no differentiation in terms of achievement or other socio-cultural characteristics. The research took place in two phases, in June 2023 in the city of Rhodes in Greece, at the historical center, and at the medieval city accordingly. In the table 1 below the distribution of the participants in age groups and gender is demonstrated.

Table 1

Cross-tabulation of Age Group and Gender

Age group * Gender Cross-tabulation		Gender		
		boy	girl	total
Age group	12-15	16	19	35
	16-18	8	15	23
total		24	34	58

Instrument and Procedures

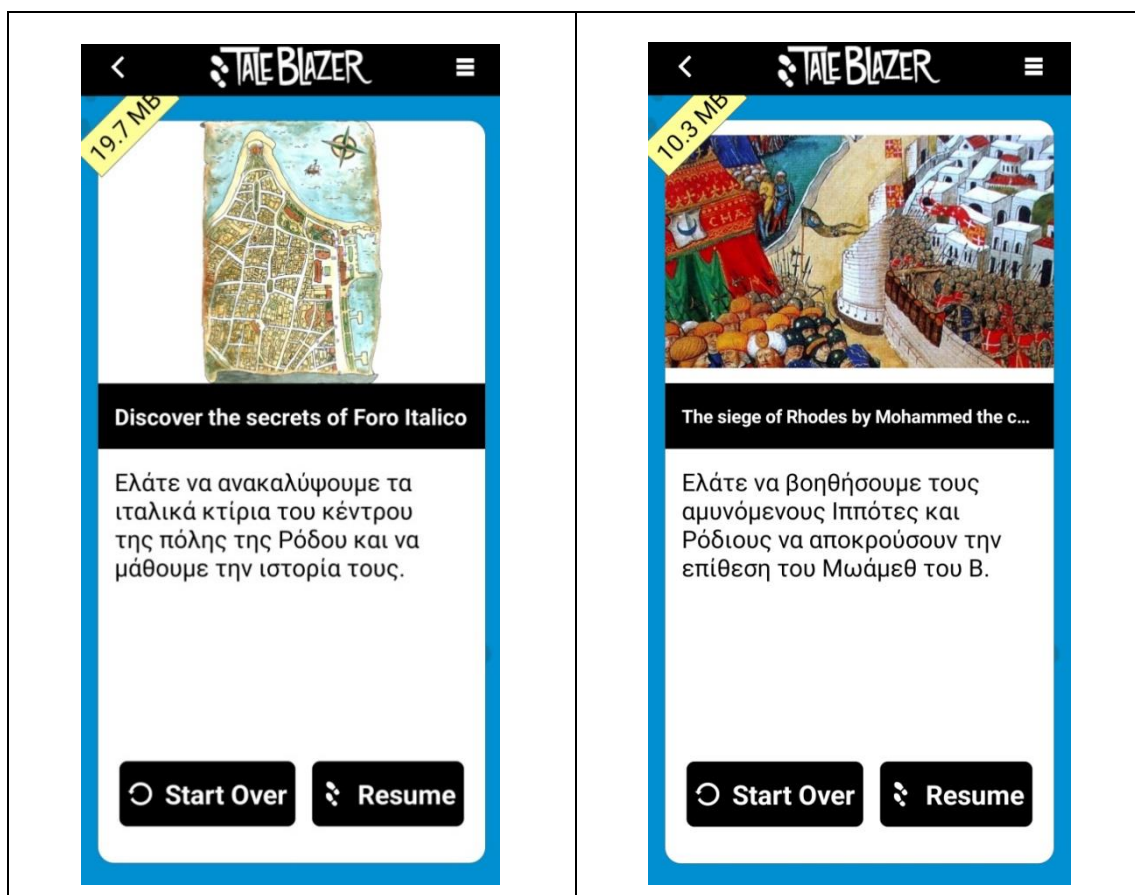
For the needs of the research, two games were created in Taleblazer with an emphasis on the different mechanics' patterns. Specifically, in Foro, quizzes, score points, and feedback were chosen as

dominant mechanisms, while in *The Siege*, a narrative-driven plot based on real historical events, mission assignment, resource gathering, and, feedback were the prominent elements of the game.

In *Foro* (figure 1), 15 prominent buildings from the period of Italian occupation in Rhodes have been selected, which were located in today's Mandraki, formerly called *foro italico*, i.e. the administrative center of the period of Italian occupation. These buildings were also the stations of the tour, in a sequenced course where each agent gained visibility upon completion of the previous phase. For each building, comprehensive information was given about its use and history, and immediately after that, a multiple choice question was activated, from the correct answer of which the players collected points. If they collected 120 points or more at the end they got an honorary diploma of the worthy researcher. Otherwise, they just accepted a comforting handshake. The players might stop whenever they wish and participate in the competition among the teams with the number of points they have gathered so far.

Figure 1 and Figure 2

Home screen of Foro Italico and The Siege on Taleblazer



Source: author own development.

In *The Siege* (figure 2) players were challenged to confront the besiegers and prevent the occupation of the island by following a series of missions historically accurate of the events of the 1480 siege. To successfully complete the missions they must move speeding to various parts of the Medieval city of Rhodes and the surrounding area to carry messages, aid in defense, manufacture ammunition, and more. In between they were called upon to collect their individual armory so that they could be knighted at the end of the game by the Grand Magister in recognition of their contribution to the salvation of the city. If a team withdrew and did not reach the final test, they did not receive any

compensation or award. The game was essentially a siege simulation, based on real facts based on historical sources, with quests, though no puzzle solving and scoring.

After the completion of the two games, participants were asked to answer a questionnaire, as follows:

- ✚ Age group (12-15/ 16-18)
- ✚ Gender (male/female)
- ✚ Previous experience: Do you have previous experience in location-based games? (yes/no)
- ✚ Ease of navigation: Did you find the navigation easy? (5 scale Likert)
- ✚ Enthusiasm: did you feel enthusiasm during the game? (5 scale Likert)
- ✚ Acquisition of knowledge: Did you acquire new knowledge? (5 scale Likert)
- ✚ Choice: Which game did you like most? (Foro/The Siege)
- ✚ Game mechanics: Which game element do you think was more exciting? (Storytelling/ scoring)
- ✚ Educational value: To your opinion does the game have educational value?
- ✚ Desire for future participation: Would you like to participate in a similar game in the future?
- ✚ Location-based mechanics as a preference criterion: Do you think that the “location-based augmented reality” technology of the games was their most exquisite feature? (5 scale Likert)
- ✚ Competitiveness: Did the games promote competitiveness? (5 scale Likert)
- ✚ Which game was more competitive? (Foro/ The Siege)
- ✚ Compatibility with other cognitive fields: To your opinion are such (location-based) games compatible with other cognitive fields? (Yes/no)
- ✚ Immersion: In which game did you feel more immersed? (Foro/The Siege)
- ✚ Collaboration: Did the games promote collaboration? (5 scale Likert)
- ✚ Which game was more collaborative? (Foro/ The Siege)

The answers were transcoded to numbers, imported to SPSS (Statistical Package for the Social Sciences), and analysed.

The questionnaire generally followed the steps of previous similar studies, was pilot tested and validated to effectively measure the constructs. Some questions regarding the factors were aimed to investigate were aided. The sample was representative of the student population of the city of Rhodes, although not demographically in terms of the wider population of the island.

Data Analysis

The study addressed a relevant and practical topic in the field of educational technology and the research utilised quantitative data analysis, which allowed for statistical comparisons and provided objective insights into the relationships between variables. The Statistical Package for the Social Sciences that served the study was considered the most reliable analytical tool for similar studies.

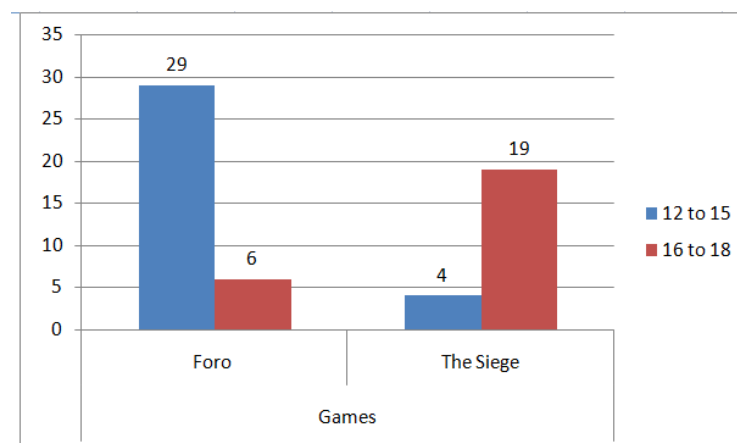
Research Results

In the beginning, to get a general idea of the games’ reception, the mean values of the participants’ responses -on the graded Likert scale from 1(minimum) to 5 (maximum) were counted, (Table 2). Storytelling, scoring, location-based mechanics, enthusiasm, and desire for future participation garnered the highest mean values among the other features.

Table 2*Mean Values of Measurable Variables*

Ease of navigation	Competitiveness	Collaboration	Enthusiasm	Acquisition of knowledge	Storytelling	Score	Desire for future participation	Location-based mechanics as a preference criterion
3,53	3,71	3,02	4,17	3,21	4,59	4,53	4,40	4,19

Crossing the age groups (chi square) with their game preferences it became apparent that the 12-15 group showed a clear preference for Foro, while the 16-18 group for the Siege (figure 3).

Figure 3*Age Groups' Preferences*

Source: author own development.

Furthermore, a non-parametric Mann-Whitney test was applied with age group as a grouping variable and a statistically significant difference was observed in a number of variables in favor of the 16-18 age group versus the 12-15 group, as follows: ease of navigation, excitement, knowledge acquisition ($p=0,0$). The storytelling outperforms as an advantage in the same age group ($p=0.19$), as do spatial sensitivity (location-based mechanics) ($p=0.33$), competitiveness ($p=0.03$) and immersion ($p=0.016$). The desire for future participation, the development of collaboration and having a score as an advantage did not have statistically significant differences. In Table 3 the mean ranks of the variables of both age groups were described.

Table 3*Mean Ranks with "Age Group" as Grouping Variable*

Variables	Age group	Mean ranks
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ease of navigation	12-15	20,93
	16-18	42,54
enthusiasm	12-15	23,34
	16-18	38,87
acquisition of knowledge	12-15	23,03
	16-18	39,35
storytelling as advantage	12-15	26,07
	16-18	34,72
score as advantage	12-15	29,44
	16-18	29,59
desire for future participation	12-15	30,24
	16-18	28,37
location-based mechanics as a preference criterion	12-15	25,99
	16-18	34,85
competitiveness	12-15	24,33
	16-18	37,37
immersion	12-15	25,41
	16-18	35,72
collaboration	12-15	29,47
	16-18	29,54

The previous experience in similar games produced statistically significant differences in the condition of experiencing immersion ($p=0.032$), competitiveness ($p=0.046$) and knowledge acquisition ($p=0.02$), meaning the group with previous experience positively responded to all the above conditions. Table 4 presents the mean scores of the aforementioned statistically significant differences, with "previous experience" as the grouping variable.

Table 4*Mean Ranks with "Previous Experience" as Grouping Variable*

Variables	Previous experience	Mean ranks
score as advantage	yes	28,21
	no	30,13
immersion	yes	35,92
	no	26,37
competitiveness	yes	35,61
	no	26,53
location-based mechanics as a preference criterion	yes	33,03
	no	27,78
desire for future participation	yes	26,53
	no	30,95
storytelling as advantage	yes	33,92
	no	27,35
acquisition of knowledge	yes	38,68
	no	25,03
enthusiasm	yes	34,87
	no	26,88
ease of navigation	yes	34,71
	no	26,96

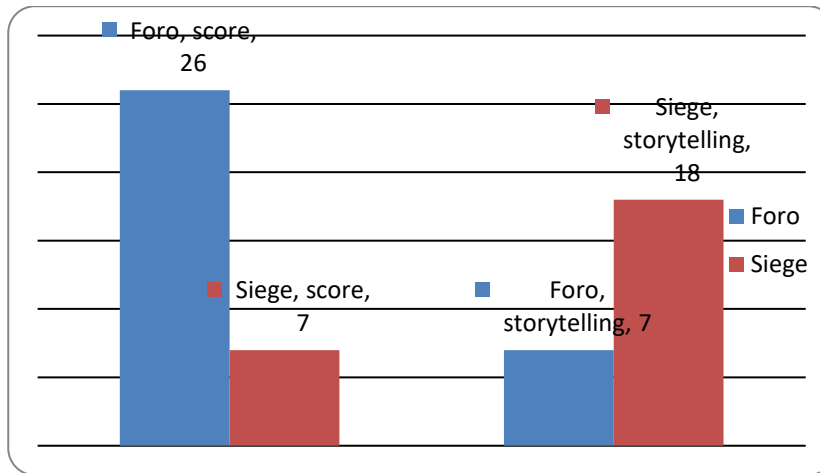
Gender as a grouping variable did not produce any statistically significant differences.

Applying the non-parametric test Mann Whitney once again, with grouping variable the preferred game, a statistically significant difference was observed in terms of the degree of immersion in favor of the Siege ($p= 0.018$) and in terms of competitiveness in the group that chose the Siege as their preferred game ($p=0.016$).

By cross-tabulating (chi-square test) the variables choice –preferred game- and preferred game feature, we came to the conclusion that those who expressed a preference for Foro, chose scoring as the most important feature of the games, while those who expressed a preference for the Siege indicated the narrative dimension of the game as the most important feature. In Figure 4 one notices that Siege is chosen for the narrative and Foro for the score.

Figure 4

Game Preference Cross-Tabulated with Game Mechanics



Source: author own development.

By applying the chi-square test again, crossing the opinion of the respondents on the educational value of the games with their opinion on the appropriateness of the application to be extended to other cognitive fields, a statistically significant relationship was identified ($p=0.019$), meaning there was a coherence in the answers of those responding positively and vice versa.

Extending the given research scope on probable additional relations, the Pearson correlation test to several variables was additionally applied.

So, a statistically significant correlation was found between the presence of storytelling and the experience of immersion ($p=0.023$) and between immersion with enthusiasm ($p=0.02$), knowledge acquisition ($p=0.02$), and competitiveness ($p=0.00$). More correlations were detected between enthusiasm and competitiveness (0.002), desire for future participation ($p=0.001$), and location-based mechanics ($p=0.00$). The desire for future participation was also statistically significantly related to location-based mechanics ($p=0.00$). The knowledge acquisition was positively related to immersion ($p=0.002$), enthusiasm ($p=0.003$) competition ($p=0.001$), and location-based mechanics ($p=0.00$).

Applying linear regression to check the predictive dynamics of the variables, it was found that enthusiasm was a predictor of the desire to participate in a similar activity ($R=0.416$) ($p=0.001$), as well as location-based mechanics ($R=0.451$) ($p=0.000$), on a moderate prediction grade.

To sum it up, having analysed the data with the grouping variables that were chosen as the axes of our research questions it was concluded that:

- 🎮 The age group 16-18 had greater ease of navigation, showed more enthusiasm and stated that they acquired new knowledge. In addition, the 16-18 age group showed a clearly greater preference for The Siege and its narrative-driven structure, location-based

mechanics as a feature of the game, and competitiveness. They also reported experiencing greater immersion in the story than the 12-15 group. On the other hand, the 12-15 age group preferred Foro and the quiz-score structure. Regarding enthusiasm and desire for future participation, both age groups yielded the same statistical results.

- ✚ The gender as a grouping variable did not produce any statistically significant differences.
- ✚ Previous experience in similar games produced statistically significant differences in the condition of experiencing immersion, competitiveness, and knowledge acquisition, in other words the group with previous experience responded positively to all the above conditions.

Statistically significant correlations between the narrative-driven structure of The Siege and experiencing immersion, and between immersion with enthusiasm, with knowledge acquisition, and with competitiveness were also detected. Enthusiasm was also correlated with the desire for future participation and location-based mechanics. The knowledge acquisition was positively related to immersion, enthusiasm, competitiveness and location-based mechanics.

Finally, it can be concluded that enthusiasm and location-based mechanics were predictors of the desire for future participation in a similar activity.

Discussion

The given research questions have been answered satisfyingly. The main purpose of the research was to inspire educators and set an example for further similar educational applications, which could be more tailored and appropriately designed for the target age audience. Taleblazer was chosen mainly for a number of advantages compared to similar tools mentioned elsewhere (Kleftodimos et al., 2023a). Prior to the creation of the games, the relevant literature on spatially sensitive educational games for history and cultural heritage was studied in order to exploit specific design features that could enrich, and enhance a location-based augmented reality experience. So, we tried to make the game simple, balance fun with learning, enforce active discovery, motivate with challenges and rewards, including competitive mechanisms, offer clues and hints, make the best out of multiple modalities, and provide chunks of information for better assimilation (DaCosta & Kinsell, 2023). The aim was not to measure physical activity, social interaction, or cartographic education (Laato et al., 2019) other than ease of navigation as an indicator of cartographic management experience.

After implementing the games, the findings were compared with those of the relevant literature on LGBs – mentioned earlier – and realised that they were quite consistent with previous studies, especially in the reported positive impact (increase in interest, active engagement, motivation for participation, physical activity, and learning outcomes).

Since the evaluation process in most studies is mainly treated as a feedback tool for future improvement of LGBs (Ribeiro et al., 2021) and there is a lack of multivariate research studies that investigate and quantify the impact of the described applications in relation to several variables, it was decided to test how reported outcomes relate to factors such as gender, age, and previous experience.

Thus, we contributed to the evolving field of research with the following conclusions:

The age group is associated with a specific type of game that includes specific features and game mechanics (younger students show preference for quizzes-score-feedback, and older ones for a narrative-driven plot) while gender does not seem to influence the specific choice. Previous experience in similar games also enhances the enjoyment of the game (immersion, competitiveness).

Limitations of the Study

Undoubtedly, a larger sample of students is needed for the results to be generalisable and more reliable. Also, there are still many features of games that could serve as criteria for student preferences or could facilitate learning. A drawback of the research is that it relies solely on quantitative data, which may not capture the nuances and deeper insights that qualitative data could provide.

While the study focused on age group as a factor, it did not delve deeply into other demographic variables, such as socioeconomic status or cultural background, which could also influence the game reception and learning outcomes.

This research focused on measuring variables embedded in these educational games, but did not delve into how they function as learning resources. It should have been followed by a knowledge test to verify whether the knowledge embedded in the games was actually mastered or remained on the surface. Undoubtedly, even the first contact with the cognitive content is a vestibule for the critical intake of knowledge later, but this is not a guarantee. Thus, this research provided a more detailed description of the impact of many factors, but much remains to be explored.

Besides, considering the average value of knowledge acquisition (3.21) which was relatively low compared to the rest of the statistical data, it was realised that the way of integration and transmission of knowledge should be further explored so that it can be assimilated seamlessly to justify the existence of similar Games .

Conclusions and Implications

The conclusions that were reached in relation to the age group and previous experience are important for the further design of similar games, suitably adapted.

The age group seems to be a criterion for the type of game mechanics to be chosen so that its reception is more positive and the learning goals more achievable.

Prior experience emerged as a factor affecting students' performance in spatially sensitive games and their reception. It is therefore essential that participants practice and navigate the digital maps before each application to ensure equal participation and the ability to enjoy the game to the same degree.

Suggestions for Future Research

Future research could focus on games that incorporate different design or mechanical elements and test what kind of response these elements elicit in students. There are many unexplored aspects in the field, which is still uncharted and promising.

For example, cognitive challenges that require problem solving could be used instead of prompts to move to a specific place, which can increase the degree of difficulty and the need for players to develop cooperation. This could prove to be a determining factor in the game's reception and player preference.

Also, in a different authoring tool (e.g. ARIS) (Batsaras & Xinogalos, 2023) or in the future version of Taleblazer that will allow monitoring the progress of the game participants, it would be interesting to measure the degree of emotional involvement of the players, thanks to visibility of ongoing scores. Further, the relationship of their degree of involvement with the learning outcome could be explored.

In addition, other socio-cultural or economic parameters of the participants' profiles could be selected as independent control variables that may influence how players respond to the game.

Certainly, investigating the appeal of an educational game with mixed features (score and narrative) compared to the games under discussion, in which these features are found individually, would shed more light on how they affect different age groups.

Even more, future research could improve the targeting of learning outcomes and their integration into game design, taking into account the current findings about the preferred model of game mechanics in relation to age groups.

Finally, the designers of such authoring tools, by providing access to statistical data on game performance and player behavior, will allow game creators to tailor them taking robust evidence into account and also create educational content and difficulty levels accordingly.

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How to cite: Adigun, A. A., Mustapha, I. A., Adisa, S. A., & Tukur, H. A. (2023). Mindfulness Skills Intervention for Alleviating Stress Manifestations Among Nursing Students in Ilorin Metropolis, Nigeria. *Futurity Education*. 3(4). 150-166. <https://doi.org/10.57125/FED.2023.12.25.09>

Mindfulness Skills Intervention for Alleviating Stress Manifestations Among Nursing Students in Ilorin Metropolis, Nigeria

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Received: September 10, 2023 | **Accepted:** October 28, 2023 | **Available online:** November 10, 2023

Abstract: The literature has indicated that nursing students are among the healthcare students that experience higher level of stress; which makes it imperative to provide them with relevant skills

they can employ to overcome stressful life conditions. This study thus adopted mindfulness skills intervention to alleviate stress manifestations among nursing students in Ilorin metropolis, Kwara State, Nigeria. The objectives of the study were to examine the effect of mindfulness skills training on physical, behavioural and psychological manifestations of stress among the participants. Using a quasi-experimental study of the pre-test, post-test design, three null hypotheses guided the conduct of this study. The population of the study consisted of 234 University of Ilorin Teaching Hospital nursing school students. A purposive sampling technique was used to select 15 participants in the treatment group. An adapted "Stress Questionnaire" (with a Reliability Index of .88) from Sinha et al. (2016) was used for data collection. The data collected were analysed using percentage and paired t-test was used to test the null hypotheses formulated at .05 level of significance. The findings revealed that mindfulness skills intervention reduced the physical ($t = 19.17, p < .05$); behavioural ($t = 11.25, p < .05$); and psychological ($t = 11.51, p < .05$) manifestations of stress among the study participants. Based on these findings, it was concluded that mindfulness skills intervention is not only applicable in clinical setting but can also be applied in an educational environment; hence, a comprehensive knowledge of the process and steps involved in these training becomes imperative for school counsellors to avail themselves with for imparting positive change in clients who are going through stressful situations. Therefore, it was recommended, among others, that professional counsellors should equip nursing students with such skills in order to help them overcome the physical, behavioural and psychological manifestations of stress.

Keywords: Mindfulness skills intervention; alleviating stress manifestations; nursing students; Ilorin metropolis, Nigeria.

Introduction

The phenomenon of stress is not new in educational research parlance. Human beings have been experiencing stress since time immemorial. Stress is part of everyday life and it arises from human relationship with the constantly changing world. Stress is defined as the sense of an imbalance between the demands of the environment (also known as stressors) and a person's ability to manage those demands. The impression of danger triggers an innate response system known as the fight or flight response, which is a response of mental action through hormone signalling. In general, the stress is not entirely negative, but it can be disastrous in extreme cases. Avoiding it could make life very boring, but excessive and unchecked stress can have terrible effects on one's mental, psychological, and physical health (Essel & Owusu, 2017). Hence, the stress is unavoidable because a minimum level of it is required to spur an individual into action.

Globally, advancements in educational delivery mechanisms have challenged the traditional higher education delivery system, which consists of a classroom setting with student and lecturer interactions. So, academic stress is one of the greatest challenges that students face in higher institutions of learning, particularly, among nursing students. Simonelli-Munoz, et al. (2018); Torre et al. (2018); and Rodriguez-Rey et al. (2019); noted that nursing students and those in other health-related disciplines have higher levels of stress than the general population. Akdeniz et al. (2018) showed in their finding among nursing students a high or severe level of stress; due to their exposure to various stressors that may hinder their learning and performance during nursing education. This follows that nursing students are experiencing significant levels of stress which usually affects their psychosocial experiences and health negatively.

Stress is a subjective mental distress originating from multiple aspects of the entire stressful life events. Stress can manifest physically, behaviourally and psychologically. The physical component manifests through tense muscles, weight loss, constant headache, sleep difficulty, fast heartbeat, and profuse sweating among others. Behavioural component is usually shown when an individual becomes aggressive, fidget, withdrawn from a social situation, engages in eating or smoking behaviours, has poor educational achievement, abuse substances, and procrastinating. Depression, suicidal thoughts, attention difficulties, loss of memory, burden, irritability, worry, excessive fear and other difficulties are the commonly observed psychological component of stress (Bjorkman, 2007).

The stress among nursing students revolves around three main stress factors; namely academic stressors (such as tests and evaluations, fear of education failure, workload problems), clinical stressors (such as fear of making a mistake while on practical, negative responses to patients' death or pains, professional expectation of nursing programme) and personal/social stressors (such as financial problems, family issues, an imbalance between the housework/school study) (Blomberg et al., 2014). Jacob and Einstein (2016) attributed the causes of higher manifestation of academic stress in healthcare students to the expansion of the knowledge base of such profession and the acquisition of clinical skills which demand a significant amount of both theoretical and education practice hours.

Since the stress is inevitable, coping with the stress is important for students' academic and overall life success. Ajibade et al. (2016) revealed that many nursing students lack effective coping skills to manage stress. While some are involved in taking alcohol and other substances, some usually visit friends or engage in social media chat, which may in turn contribute to their level of stress. In this regard, the researchers deem it imperative to introduce mindfulness skills training and solution-focused brief counselling technique as stress-coping interventions among nursing students.

Studies like those by Chiesa and Serretti (2009) and Eberth and Sedlmeier (2012) have shown that interventions based on mindfulness significantly reduce stress. Mindfulness-Based Stress Reduction (MBSR), an accessible psycho-educational eight-session program, is a development of mindfulness skills training from Buddhist mindfulness meditation practices. It was subsequently included in the Cognitive Behaviour Theory under the name Mindfulness-based Cognitive Therapy (MBCT), which emphasizes cultivating detached observation and awareness of the contents of consciousness to alter how people react to occurrences in their lives. It contributes to several beneficial psychological effects, such as improved behaviour regulation, greater subjective well-being, and decreased psychiatric symptoms and emotional reactivity (Keng et al., 2011).

Problem Statement

Trainee nurses are supposed to be physically and psychologically fit to be able to surmount the academic rigors in nursing schools. However, high level of stress has been shown to have a negative influence on nursing students' overall adjustment. Based on the researchers' (as the school counsellor) observation and interaction with some nursing students on the level of stress they experienced during the course of their study and their coping strategies with the stressful situation; many of them complained of inability to manage their time, others talked about cumbersome workload, juggling from the teaching hospital to their school for practical, attending early morning lectures, lack of time for social activities, impromptu examinations among others.

Many of these students are using negative coping strategies such as the abuse of alcohol and other psychoactive substances, excessive sleeping, engaging in illicit sexual activities, indulging in excessive social media chatting and night clubbing. Consequently, they experienced negative changes in their psychosocial lives and long-term physical and mental well-being. They may also become irritable, show

a lack of concentration, decreased academic performance, poor inter-personal relations and poor academic achievers; some may become half-baked nurses after being employed and that has resulted in the current shortage of nurses and incompetent ones found in different hospitals in Nigeria causing a great number of havocs to the citizens.

There is a shortage of experimental studies on coping strategies that help in navigating stress among nursing students in Nigeria. Prominent research in this regard were survey studies (Dike et al., 2017), some focused on the solution to stress experienced by university students or the general population (Ilbay & Akin, 2014); and students in other medical-related fields (Spinelli, et al., 2019). Therefore, there is a need to fill the existing gap in the previous studies by investigating the mindfulness skills intervention on stress manifestations among nursing students in the Ilorin metropolis, Kwara State.

Literature Review

The stress is an unavoidable condition that every individual is bound to experience regardless of their socio-demographic variations. Fink (2016) and Fink (2017) described the stress as a psycho-physiological reaction that occurs in response to felt demands. In the context of nursing students, stress is considered an overload of tension that is generated by demanding situations or pressure either from academic or other life events, which may lead to different mental health challenges. Such stress may either be a positive or negative reaction. The positive stress allows or aids individuals navigating daily life challenges; while the negative part increases a person's vulnerability to other mental health problems such as anxiety or depression (Schonfeld et al., 2016; Segal et al., 2023). According to Soliman (2014), excessive stress can increase the likelihood of delinquent behaviour including cheating and poor performance in addition to causing anxiety and a loss of objectivity (Marks, 2023). In this regard, managing stress is an important factor in enabling nursing students to excel in their healthcare studies and one of the important stress management strategies is the mindfulness intervention.

According to Tams (2023), mindfulness training includes both formal meditation exercises (such as paying attention to the body, lying on the ground, or moving slowly while being aware of one's surroundings) and informal exercises (such as paying close attention to what one is doing or experiencing at any given time). People may cope with stress by being aware of their thoughts, their bodies and themselves. Turow (2023) stated that mindfulness meditation is both a mindset and a technique for alleviating personal suffering and growing in wisdom and compassion. Modern psychology views mindfulness as a way to heighten awareness and respond to mental processes that result in emotional pain and unhelpful behaviour in the best possible way (Gu et al., 2015). Janssen et al. (2018) claimed that mindfulness is an improved attention to and awareness of current experience or present reality. When someone is aware, they are conscious of what they are going through without making those feelings the centre of their attention. Focusing conscious awareness on certain experiences is the activity of paying attention.

Simply because mindfulness encourages acceptance of stressors rather than avoidance of them, it can be a useful stress management technique (Chaskalson & Hadley, 2015). Additionally, attentive observation helps people learn to control their attention, which is a valuable ability for those who struggle to finish critical tasks because they are side-tracked by anxieties, memories, or bad moods (Chaskalson & Hadley, 2015). An individual may discover how to more effectively assess their stressors if they see things as they truly happen. People who practice mindfulness may be able to see their pressures as more tolerable and less dangerous. By enhancing one's self-control and ability to

concentrate, mindful awareness can also assist people in better converting their intentions into behaviour (Jinpa, 2019).

According to Jinpa (2019), the practice of mindfulness is characterised by four key abilities: attentive observation of one's internal and external experience, mindful description of one's observations, acting with awareness, and non-judgmental acceptance. Attention and presence, compassion for oneself and others, empathy, and the ability to regulate one's emotions are therapeutic traits that can be developed via mindfulness practice (Schuman-Olivier et al., 2020). The goal of the MBCT is to help people become more conscious of their thoughts and feelings so they can connect them in a broader, detachment, detached perspective as mental events rather than cling to or concentrate on those unpleasant thoughts (Sedlmeier et al., 2023). Sedlmeier et al. (2023) stated that mindfulness training aids a person in developing the capacity to be kind and understanding of his or her present thoughts, feelings, and physical sensations. Between one's perception (such as a stressful stimulus) and response (thoughts, speech, and actions), it generates a psychological "space." Individuals are therefore able to respond positively rather than impulsively reacting with negative feelings. In other words, mindfulness aids in the mobilisation of inner resources that enable one to meet challenges head-on, to be conscious of and position oneself to deal with pressure, and to go past it.

The usefulness of mindfulness skills intervention in overcoming stressful situations has been demonstrated several scientific investigations. For instance, a study by Felton et al. (2015) looked into how mindfulness training affected Southern Sweden students' feelings of stress. The study's findings showed that the intervention had a positive impact on the participants' capacity to anticipate stress as well as their levels of confidence and compassion in dealing with it. Additionally, Sivasubramoney et al. (2017) discovered in their study that the general public, which is plagued by daily stress, can try a mindfulness intervention. Similar results were reported by Galante et al. (2018), Solhaug et al. (2019), and Spinelli et al. (2019), where the intervention groups reported a small reduction in psychological distress, no harm to oneself or others, or suicidality and fostered long-lasting effects on mental distress and coping in healthcare students at post-interventions.

Research Objectives

The objectives of the study include to examine:

1. The effect of mindfulness skills intervention on physical manifestation of stress among nursing students in Ilorin metropolis.
2. The effect of mindfulness skills training on behavioural manifestation of stress among nursing students in Ilorin metropolis.
3. The effect of psychological skills training on physical manifestation of academic stress nursing students in Ilorin metropolis.

Hypotheses

The following null hypotheses were tested:

H₀₁: There is no significant effect of mindfulness skills training on physical manifestation of stress among nursing students in Ilorin metropolis.

H₀₂: There is no significant effect of mindfulness skills training on behavioural manifestation of stress among nursing students in Ilorin metropolis.

H₀₃: There is no significant effect of mindfulness skills training on psychological manifestation of stress among nursing students in Ilorin metropolis.

Research Methodology

General Background

The research design adopted for this study was the quasi-experimental design which involved the pre-test and post-test design. It is often used to evaluate the effect of a treatment, perhaps, a type of psychotherapeutic or educational intervention on one or more dependent variable(s). The adoption of this research design went with the assertion of Shuttleworth (n. d.) that without undertaking extensive pre-screening and randomisation processes, a quasi-experimental design reduces the time and resources needed for experimentation. The researcher thus chose quasi-experiment because of its strength to maximise internal and external validity in the effects of mindfulness skills training on stress among nursing school students in the Ilorin metropolis. The design is graphically illustrated as follows:

G1 O1 ----- X1 ----- O2

Where: G1 = Experimental group (Mindfulness Skills Training)

O1 = Pre-test

O1 = Post-test

X1 = Treatment

Selection and Description of Participants

All 234 nursing students studying at the University of Ilorin Teaching Hospital (UITH) School Complex, Maraba, Ilorin constitute the population of this study. However, the nursing students in the 200 level were the target population of the study. This is based on the fact that they were at the intermediate level and just started combining clinical training with academic work, with which they have been struggling to cope effectively; thus, many of them are employing unhealthy coping strategies towards stress; as observed by the researchers. The sample size for this study was 15 participants. This is in line with the submission of Ezhumalai et al. (2018) who stated that between 6- and 15 clients are required in group counselling. The sample was selected using the purposive sampling technique. A purposive sampling technique was used to select 15 nursing students with high levels of stress. The pre-test exercise was used to determine those qualified to be in the treatment or experimental group.

Instrument and Procedures

The instrument used for data collection was an adapted Stress Questionnaire from Sinha et al. (2016). The instrument has two sections; A and B. Section A consists of the demographic data of the respondents. The bio-data information of the participants includes; gender and age; while section B of the instrument contains 30 items, with 3 sub-sections and 10 items under each sub-section.

The Stress Questionnaire was segmented into three categories physical, behavioural and psychological dimensions of stress. The scoring method adopted for the instrument was a five-point Likert rating format of; Always - 5; Often - 4; Sometimes - 3; Rarely - 2; and Never - 1 respectively. However, there is no standard for the number of points on rating scales and common practice varies widely (Krosnick & Presser, 2010). However, experts in measurement and evaluation (Dawes, 2008) have contended that the large number of intervals provides respondents with greater choice and

discrimination to find the point that is most reflective of their rating and it is also quite simple to analyse the research data; hence, the use of five-point rating system.

The content validity of the adapted Stress Questionnaire was determined by experts in the field of Guidance and Counselling, Educational Psychology; and Measurement and Evaluation. The instrument was subjected to an alternate reliability method to determine its internal consistency and 0.88 index of Cronbach Alpha statistics was obtained; which adjudged the instrument appropriate for the conduct of the study. The scoring procedure is illustrated in table 1 as follows:

Table 1

Level of Stress Scoring Method

Level of Stress	Score range	No of Items	Highest score	Lowest score
Lower stress	Between 1 and 60			
Moderate stress	Between 61 and 90	30 (10 items/segment)	150 (5 * 30)	30 (1 * 30)
High stress	Between 91 and 150			

The highest score participants can get for each of the items on the instrument is 5, while the lowest score is 1. However, based on the responses to the 30-items scale, the maximum score a participant could get when all items are responded to is 150 (that is, 5 * 30), while the lowest score is 30 (that is, 1 * 30). Given this, participants who scored between 1 and 60 were considered to having a low level of stress, participants between 61 and 90 ranges of score were regarded as average levels of stress; while those between 91 and 150 score range were regarded as having a high level of stress. At the pre-test stage, those with higher and average level of stress were considered for participation in this study; while those with lower levels of stress were exempted. The scoring format for the instrument was applied to all participants for both pre-test and post-test in the study.

Treatment Procedure

The mindfulness skills intervention template was adapted from the book entitled “Mindfulness-Based Cognitive Therapy: The CBT Distinctive Feature Series” (Wills, 2022). The book provides the practical and accessible applications of mindfulness skills practice. At the initial stage of the session and having created a safe and conducive counselling environment, the researcher introduced himself and did orientation for the class. This was done by honouring the commitment they have all made, asking that they come and continue coming with an open mind and heart; setting the ground rules regarding confidentiality, participation and timekeeping; and asking the participants to tune in to their intentions for coming and then pair up and introduce themselves to each other and then to the group as a whole.

Table 2*Mindfulness Skills Training Template*

Week 1	Automatic Pilot
Activities	Setting the group rules and regulations, raising awareness and body scan meditation
Assignment	A 45-minute body scan meditation.
Week 2	Dealing with Barriers
Activities	Body scan meditation. Ten minutes of mindfulness of breathing.
Assignment	Bringing attention to a different routine activity.
Week 3	Mindfulness of the Breath and Body Movement
Activities	Standing mindful stretches, followed by sitting meditation focusing on awareness of breath and body.
Assignment	Keeping a daily record of the experience of an unpleasant event. 3 minutes breathing space three times per day.
Week 4	Staying Present
Activities	5 minutes mindfulness of seeing or hearing.
Assignment	Sitting meditation. 3-minutes breathing space
Week 5	Acceptance and Allowing/Letting Be
Activities	Exercise exploring habitual patterns of reaction and the potential use of mindfulness skills to facilitate greater responsiveness to present-moment experience.
Assignment	Sitting meditation – 3 minutes breathing space
Week 6	Thoughts are not facts
Activities	Sitting meditation; 3 minute breathing space
Assignment	Beginning to develop a personal relapse signature and action plan. Practicing for 40 minutes per day - work with different combinations of the three core practices.
Week 7	How can I best take care of myself?
Activities	Explorations of the links between activity and mood. Generate list of daily activities and consider which feel “depleting” or “nourishing” and which give a sense of “mastery” or “pleasure”. Consider ways of increasing the “nourishing” activities. Identifying relapse signatures and actions to deal with the threat of relapse/recurrence
Assignment	Develop action plan to be used in the face of uncomfortable experience.
Week 8	Using what has been learned to deal with future experience
Activities	Ending meditation.
Assignment	Set a plan of home practice that they can sustain for the next month. The follow up session was done through a phone call.

Ethical Consideration

Permission and cooperation were sought from the authority of the healthcare institution in which this study was carried out. Confidentiality on the participants’ information was maintained and they voluntarily participated in the research exercise.

Data Analysis

The data collected was analysed using paired t-test statistic. A paired t-test is used when a researcher is interested in the difference between two variables for the same subject; an instance is where same participants are tested repeatedly; before and after receiving the treatment (Hayes, 2023). The statistical software was the SPSS statistical package (version 23).

Research Results

The descriptive statistic of frequency and percentage was used to presents the demographic profiles of the participants. This is illustrated as follows:

Table 3

Percentage Distribution of Participants by Gender

Gender	Frequency	Percentage %
Male	3	20.0
Female	12	80.0
Total	15	100.0

Table 3 presents the percentage distributions of participants' gender in the mindfulness and solution-focused groups. The table shows that, 3 (20.0%) of the participants were males; while 12 (80.0%) were females. This implies that, female nursing students were more represented in the intervention than their female counterparts.

Table 4

Percentage Distribution of Participants by Age

Age	Frequency	Percentage %
19-22 years	12	80.0
23 years & above	3	20.0
Total	15	100.0

Table 4 presents the percentage distributions of participants' age in the mindfulness and solution-focused groups. The table shows that, 80 (80.0%) of the participants were between 19-22 years of age; while 20 (20.0%) were between 23 years and above. This suggests that, nursing students in the adolescence stage of development were more represented in the research experiments than their older counterparts.

H₀₁: There is no significant effect of mindfulness skills training on physical manifestation of stress among nursing students in Ilorin metropolis.

Table 5

Paired Sample t-test Comparing Pre-Test and Post-Test Intervention on Physical Manifestation of Stress among Participants

Variables	N	Mean	SD	df	Cal. t	p-value
Pre-test	15	31.00	2.976			
				14	19.17*	.000
Post-test	15	13.87	1.642			

Note. Sig. at $p < .05$

Table 5 shows that at the degree of freedom (df) of 14, the calculated t-value is 19.17 ($p = .000 < .05$). This indicates that there is statistically significant effect of mindfulness skills intervention on physical manifestation of stress among nursing students in Ilorin metropolis; hence, the null hypothesis is rejected.

H₀₂: There is no significant effect of mindfulness skills training on behavioural manifestation of stress among nursing students in Ilorin metropolis.

Table 6

Paired-Sample t-test Comparing Pre-Test and Post-Test Intervention on Behavioural Manifestation of Stress among Participants

Variables	N	Mean	SD	df	Cal. t	p-value
Pre-test	15	30.53	5.527			
				14	11.25*	.000
Post-test	15	13.07	1.438			

Note. Sig. at $p < .05$

Table 6 shows that at the degree of freedom (df) of 14, the calculated t-value is 11.25 ($p = .000 < .05$). This indicates that there is statistically significant effect of mindfulness skills intervention on behavioural manifestation of stress among nursing students in Ilorin metropolis; hence, the null hypothesis is rejected.

H₀₃: There is no significant effect of mindfulness skills training on psychological manifestation of stress among nursing students in Ilorin metropolis.

Table 7

Paired Sample t-test Comparing Pre-Test and Post-Test Intervention on Psychological Manifestation of Stress among Participants

Variables	N	Mean	SD	df	Cal. t	p-value
Pre-test	15	28.00	5.210			
				14	11.51*	.000
Post-test	15	15.07	1.580			

Note. Sig. at $p < .05$

Table 7 shows that at the degree of freedom (df) of 14, the calculated t-value is 11.51 ($p = .000 < .05$). This indicates that there is statistically significant effect of mindfulness skills intervention on psychological manifestation of stress among nursing students in Ilorin metropolis; hence, the null hypothesis is rejected.

Discussion

The study's findings showed that compared to the pre-test group, nursing students who participated in the post-test experienced a significant decrease in physical stress. Physical signs of stress, such as headaches, stiffness in the muscles and exhaustion, were reduced in the mindfulness group. These findings imply that teaching mindfulness techniques may be a useful intervention for nursing students to reduce physical stress. There are few studies like this one that use rigorous research designs, even though this a non-randomised, without-control design was used. The generalisability and reproducibility of the findings may be constrained by the lack of randomised controlled trials. Small sample sizes are another issue with studies like the one under consideration. For instance, the study by Smith et al. (2020) is no exception. The small sample size reduced the statistical power of this study and increased the likelihood of Type II errors. Future studies should thus aim for larger sample sizes to enhance the validity and generalisability of their findings.

Previous studies on mindfulness practices with different demographics have produced encouraging stress-reduction effects. This finding is consistent with other research that showed

mindfulness has a positive impact on stress reduction among healthcare workers like nurses. The research by Regehr et al. (2014), Burton et al. (2016), and Smith et al. (2020), which focused on the physical signs of stress in nursing students, added to this body of knowledge. The majority of this research concentrates on the immediate results of mindfulness therapies. Future research should look into how mindfulness training affects nursing students' long-term physical stress levels. It would be insightful to investigate whether the advantages persisted over time and to look at potential moderators and mediators of long-term impacts.

Future studies could compare several mindfulness-based therapies to find the best strategy for lowering physical stress in nursing students. One way to determine the ideal length and intensity of mindfulness training is to compare the mindfulness-based stress reduction programs with shorter mindfulness interventions. The incorporation of mindfulness training into the nursing curriculum is another unknown topic. The viability and effectiveness of teaching nursing student's mindfulness techniques might be investigated through research, which would also look at how it affects students' resilience, stress management, and general well-being.

This study also showed a substantial decrease in behavioural stress among participants who followed the mindfulness-based stress reduction program compared to the pre-test stage. The interpersonal relationships and emotional weariness were reduced in the mindfulness group. These findings imply that teaching mindfulness techniques could help nursing students reduce behavioural stress and improve their overall wellbeing. While numerous researches have demonstrated the effectiveness of mindfulness interventions in lowering behavioural stress among nursing students (de Vibe et al., 2013; Whitesman & Mash, 2015), there is significant variation in the intervention components across studies. It is challenging to evaluate study results and identify the best elements of mindfulness therapies because of this diversity. Similarly, the majority of studies examining the effects of mindfulness interventions on behavioural stress among nursing students are cross-sectional or short-term longitudinal studies. There is a lack of long-term follow-up studies to analyse the sustained effects of mindfulness interventions on behaviour stress.

Previous studies on mindfulness therapies with different groups have produced encouraging outcomes in terms of lowering stress and enhancing wellbeing. The results of the studies conducted by Sivasubramoney, et al. (2017), Galante et al. (2018), and Zhang et al. (2020) are in line with earlier studies that have shown the value of mindfulness-based therapies for lowering behavioural stress in healthcare professionals. Future studies might look at the best aspects of mindfulness programs for lowering behavioural stress in nursing students. The most efficient solution for nursing students may be found by contrasting several methods such as cognitive-behavioural therapy, mindfulness-based cognitive therapy, and programs for reducing stress based on mindfulness. Future studies might concentrate on figuring out the processes by which mindfulness therapies reduce behavioural stress in nursing students. Examining potential moderators and mediators, such as self-compassion, emotion regulation, and resilience, could provide valuable insights. The majority of studies investigating the effects of mindfulness interventions on behavioural stress among nursing students have been conducted in Western countries. Future studies should examine the generalizability of these findings to other cultural contexts and diverse populations.

The finding further revealed that, when compared to the pre-test stage, nursing students who took part in the mindfulness-based stress reduction programme had a significant decrease in psychological stress. In addition to higher levels of self-compassion and mindfulness, the mindfulness group showed lower levels of perceived stress. These findings imply that teaching mindfulness techniques can help nursing students reduce their psychological stress. Studies exploring the impact of mindfulness

exercises on psychological stress in nursing students include a range of intervention lengths. Longer interventions (like 8 weeks) were employed in certain research (like those by Felton et al., 2015; de Vibe et al., 2013) whereas shorter interventions (like 4 weeks) were used in others. The variations in intervention length make it challenging to determine the optimal duration of mindfulness training for maximum stress reduction. This study lacked well-designed control groups, which limits the ability to attribute the observed effects solely to mindfulness training. Some studies utilise passive control groups, such as waitlist controls, which may introduce confounding variables and reduce the validity of the findings.

Previous studies on mindfulness practices with a range of populations have consistently demonstrated beneficial effects on psychological stress reduction. The results of the studies by Lu et al. (2016), Solhaug et al. (2019), and Spinelli et al. (2020) were consistent with other studies that had shown how mindfulness training reduced psychological stress in a variety of populations, including students and healthcare workers. Future studies might examine the varying impacts of various mindfulness practices (such as group versus individual, in-person versus online, etc.) on psychological stress in nursing students. It would be easier to identify the most appropriate and approachable mindfulness interventions for this population by comparing different formats. It is necessary to carry out further research on the processes that underlie the success of mindfulness therapies. Examining potential moderators and mediators (such as personality factors, prior mindfulness experience, and self-compassion) may provide insights into the precise mechanisms through which mindfulness skills affect psychological stress in nursing students. The majority of studies looking at how mindfulness practices affect psychological stress in nursing students employ a short-term outcome-oriented approach. Future studies could look into the impact of mindfulness training over the long term to see if the advantages persist.

Conclusion

The research findings demonstrated a positive effect of mindfulness skills on physical, behavioural and psychological stress among nursing students. However, future research is needed to address the limitations of existing studies, compare different mindfulness interventions and explore the long-term effects and integration of mindfulness in nursing education. Also, there is a need to examine optimal components of mindfulness interventions, investigate potential mediators and moderators, identify mechanisms of change, and investigate the findings generalisability. These areas offer potential for further investigation and hold promise for enhancing the well-being of nursing students and improving their ability to manage stress.

Recommendations

Based on the findings, it was recommended that:

1. Counsellors should be trained on appropriate ways or processes involved in the use of mindfulness skills training to combat stress among nursing school students. Having in-depth knowledge of this will help them assist students better to adjust effectively to their life endeavours and perceive stress as a motivation to accomplish a task effectively.
2. Professional counsellors should adopt mindfulness skills intervention on varying manifestations of stress (physical, behavioural and psychological) experienced by nursing students.
3. Since the practices of mindfulness skills programmes reinforce coping skills with stress among nursing students, professional counsellors can utilize those techniques in the context of preventive guidance services by, on a regular basis, educating nursing educators and healthcare professionals in the school system on ways to adopt these strategies in overcoming stressful conditions.

Limitations of the Study

One of the limitations of this study was the sample size of 15. With a small sample size, the findings may have limited generalisability to the broader population. The smaller the sample, the greater the risks of obtaining results that are specific to the sample itself, rather than reflecting the true population characteristics. In addition, a smaller sample size may reduce the statistical power of the study. Insufficient power increases the risk of false-negative results, where a real effect is not detected due to the small sample size. The smaller sample size has wider confidence intervals, which reflect the range of values within which the true population parameter is likely to fall. However, this sample size was considered appropriate because of the difficult access to the participants, as their academic schedule was so cumbersome that it hardly gave room for the researcher to conduct the exercise. This is also necessary to detect the larger effect of the independent variable on the dependent variable. According to Serdar et al. (2021), if the effect being studied is large, a smaller sample size may be sufficient to detect a statistically significant effect. With a large effect size, the sample size requirement decreases, as larger effects are generally easier to detect with smaller samples.

Another limitation of this study was the lack of a control group, which might affect the internal validity of its findings. Without a control group, it may become challenging to establish a causal-effect relationship between the independent variable (mindfulness training) and the dependent variable (stress). There may be other factors at play, such as participants' pre-existing characteristics, external events, or other concurrent interventions, that could account for the observed changes. However, the study lacks a control group because it was conducted in an educational setting where it was difficult to assign the students to different classrooms due to logistics limitations and educational policy. Given these implications, it is important to interpret these findings cautiously. While this study can provide valuable insights and generate hypotheses, it may not allow for strong causal claims or generalisability beyond the specific sample and context.

Suggestions for Future Research

The quasi-experimental study on mindfulness skills intervention for alleviating stress manifestations among nursing students in Ilorin metropolis, Nigeria provides valuable insights into the potential benefits of mindfulness in a specific population. To further enhance the understanding of this topic and contribute to the existing body of knowledge, it was suggested that future researchers should:

- Conduct a longitudinal study with an extended follow-up period to examine the long-term effects of mindfulness skills intervention on stress reduction among nursing students to further advance our understanding of this topic and add to the body of knowledge already in place. This would assist in ascertaining whether mindfulness benefits endure after the intervention period and whether its effects are sustainable.
- Examine how well mindfulness skills interventions work in comparison to other stress-reduction strategies or tactics, like cognitive-behavioral therapy or relaxation methods. This would give a thorough grasp of mindfulness's relative effectiveness over other well-researched therapies and determine the best strategy for nursing students in the city of Ilorin.
- Explore the lived experiences and perspectives of nursing students who have received mindfulness skills instruction using qualitative research techniques like focus groups and interviews. This would offer a more thorough comprehension of the individualized

experiences, difficulties, and advantages linked to mindfulness in the context of nursing students' stress management.

- Determine how mindfulness interventions can be culturally adjusted for nursing students in the city of Ilorin. Examine the potential impact of cultural variables on the adoption, efficacy, and acceptance of mindfulness practices in Nigeria. The results of this study will be useful in adapting mindfulness therapies to the target population's unique cultural demands and preferences.
- Examine the impact of mindfulness therapies affect nursing students' academic achievement. This will help determine whether adopting mindfulness techniques might lower stress levels and lead to better academic results, such as test scores, GPA, or clinical performance.

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DOI: <https://doi.org/10.57125/FED.2023.12.25.10>

How to cite: Katerini, I. (2023). Development Perspectives of German Language Teaching for Special Purposes: Exemplary Teaching Practices in Academic Lessons in Greece. *Futurity Education*. 3(4). 167-182.
<https://doi.org/10.57125/FED.2023.12.25.10>

Development Perspectives of German Language Teaching for Special Purposes: Exemplary Teaching Practices in Academic Lessons in Greece

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Received: September 12, 2023 | **Accepted:** November 2, 2023 | **Available online:** November 13, 2023

Abstract: The development of German language teaching for special purposes has seen several advancements in recent years, with the incorporation of innovative teaching practices to enhance the learning experience for students. Here are a few exemplary teaching practices in this field. The aim of the paper was to present basic aspects of teaching German language for special purposes. The methodology of the paper was a case-study in undergraduate courses for German, technical terminology at the University of Ioannina, (Greece), as well as in National and Kapodistrian University of Athens (Greece) that resulted in that though the empirical approach of teaching German, the understanding of technical terminology in academic undergraduate courses arose. The findings could suggest that a better understanding of technical terminology can improve students' language proficiency and communication skills, making them more competitive in their academic and professional pursuits. This can lead to improved academic performance, better job opportunities, and increased success in their chosen fields. The necessity to enrich and redesign the curriculum to meet new professional and academic requirements indicates that the current curriculum is lacking in terms of addressing the needs of students in the modern world. This point could be expanded upon by discussing specific ways in which the curriculum can be updated, such as the inclusion of more technology-related content, project-based assignments, and collaboration with industry professionals. Changes in the curriculum and teaching practices can impact the future of education by better preparing students for the evolving demands of their respective fields. By integrating innovative teaching practices, educators can create more engaging

and dynamic learning environments, which can foster creativity, critical thinking, and problem-solving skills in students. This can ultimately lead to a more skilled and adaptable workforce that is better equipped to succeed in a rapidly changing world.

Keywords: German for specific purposes, teaching practices in higher education, curriculum design, pedagogical approaches, specialised vocabulary, student motivation, teacher training.

Introduction

Recently, German language courses for special, scientific and professional purposes have been offered by many University departments in Greece. The increasing interest of students in specialised language training and gaining technical knowledge of terminology in different scientific fields, such as the health assessment, requires the enrichment of the contents of the academic German language courses offered, as also the redefinition of their goals. Overall, the development of German language teaching for special purposes relies on embracing innovative teaching practices that cater to the unique needs and goals of students. By incorporating task-based learning, authentic materials, technology integration, industry expert involvement, and project-based learning, educators can create a dynamic and effective learning environment for students aiming to excel in their specific field. The novelty of the study consists in underlining the prospects for development of teaching technical terminologies in the German language as well as highlighting the necessity of enriching and redesigning the curriculum of Teaching German language for special, scientific purposes with innovative teaching applications, adapted to the new professional and academic requirements, so as to make the courses in question more up-to-date, attractive and effective for the future workers/scientist.

According to the "Model of workplace discourse and its contextual frames" by Gunnarsson (2009, p. 20–27), the multilingual person/professional has language and communication skills, a rich professional language repertoire and is also able to effectively utilise language practices in a specific social context. Based on the above theory, the updated curricula for learning a foreign language for professional purposes deal with each communicative event at a linguistic level (Mavridou, 2022, p. 23).

The increasing challenges in the professional and academic arena require an upgrading of specialised language courses with the aim of acquiring/mastering the technical, foreign language terminology and the required communication, intercultural skills by young learners and professionals, throughout more scientific fields (González-Pérez & Ramírez-Montoya, 2022). The aim of this paper was to highlight the perspectives for the development of teaching German language for special purposes through the presentation of examples of teaching practices, which are empirically applied in teaching, in undergraduate courses for German, technical terminology at the University of Ioannina, Greece.

Exemplary Teaching Practices in Academic Lessons in Greece seems interesting, and it is important to identify any potential gaps or areas that require further research. Here are some possible lacks and purposes for future research in this area: there is a lack of research on the effectiveness of specific German language teaching methodologies for special purposes; there are limited exploration of learner-centered approaches in German language teaching for special purposes; insufficient research on the use of technology in German language teaching for special purposes; limited empirical research on the role of cultural competence in German language teaching for special purposes; a lack of research on the effectiveness of assessment techniques in German language teaching for special purposes. By addressing these research gaps, future studies can contribute to enhancing the quality of German

language teaching for special purposes, as well as provide valuable insights for educators, curriculum designers, and policymakers in Greece.

Literature Review

Recently, the teaching of modern foreign languages in compulsory schools was inspired by the tradition of teaching the classical languages, Latin and Greek, dating back to the 16th century. The grammatical-translation method served as the standard model: students memorised the vocabulary, conjugated verbs, learned grammatical rules, and then applied this knowledge to translate passages from one language into another (Weißenfels et al., 2022). The traditional approach seemed adequate for developing a clear knowledge of the second language and its functioning. However, due to the need to focus on foreign languages for special purpose, especially on the oral communication and the acquisition of terminology, the goals of teaching have shifted from a clear knowledge of the language to the use of new techniques (Lim & Aryadoust, 2022). Many attempts have been made to incorporate the findings of research in the field of foreign language teaching in vocational schools (Cutrim Schmid, 2022). Research in foreign language teaching has been inspired particularly by the cognitive psychology. Although researchers have accepted the idea that the language proficiency requires the development of implicit competence in the language - explicit knowledge of vocabulary, verb forms and grammatical rules - there is a need for techniques for learning professional vocabulary (Troyan et al., 2022). The development of the ability to memorise such vocabulary has thus been conceptualised as a process similar to that used in teaching other school subjects (Gabriel et al., 2022). The generally accepted reference models of the foreign language learning process were those of Anderson (1990) and De Keyser (1998). De Keyser, as cited by Killman (2023), suggests that learning takes place in three stages in three stages: acquisition of language knowledge, consolidation through exercises, and through the transfer of knowledge to professional activities.

However, many of the new approaches that emerged in the last ten years in the context of new official guidelines did not sufficiently address the professional language (Sanusi et al., 2022).

In order to fill this gap, four skills should be identified: oral comprehension, written comprehension, oral speaking and written expression. Tenieshvili (2023) notes in this regard that the emphasis is on the principle of sequential progression in learning, which goes from simple to complex, from general to specific and from general to specific (Fitria, 2023). There is also a fifth, so-called methodological skill, which is usually referred to as interdisciplinary.

This is in line with the idea of autonomy and the learner centred approach. Students are encouraged to acquire strategies for professional interaction, self-assessment and reflection on their learning. Grammar (then) returns in this specific subject as part of the stage of reflection in context and induction of syntactic rules (Ruggiero, 2022). New pedagogical and didactic developments called the the multi-prism approach of the scientific subject emerged in order to complement the above-mentioned approaches and to achieve better results in teaching and learning foreign languages for special purpose (Haddadi & Sadri, 2021).

The main features of this approach are that it is active, physical, participatory and proactive. It aims to bring the language to life, to activate the learner.

Problem Statement

There is a lack of perspectives comprehensive development in German language teaching for special purposes, which hinders the effective acquisition and application of the language for specific

domains such as business, law, medicine, and engineering. Currently, most German language courses focus on general proficiency without addressing the specific language needs and goals of learners in specialised fields. As a result, professionals seeking to enhance their German language skills for specific purposes face significant challenges in finding suitable resources and learning opportunities. This gap in the development of German language teaching for special purposes limits the potential for improved communication and collaboration between German-speaking professionals and their international counterparts. Therefore, there is a need for the establishment of comprehensive development perspectives that cater to the specific language needs of professionals in various specialised domains, facilitating their effective acquisition and application of German language skills in their respective fields.

Research Aim and Research Questions

As the aim of the paper was to present basic aspects of teaching German language for special purposes, the next research questions were developed:

1. Are the empirical approaches to the teaching of the German language for special, scientific purposes useful and approved?
2. What is the main conceptualization of teaching German Medical Terminology?
3. What are the new perspectives in teaching German Terminology in the Field of Psychology?

Research Methodology

General Background

The aim of this paper was to highlight the perspectives for the development of teaching German language for special purposes through the presentation of examples of teaching practices, which were empirically applied in teaching, in undergraduate courses for German, technical terminology at the University of Ioannina, Greece. To answer the question, a case-study was accomplished and then the results were used at the University of Ioannina, Greece in learning practice.

Sample

The case-study was accomplished in order to make more effective the learning of German with the help of three parameters of language acquisition: a) the terminological, systemic-linguistic acquisition, b) the pragmatic-linguistic acquisition and c) the cognitive-linguistic acquisition. For this purpose 41 scientific articles from Greek and worldwide authors were examined. Based on the above multi-prism approach of the scientific subject in question was attempted, in the academic, undergraduate courses "German for Academic Purposes" and "German for Medical Purposes" offered by the University of Ioannina.

Instrument Procedures

The goal of the introduction of such new approaches of language acquisition should prove the hypothesis of the paper that the development perspectives of German language teaching for special purposes in the field of medical psychology can provide significant benefits to students pursuing careers in this field, namely: Enhanced Communication Skills; Cultural Competence; Professional Development; Research and Academic Collaboration; Study Abroad Opportunities; Patient Care and Outcomes. The case-study presented in this paper aimed to demonstrate how integrating German language acquisition into the curriculum of medical psychology students can lead to the realisation of these benefits. The first

benefit, enhanced communication skills, referred to the ability of students to effectively communicate with German-speaking patients and colleagues. By learning the German language, students will be able to understand and respond to the specific needs and concerns of German-speaking patients, thereby improving patient care and outcomes. Cultural competence is another important skill that can be developed through German language acquisition. Understanding the customs, beliefs, and values of German-speaking patients can help medical psychology students provide culturally sensitive care and establish strong therapeutic relationships. Furthermore, integrating German language learning into the curriculum can contribute to the professional development of students. In an increasingly globalized world, being bilingual or multilingual is seen as a valuable asset in many professions, including medical psychology. By acquiring German language skills, students can enhance their employment prospects and gain a competitive edge in the job market. Research and academic collaboration is another potential benefit of learning German in the field of medical psychology. By being proficient in the German language, students can access and contribute to German-language research literature, collaborate with German-speaking researchers, and potentially participate in international conferences and exchange programs. Moreover, the introduction of German language acquisition can open up study abroad opportunities for medical psychology students. Studying and immersing themselves in a German-speaking country can provide students with firsthand experience of the German healthcare system and enhance their understanding of medical psychology in a global context. Lastly, learning German can contribute to the improvement of patient care and outcomes. By being able to communicate directly with German-speaking patients and understand their needs, medical psychology students can tailor their interventions and treatment plans, leading to better patient satisfaction and treatment success. Overall, the case-study presented in this paper aimed to demonstrate how incorporating German language acquisition into the curriculum of medical psychology students can provide significant benefits, including enhanced communication skills, cultural competence, professional development, research and academic collaboration, study abroad opportunities, and improved patient care and outcomes. By realising these benefits, students pursuing careers in medical psychology can better meet the challenges of a diverse and globalized healthcare system.

Research Results

Clarification of the Term "German for Special Purposes"

According to the bibliography, the most referred and applied found term is the term: "German for specific purposes" (GSP) (Byrnes, 2012). The concept of "specific purpose" refers to the targeting of language courses in order to achieve learning outcomes related to the respective professional/scientific field. The terms, that are also found in the bibliography are: "German for special purposes" (Grosseck, 2010), "German for Academic Purposes" (LAP), "Deutsch für akademische/spezifische Zwecke" and "Deutsch als Wissenschaftssprache" (DaW) (Jaworska, 2015) in specific scientific fields.

Characteristics of Foreign Language for special purpose courses include: the importance of using authentic material, emphasising the aim and purpose of the course through the use of simulated, interactive exercises, and promoting self-direction (Giannarou, 2021) of the learner, in to become an autonomous user of the language himself. Based on the bibliographic review, few research and empirical studies are found regarding the teaching of the German language for special purposes in Greek universities.

For example, Palasaki (2018, p. 127) presented, indicatively, different listening comprehension and note-taking techniques that can be used in German language classes for academic purposes. Daffa

(2003) presented exemplary applications of the use of German, medical and legal terminology using Greek-German and German-Greek dictionaries.

Empirical Approaches to the Teaching of the German Language for Special, Scientific Purposes

This article presented a case-study in teaching German language for special purposes in the context of undergraduate courses offered by the University of Ioannina, which concerned applied teaching practices in technical terminology courses in the scientific fields of medicine and psychology. The study included an additional case from the Greek university – National and Kapodistrian University of Athens (Greece). The School of Philosophy offers courses in German for specific purposes, including German for medical professionals, legal German, and German for tourism in order to indeed strengthen the overall argument. These two cases from the Greek universities enhanced the validity and strength of the arguments, provided a broader perspective, and enabled more meaningful comparisons.

Teaching of German, Medical Terminology. According to the conceptualisation of the term "medical, technical terminology" (Fachsprache Medizin) by Schön and Schrimpf (2010, p. 50), teaching and learning of technical terminology in the field of Medicine is related to the composition of three parameters of language acquisition: a) the terminological, systemic-linguistic acquisition (terminologischer, systemlinguistischer Zugriff), b) the pragmatic-linguistic acquisition (pragmalinguistischer Zugriff) and c) the cognitive-linguistic acquisition (kognitionslinguistischer Zugriff).

Based on the above holistic view on teaching German medical terminology, the multi-prism approach of the scientific subject in question is attempted, in the academic, undergraduate courses "German for Academic Purposes" and "German for Medical Purposes" offered by the University of Ioannina. In particular, the teaching goals are:

- the processing and consolidation of specialised vocabulary at different levels (linguistisches Inventar, soziolinguistische Kompetenz, Diskurskompetenz, Strategische Kompetenz) (Borowski et al., 2016).
- The acquisition of communication and intercultural skills (kommunikative-interkulturelle Kompetenzen) in a specialised, social context (work-academic).

During teaching, a variety of teaching tools/media are used and collective actions are carried, such as (tab.1):

Table 1

Teaching Tools for Learning German for Special Purpose

Authentic material	(Authentische Texte) with information on medical studies in Germany as well as updates on current medical issues (use of slides, diagrams, images, blogs, websites).
Language exercises	(Arbeitsblätter) to understand and consolidate technical terminology (termini/Fachsprache) by analyzing terms into parts, matching terms (lemmas) in German and Greek (ancient Greek), interpretation of abbreviations (Abkürzungen) and symbols of medical content: to update the patients' medical files (Documentation).

Real scenarios from everyday medical life in order to transfer the student to the medical context (Szenario using Podcasts, videos/youtube)	For example, the techniques of taking notes and summarising medical cases using video (you-tube): to obtain medical history of patients (Anamnesegegespräch), to inform patients regarding diagnosis and/or treatment (e.g. Patientenaufklärung, Diagnose mitteilen, Behandlungsplan), to complete referrals and medical reports (Konsilschein, Struktur des Arztbriefes).
Real scenarios from everyday medical life in order to transfer the student to the medical context (Szenario using Podcasts, videos/youtube)	For example, the techniques of taking notes and summarizing medical cases using video (you-tube): to obtain medical history of patients (Anamnesegegespräch), - nform patients regarding diagnosis and/or treatment (e.g. Patientenaufklärung, Diagnose mitteilen, Behandlungsplan), to complete referrals and medical reports (Konsilschein, Struktur des Arztbriefes), to update the patients' medical files (Documentation).
Role-playing games to practice the use of medical-technical terms	(e.g. die Körperliche Untersuchung, die Patientenvorstellung) with simulation of real working conditions (e.g. Handlungsfelder: 1. Arzt-Patient/Angehörige, 2. Arzt-Arzt, 3. Arzt-Pflegepersonal/Verwaltung).
Digital resources with medical content	such as websites and social media platforms (e.g. the platform for intercultural medical communication in Europe "www.imed-komm.eu", the informative profiles: quarks.de, pflege_medizin_deutsch, #medizin on Instagram).
Digital applications and teaching tools (smart Devices und medizinische Apps)	(Iberika Sprachschulen, 2023), which are connected to the so-called digital literacy "data literacy" (Kuhn et al., 2018), such as: a. interactive quizzes (e.g. Kenhub, Speed Anatomy, Smart Histology), b) digital presentations (e.g. Organs 3d Anatomy, Essential Anatomy 5, Die Prometheus-app).
Conducting and presenting group assignments by the students on current medical topics/issues, e.g.	"die Ärztekammern in Deutschland (the medical associations in Germany), "medizinische Fachrichtungen (medical specialties), das deutsche Gesundheitssystem (the health system in Germany)".
The use of specialised teaching manuals	(i-book) and German-Greek/Greek-German dictionaries, medical terms, paper and digital (e.g. Doccheck Flexikon), as auxiliary means/materials to consolidate the technical terminology to be processed
Participation of students in training seminars	by teachers of German, medical terminology from the University of Pécs - in the context of Erasmus mobility - on the practices of teaching German for Medical Purposes at the University of Pécs (Hungary) as well as the development prospects of foreign language medical terminology.

Source: the authors' own design.

In the context of investigating language learning strategies applied by the students for special purposes, a questionnaire survey was conducted during the academic year 2022–2023, which highlighted important aspects regarding the relationship between the most frequently applied learning strategies (cognitive strategies - SILL of Oxford) and their willingness to communicate (WTC/FLS/ by Baghaei) during teaching. The results of the research were presented at the international conference “Impact of Sociocultural Factors on Health, Semmelweis Medical Linguistics Conference 2023” (Tseligka et al., 2023).

Teaching German Terminology in the Field of Psychology. As part of the teaching of German language and terminology courses in the Psychology department, it is taught in the A and B semesters in addition to the content of general linguistics (level B1) and technical terminology (Fachsprache) in the field of Psychology. Specifically, it aims to:

- ✓ The recognition of language structures and terminology "Fachsprache" from the scientific field of Psychology,
- ✓ The understanding and interpretation of scientific texts with themes matter corresponding to the subject,
- ✓ The development of language skills for specific, academic purposes
- ✓ the production of written and speaking academic discourse, through the writing of assignments and the creation of individual/group presentations to promote critical thinking and collaborative reasoning.

Next, teaching techniques and practices for the processing, analysis and consolidation of technical terminology in the field of Psychology are presented.

- ✓ Utilization of authentic texts from German-language literature and articles (e.g. www.journal-für-psychologie.de) with topics such as: "The relationship between Philosophy and Psychology. The philosophical basis of Psychological terms. Theoretical schools of Psychology (e.g. Allgemeine Psychologie vs Wissenschaftliche Psychologie, Entwicklungspsychologie, Sozialpsychologie). Scientific Examples (e.g. Gestaltpsychologie, Behaviorismus, Tiefenpsychologie, kognitive Wende, moderne Psychologie). Great personalities of Psychology/Psychiatry from the German-speaking area".
- ✓ Practical applications of comparing/matching the psychological terms (Terminologie und Fachbegriffe) from the ancient Greek language and the German language:

-using surnames/Eponyms (e.g. Alzheimer, Münchhausen-Syndrom), acronyms (Akronyme, e.g. PsychTh/Psychotherapeut), synonyms (Synonyme, e.g. Psychologie/Seelenheilkunde).

-With the technique of analyzing lemmas in parts: e.g. a) Prefixes (Präfixe), such as pro- (pro) prophylaxis, syn- (sy) Synapse, Syndrom, b) Suffixes (Suffixe), such as -ose (Neurose), -ater (Psychiater) c) basic terms (Basiswort/ Merkhilfen), such as Anthropologie < anthrōpos + logos (Mensch+Lehre), Psychosomatik <psyche/soul + soma/body (Seele + Körper).

- ✓ Analysis of abbreviations (Abkürzungen), e.g. ADHS-Aufmerksamkeitsdefizit-Hyperaktivitätsstörung, APKS- Allgemeine Psychologie und kognitive Selbstregulation and investigation of possible corresponding Greek abbreviations.
- ✓ Utilisation of paper and digital dictionaries (e.g. www.spektrum.de, www.psylex.de).
- ✓ Use of websites and blogs for information on issues of the daily working life of professionals in Mental Health in the German-speaking area (e.g. <https://www.dgps.de>; <https://blog.neuronation.com>; <https://www.beltz.de>).
- ✓ Utilisation of German-speaking educational platforms and digital applications (Trainingsplattform) for Mental Health (e.g. www.etraining-kindertherapie.de, ApkOnline-Psychologie Dictionary Definitions Terms, www.psychologenverlag.de) for practicing and consolidating technical terminology.
- ✓ Writing and presentation of individual/group assignments of the students with research topics, concerning the scientific field of Psychology (e.g. “Berühmte deutsche Psychiater”, “die Neuroplasticizät”, “die Ausbildung für Psychotherapeuten”)

The aforementioned teaching practices are only a few examples of the multidimensional and complex content of German language courses for learning psychological terms. The science of Psychology constitutes a demanding, interdisciplinary scientific field, in which teachers and trainees should systematically update their knowledge and be updated on the developments of internationally applied, technical terminology.

The National and Kapodistrian University of Athens, specifically the School of Philosophy, offers specialised courses in German for specific purposes. These courses aim to provide students with the necessary language skills and knowledge in various professional fields. The German for Medical Professionals course focuses on teaching medical terminology, communication skills, and specific vocabulary relevant to the healthcare industry. It equips students with the ability to communicate effectively with German-speaking patients, colleagues, and medical professionals. The Legal German course focuses on teaching legal terminology and communication skills necessary for professionals working in the legal field. Students learn about German legal systems, contracts, court procedures, and related vocabulary. The German for Tourism course is designed for those interested in pursuing a career in the tourism industry. It covers topics such as customer service, cultural aspects, travel agencies, hotels, and tour guiding. Students develop language and communication skills necessary for handling German-speaking tourists and providing excellent service. These specialised courses in German for specific purposes aim to equip students with the necessary language skills and knowledge to succeed in their respective fields. They provide an opportunity for professionals, or future professionals, to develop their German language proficiency in a targeted and practical way.

These cases allowed for comparison and analysis. They enabled identifying patterns and similarities in two universities, broadening the scope of the article. This case-study provided a comprehensive understanding of the topic and allowed drawing more informed conclusions.

Discussion

This article focused on the teaching of German for special purposes in Greek universities, for which few research sources can be found in the literature. The aim of the article was to highlight the new challenges in foreign language academic education as well as the prospects for the development of the academic subject of German language teaching for special purposes.

The use of new, digital teaching tools (Reichert-Schlag et al., 2023) in foreign language teaching for special purposes is deemed more necessary today than ever. Apprentices utilise alternative learning strategies (Arras & Widmann, 2018), consolidation and use of the foreign language, technical terminology as well as the required communication skills based on the emerging social contexts of scientific action and work.

In comparison to the above, it is deemed necessary to enrich the Study Programs of the university schools with language courses with a clear orientation to the development of the social and scientific functionality of the students, which will aim at learning intercultural strategies and the application of modern teaching practices when teaching a foreign language technical terminology (Aulenkamp et al., 2021). The development perspectives of German language teaching for special purposes in the field of medical psychology can provide significant benefits to students pursuing careers in this field (Genç, 2020). In terms of the paper's experiment Fu (2020) underlines the enhanced Communication Skills. According to Illés (2020) a specific focus on medical psychology-related language ensures that students develop the necessary vocabulary, phrases, and expressions to effectively communicate with patients, colleagues, and other healthcare professionals. Indeed, this can minimise misunderstandings and facilitate more accurate information exchange. In terms of the cultural competence, Wang (2020) states that teaching German with a focus on medical psychology can also foster cultural competence among students. Understanding the cultural nuances and beliefs related to mental health and psychology in German-speaking countries can enable students providing more empathetic and culturally-sensitive care.

The results of the paper underlined the skill of professional Development. In this context Zhang and Zou (2022) accentuate, that by offering specialised German language classes, universities and language institutions can cater to the needs of students who are specifically interested in pursuing a career in medical psychology. This can provide a more targeted and tailored learning experience, which can be of high value for future job prospects (Onishchuk et al., 2020).

A very important moment is the research and Academic Collaboration. A focus on German language teaching for special purposes in medical psychology can facilitate academic collaboration and research opportunities between institutions and experts in both Germany and other German-speaking countries (Ying et al., 2018). This can contribute to knowledge exchange, comparative studies, and advancements in the field (Kazhan et al., 2020). In turn, it can give the opportunity to study abroad. It means integrating language teaching with medical psychology can further encourage students to participate in study abroad programs in German-speaking countries (Kamila et al., 2020). Of course, an immersive experience can provide invaluable exposure to different healthcare systems, clinical practices, and research methods specific to medical psychology, setting students apart in terms of international experience and proficiency in the German language (Venzhynovych et al., 2021). As for the patient care outcomes, Muñoz-Restrepo et al. (2020) argue, that ultimately, the main benefit of German language teaching for special purposes in medical psychology is improving patient care and outcomes. Effective communication can lead to better patient-doctor relationships, accurate diagnosis, suitable treatment plans, and improved mental health outcomes. To evaluate the effectiveness of the language learning, Zhang et al. (2020) propose various assessment methods as exams, oral presentations, role-playing exercises, and case studies. But, there is a lack of research on the effectiveness of assessment techniques in German language teaching for special purposes. While assessment plays a crucial role in language education, there may be a lack of research specifically examining the effectiveness of assessment techniques in the context of German language teaching for special purposes in Greece. Future research could explore innovative and valid assessment methods that accurately measure learners' proficiency and progress in specialized German language domains.

Overall, the development of German language teaching for special purposes in the context of medical psychology holds much promise in providing students with the necessary language skills and cultural competencies to excel in this particular field. According to a similar European case-study, German is the most widely spoken native language in the European Union and is often required or recommended for academic programs in various fields such as engineering, science, and humanities. Learning a new language like German can broaden one's horizons, stimulate the mind, and boost cognitive abilities. It offers a unique opportunity to engage with a different linguistic and cultural system, expanding one's understanding of the world. Additionally, acquiring proficiency in German can foster intercultural connections and friendships with native speakers, promoting social and personal growth. Thus, the specific purpose for learning German in Europe is subjective and depends on the goals, interests, and circumstances of each individual (Seven, 2020).

Especially, as regards the teaching of the German language for special purposes, the need to expand and create more special language courses in different scientific fields in all the country's academic institutions is identified - based on European trends.

Conclusions and Implications

German language teaching for special purposes (LSP) gained a significant importance in recent years due to the globalisation of industries and the need for specialised language skills in various professional fields. The development of German LSP has been influenced by various factors such as the specific needs and requirements of target industries, advancements in technology, and changes in language and communication practices.

Thus, the results showed that the empirical approaches to the teaching of the German language for special, scientific purposes in Greece are useful and approved. The current state of German LSP shows a strong focus on vocational training programs and a growing demand for specialised language courses targeting specific professional sectors such as business, medicine, and engineering. The integration of digital technologies and online platforms has played a crucial role in the development of German LSP, allowing for greater flexibility in learning and providing access to a wider range of resources and materials.

The main conceptualisation of teaching German Medical Terminology in Greece was the use of three parameters of language acquisition: the terminological, systemic-linguistic acquisition, the pragmatic-linguistic acquisition, the cognitive-linguistic acquisition in order to achieve the teaching goals like the processing and consolidation of specialized vocabulary at different levels and the acquisition of communication and intercultural skills.

Concerning the new perspectives in teaching German Terminology in the Field of Psychology in Greece, the research question proved that the aforementioned teaching practices should be multidimensional and complex as the science of Psychology constitutes a demanding, interdisciplinary scientific field, in which teachers and trainees should systematically update their knowledge.

The study's findings paved the way for a transformation in language education methodologies. The need for more immersive and communicative language learning approaches was underlined. Thereby shifting from traditional grammar-focused instruction to more experiential and interactive methods could improve students' language proficiency and overall learning outcomes. The findings highlighted the necessity for updating language education curricula. Based on the study's results, educational authorities could consider revising the existing curriculum to integrate more skill-based activities, authentic materials, and real-life contexts. By doing so, students would be better equipped to

apply their language skills in practical situations, making language learning more relevant and effective. The study's implications might include the creation of innovative learning environments to support German LSP education. These environments could involve the use of technology, such as language learning apps, online platforms, and virtual reality tools. By utilising these innovative resources, students' engagement and motivation could be increased, ultimately enhancing their language learning experience.

While the study is focused on the German LSP challenges faced in Greece, it is essential to consider its broader international relevance. The findings and recommendations could be valuable for other countries or educational contexts grappling with similar issues in German LSP education. By drawing parallels and comparing strategies, policymakers and educators worldwide could adapt and apply the study's insights to their respective situations.

However, there are still some challenges and limitations in the field of German LSP, such as the need for updated and relevant teaching materials, the effective utilization of digital technologies, and the development of pedagogical strategies that cater to the specific needs of learners in different professional domains. Collaboration between language teachers and professionals from different industries should be encouraged to ensure the relevance and effectiveness of German LSP programs.

As for the implications, policy changes and financial support should be provided to promote the development and implementation of German LSP programs, especially in areas where there is a high demand for specialised language skills.

Suggestions for Future Research

The research findings have significant implications for Greek language teachers, curriculum developers, and policymakers involved in the field of German language education. It is vital for them to consider the specific needs and requirements of learners in various professional domains when designing German language for Specific Purposes (LSP) courses and materials. Moreover, there is a need to further explore and expand the integration of digital technologies in German LSP to enhance the learning experience and provide learners with ample opportunities to practice and apply their language skills in authentic real-world contexts. Additionally, future research should investigate the effectiveness of different pedagogical approaches and methodologies in German LSP, with a particular focus on the development of communicative and task-based learning activities. It is also imperative to delve into the role of digital technologies in facilitating the learning and teaching of German LSP, including examining the effectiveness of online platforms, virtual reality, and mobile applications in supporting language acquisition and proficiency. Conducting needs analysis and assessments of learners in various professional domains is crucial for identifying specific areas of language proficiency that need to be targeted in German LSP programs. Moreover, longitudinal studies can provide valuable insights into the language development and proficiency levels of learners in German LSP programs over an extended period, thus shedding light on the long-term impact of specialized language training. To gain a comprehensive understanding of the field, comparative studies can be undertaken to compare the development and implementation of German LSP programs in different countries. These studies can explore the similarities and differences in approaches, pedagogies, and outcomes, thereby contributing to the advancement of German LSP education across borders.

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DOI: <https://doi.org/10.57125/FED.2023.12.25.11>

How to cite: Mgonja, M. R., & Kambuga, Y. M. (2023). "Play is Play" and "Learning is Learning": Beliefs and Practices Linked to Pre-Primary Children's Play and Learning in Tanzania. *Futurity Education*. 3(4). 183-197. <https://doi.org/10.57125/FED.2023.12.25.11>

"Play is Play" and "Learning is Learning": Beliefs and Practices Linked to Pre-Primary Children's Play and Learning in Tanzania

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Received: August 18, 2023 | **Accepted:** November 4, 2023 | **Available online:** November 15, 2023

Abstract: The beliefs and practices of selected preschools in the Dodoma Region regarding the role of play in pre-class learning were examined in this study. The main goal was to understand how teachers and parents view play as a significant role in child development and how they incorporate it into their teaching and learning activities. The study's guiding questions concerned the status of play in the curriculum guidelines in Tanzania, how teachers and parents perceive the play for pre-primary school children and the challenges pre-primary teachers face in using play as a curricular tool. A qualitative research design approach was used with face-to-face interviews and documentary analysis to gather information from 17 participants, including heads of teachers, pre-class teachers, and parents. The study participants were expertly purposive and cluster sampled. Data were collected from four selected preschools located in the urban and rural Dodoma region. The study found that the play was almost unreal in all visited preschools and that pre-classrooms were dominated by academic instructions, despite teachers' awareness of the significant contribution of play in the cognitive and

academic development of a child. The study also revealed that factors such as limited play materials, academic pressures on teachers, playground safety, and unqualified teachers to teach in pre-classes could negatively impact children's cognitive and socio-emotional growth. Based on the study's findings, recommendations included curriculum adjustments and enhanced pre-primary teacher education programs.

Keywords: Play, learning, preschool, early childhood, pre-class, Teachers

Introduction

Early Childhood Education is a fundamental right for every child worldwide, regardless of ethnic background. The United Nations conventions declare that children have the right to be protected and provided with education, playtime, and other fundamental human rights (United Nations, 1989). Further, the United Nations international treaty requires all state parties to acknowledge and uphold children's rights, regardless of age or ethnicity. As a signatory of UN treaties, Tanzania has demonstrated its commitment to prioritising children's rights by enacting laws such as the Child Act of 2009 and the Disabilities Act of 2010.

The Law of the Child Act (2009) categorically states that: *"A person shall not deprive a child of access to education, immunisation, food, clothing, shelter, health and medical care or any other thing required for his development"*. Furthermore, the Act states that *"A person shall not deprive a child the right to participate in sports, or in positive cultural and artistic activities or other leisure activities unless, in the opinion of the parent, guardian or relative such participation or activity is not in the best interest of the child"*. Additionally, the Persons with Disabilities Act (2010) states that *"Persons with disabilities in all ages and genders shall have same rights to education, training in inclusive settings and the benefits of research as other citizens as well as encourage and promote the participation of persons with disabilities in sports activities at all levels"*. Besides, the country has put in place a national strategy for inclusive education and updated education policies to ensure the protection of children's rights to education (Mgonja, 2014; Mabagala & Mabagala, 2012; Kambuga & Hussein, 2022; Kejo, 2017). These rights include the right to rest, play, and participate in recreational activities. Article 37 of the United Nations treaty explicitly emphasises the importance of promoting children's right to play, and state parties are also required to educate families, communities, and parents about cultural beliefs that may impact children's rights (United Nations, 1989).

The play at an early age of child signifies a vital part of human development and is recognised as a fundamental right for every child (Karaoglu, 2020; Brockman et al., 2011; Mgonja, 2014; Kejo, 2017; Fisher, et al., 2008; UNICEF, 2018). Despite this, many caregivers and educators underestimate its power and is often overlooked as a learning tool. Some African countries, Tanzania particularly, have tried to include play in early childhood curricular education, but there has been a decline in understanding of its role in cognitive development due to increased emphasis on accountability (Ezati & Odele, 2022; Karaoglu, 2020; Bodrova, 2008; Mgonja, 2014; Kejo, 2017). In pre-primary schools in Tanzania, the play is a crucial aspect of early childhood education (Mgonja, 2014; Kejo, 2017; Shukia & Marobo, 2022; James, 2023). However, it is important maintaining a balance between conventional learning, e.g., the alphabet, memorisation of facts and poems, and recreational activities to ensure that children receive holistic support for their development (Mabagala & Shukia, 2019; Ndijuye et al., 2020; Shukia & Marobo, 2022; James, 2023). Studies reveal that, in the classroom, educators' beliefs about play can impact children's experiences and create challenges in managing the classroom. Meanwhile, caregivers often see play as a fun activity enhancing learning (Ranz-Smith, 2007; Omoera, 2011; Kejo, 2017).

Research has shown that the play was a powerful tool in education that could positively impact the development and pathways of the brain (Lester & Russell, 2008; Jing & Li, 2015; Karaoğlu, 2020). By integrating the play into the curriculum, pupils can improve their ability to focus on teacher-directed tasks and become better prepared for academic learning, including instruction in the alphabet, numbers, colour, and other important skills. This paper examined how teachers and parents view the play, its significant role in child development, and how they incorporate it into their teaching and learning activities. It seeks to answer related questions.

Research Problem

Child Playing in schools is very important for educational and cognitive development and for fostering social-emotional skills and language abilities. Play's nature and perceived role may vary across different cultures and contexts. In some societies, the child play is closely related to the free learning rather than teacher-directed learning and is consequently viewed as a valuable tool for child education development. Despite the fact that research and theory support the idea that the play is an important part of child learning in developed countries, there is scanty information available about how parents and teachers in Tanzania view the play in pre-classes and its role in preparing children for academic tasks in the future.

Research Focus

The dynamic relationship between beliefs and practices in pre-primary education provides new light on the influence of play and learning on children's development. This investigation portrays the alignment between these beliefs, actual classroom practices, and their influence on child development. The dynamic interplay between beliefs and practices offers new perspectives on the results of pre-primary education about the significant role of the play and learning in children's development and their potential implications for pre-education in Tanzania.

Research Aim and Research Questions

The study explored parents' and teachers' beliefs and practices with regard to the play as a learning tool in pre-classes in Tanzania. The aim was to gain insights into how selected participants understood the play and its significant role in teaching and learning activities as well as how beliefs about the play and learning influenced their practices in the classrooms and home settings. The main multifaceted question guiding the study was as follows: What is the status of play in the curriculum guidelines in Tanzania? How do teachers and parents perceive the play for pre-primary school children? and What challenges do pre-primary teachers face in using the play as a curricular tool?

Research Methodology

General Background

In this study, the use of a qualitative design, as described by Creswell (2014) and Johnson and Christensen (2014), as an inquiry process of describing life experiences and giving them meaning to social or human problems opted. This design allowed a comprehensive understanding of the ideas, perceptions, opinions, and beliefs of the study participants regarding their attitudes and practices towards the play. So far, this design has helped reduce misunderstandings with key informants by allowing participants to express their feelings and experiences.

Sample / Participants / Group

The study was conducted from 2021-2022 by involving four primary schools in the Dodoma region's urban and rural areas. The selected sample consisted of 17 participants, including four Heads of schools, eight pre-primary class teachers, and five parents. These study participants were homogeneously selected using a sampling technique helping to explore their beliefs and practices about the contribution of the play as a teaching approach in pre-primary child brain development in Tanzania. The selected 17 participants were obtained using expert purposive and cluster sampling techniques. The head of school and pre-class teachers were selected from the chosen school sites using expert purposive sampling. In contrast, parents with children in pre-primary classes and who lived near schools were selected using cluster sampling for easy access.

Instrument and Procedures

The researcher used a face-to-face semi-structured interview and documentary analysis to obtain information from the study participants. The interview questions were designed to capture verbal interactions between the participants and the researcher. Creswell (2014) explains that a semi-structured interview is a flexible tool that enables new questions to be introduced during the interview based on the interviewee's responses. The researchers used this technique to capture the beliefs and classroom practices of teachers and parents at home regarding the role of play in developing children's mental cognition. The documents were reviewed to see what directives and guidelines are regarding the implementation of play as the pedagogy in pre-schools. Since Kiswahili is the medium of instruction in pre-class in Tanzania, the interview guide questions were transcribed into Kiswahili for all key informants. Later, the Kiswahili version was translated into English for analytical interpretation. The questions were the following:

Interview Guide Questions for Teachers: 1. When reading the early childhood curriculum guidelines, what do you reflect on the position on play within these guidelines? 2. To what extent do you implement these guidelines in your classroom when it comes to children's play? 3. Why do you think children's play is important for their learning? 4. Can you explain the link between play and children's learning? 5. What do you believe are the obstacles preschool teachers face when using play to help children learn?

Interview Guide Questions for Parents: 1. In your opinion, what is the role of play in a child's development? 2. Can you explain the link between play and children's education? 3. How frequently do you encourage your children to engage in playtime at home? 4. Do you believe that preschool teachers should prioritise play over academic instruction? 5. What do you think are the challenges teachers face when implementing play-based learning strategies in schools?

Data Analysis

Data analysis is an ongoing process of sorting, sifting, reading, and rereading data (Creswell, 2014). To accomplish a common interpretation pattern across the data set, the researcher transcribed, summarised, reduced the volume of raw information, and constructed a framework for communicating the essence of what the data revealed. Thereafter, thematic inductive content analysis was done to produce themes and align them to the study's guiding questions. Finally, the data collected from all sources were presented as thematic paraphrases and verbatim quotes.

Research Results

This study was conducted in the natural settings of schools where teachers have autonomy in their classroom environments. The research explores the beliefs and practices of teachers and parents regarding the play as a curricular learning tool in pre-primary schools. The study findings were presented based on the research questions.

Status of Play in the Curriculum Guidelines in Tanzania

The first question of this study sought to identify the status of the play in the curriculum guidelines in Tanzania. The results reveal that the play was one of the more excellent central approaches to educating young children as it aids children's early development of arithmetic, language literacy skills, and social as well as self-regulatory skills. The government of Tanzania acknowledged play in pre-primary as the methodical approach under the educational and training policy of 2014 and the Pre-primary syllabus of 2016. These two government documents consider the play to be the main activity for young children, and pre-primary and class teachers are encouraged to use the play to facilitate teaching and learning by motivating and increasing interest in the learning process. The Educational and Training Policy of 2014 and the Pre-primary Syllabus 2016 put more emphasis on the play as a multi-sensory experiential learning for children aged one to three by directing class teachers to offer a hands-on and play-based program. These documents require children to engage in various activities such as messy play, sand and water play, swimming, and physical education sessions on the school playground.

"Teaching methods constitute one of the key factors that promote the child's interest in learning. To promote the child's interest, the teacher is required to use methods that will encourage children's participation in performing different activities. Since the play is the main activity for young children, teachers are encouraged to use the play to facilitate teaching and learning" (pre-primary school syllabus, pg. 21).

Despite the high-level status of the play in the documents, the interviewed teachers at pre-primary schools noted that the play is theoretically given a high value in the documents but in practice is less valued. Some interviewed teachers view the use of the play approach as taxing because school environments do not support its implementation. As one teacher said:

"Look we are stressed by the authority to ensure children at this level know the 3Rs (read, write and arithmetic) so no teacher will go for the play method while you will be questioned whether children can the 3Rs. In practice children at the age of 1 to 3 years are not supposed to have such subjects as this, they were supposed to be outside playing".

Although pre-primary curriculum documents insist on play-based teaching and learning as the main approach, most teachers prioritise didactic methods that place too much emphasis on 3Rs skills and with less emphasis on learning through the play. These practices probably might be caused by either the majority of teachers being unfamiliar with pre-primary guidelines or prospective pre-primary teachers being taught in the same ways as primary school teachers in colleges.

Teachers' and Parents' Perceptions of Play for Pre-Primary School Children

The second question of this study explored teachers' and parents' perceptions of play as a teaching strategy for pre-primary school children in schools. The results showed that all participants recognised the play as the children's basic right that needs to be managed in educating young children. The participant's views are categorically presented below;

Views of teachers. Most teachers view the play for children in school as a fundamental right as it aids in their growth and is something that cannot be separated from child development and learning. One of teacher said the following:

“Most of the teachers think that their task to these pre-primary children was to make sure that they know how to 3Rs skills, but we forget this important aspect in child development without knowing that we deny one of the basic rights of the child”.

Another teacher said the following;

“Children learn by seeing, doing, and even by touching. I think play is important for all children, especially those ages 2 to 3. It is good for their memory because as they engage in play, especially group play, they also learn various skills, friendships and many things that make them confident”.

Also, another teacher said the following:

“Sports are not just activities of roving around the playing field, and that is all. Playing any sports helps to enrich a child mentally, not only because they get time to relax their mind after school hours but also because the development of winning strategies and the cultivation of a spirit of daring in sports can be transferred to classroom work.”

The researchers were under the impression that the play as the teaching method was not prioritised in many pre-primary schools. Our impression was not far from one of the teachers who provided the following statement:

“In my school, the play is practised as one of the teaching methods, although not to the extent because the school timetable is limited. Much of our efforts are on teaching 3Rs skills only. Also, the reason why play takes a small part in our school activities is because performance indicates big results now influences. So many schools are struggling to achieve that goal”

Contrary to the majority, one teacher made the following statement:

“Children need to be encouraged to learn more academic subjects than being engaged in the play. I think the play should be part of an extra-curricular activity after break time. Remember these children have a short time of learning as they are alive at 8.00 am and leave at 12. 00 pm. So, if we devote much time to playing outside as required by the guidelines, when and how they will develop 3R skills, which to me is more important than play”.

Views of parents. On the other hand, parents had divergent views on the play as the teaching and learning method for children in pre-primary classes. Although most of the parents viewed the play as a time waste that could be devoted to learning. One of them said the following:

“There is no way for these young children can learn academic subjects while playing. Teachers in school should prioritise one of them play or studies.”

Another parent provided a condemning statement to some teachers in school by saying the following:

“You know these days teachers are not doing their work properly. I am the neighbour of this school, but most of the time I see these children playing the time they are supposed to be in class. I always ask myself, when do these children learn?’ It seems the only thing teachers and schools do is let our children play and not learn that is why our children are not able to read or write. Children should be able to read and write at an early age and master of language”.

Another parent said the following:

“Our children should play at their own time because classroom time is occupied with academic instructions. children play every day at their homes where there is plenty of time. I think should be a place of learning not playing”.

Contrary to this view other parents see the play as a curriculum tool that creates an opportunity for children to learn from new experiences by being close to the community and objects with which they are familiar, and that the school setting is the best avenue for creating such opportunity. One of the parents made the following statement:

“The play and learning are the two related things because when children play, they also learn about numbers and word pronunciation which help them in learning different academic subjects”.

Another parent said the following:

“The play is a recreation for children after classroom hours they need to refresh. To me, I don’t see the problem of play but it should not be too much because playing is part of stimulating their bodies and keeping them physically and mentally fit”.

Additionally, another parent nailed it:

“My children play almost every day. I don’t have to tell them how and where to play. As a parent, I think have more important issues to work on than playing with children. The important thing is that I don’t stop them from playing”.

Considering the views of parents, it is clear that the majority of parents were not aware of the benefits of the play as a curriculum tool in enriching a child's learning ability and mental development.

Challenges pre-primary teachers face in using play as a curricular tool

The third question of this study explored the challenges pre-primary teachers face in using the play as a curricular tool. The results showed that the Big Results Now Education (BRED) requirement, inadequate playing materials, and the lack of sufficient and comprehensive skills for pre-primary teachers in the use of play-based learning techniques were reported to be challenges facing the use of play as the teaching tool in Pre-primary schools. During the interview session, teachers have various opinions on the challenge facing them in the use of play as a strategy to enhance the competencies of pre-primary pupils.

Pressure from Big Results Now Education (BRNED) directives. The government of Tanzania launched the BRNED initiative in 2013 as a response to the dramatic deterioration in academic and non-academic skills due to poor average pass rate in national examinations which dropped from 90% in 2007 to 43% in 2012 in both the primary and secondary schooling systems (United Republic of Tanzania, 2014). In response to this drastic decline, the Big Results Now Education (BRNED) Initiative from the Malaysian government in 2013 was adopted to improve the pass rate in schools. In so doing, teachers were capacitated in different approaches to ensure they help to trigger students’ academic performance and consequently improve the quality of education in government schools. One teacher said the following:

“To me, the play is the best approach to teach these kids but since the government launched the Big Result Now Education (BRNED) our effort is in teaching 3Rs to both preschools and standard one pupil. It is not our fault, it is the BRN requirement to ensure that all children should be able to read, write and account at an early age to reduce or do away with children who complete primary education while unable to read and write”.

Another teacher stated that:

“The BRN is pressuring us too much and we have no time to think of play because, at the end of the year, you will be asked about how many pupils know or don’t know to read, write and account but not how many pupils know how to play”.

Contrary to pre-class teachers, heads of schools pointed out that BRNED directives encouraged teachers to use all possible means to ensure that the BRNED goals are achieved and none of the government officials nor school heads prohibited teachers from using play as a teaching method in pre-primary schools. One head said the following:

“Look my school have two classes of pre-primary with more than 150 pupils. I have been encouraging my teachers to use friendly teaching methods for these pupils because we want them to love the school and come every day. I think the problem is not the BRNED directives the problem in teachers' ability to improvise different play activities in their classrooms”.

Inadequate playing materials. The study found that having appropriate play materials is of noteworthy standing for the learning and brain development of children in school. However, during visits to all the schools, school heads and pre-class teachers mentioned that insufficient play materials pose a challenge, making the use of the play as a teaching method in preschools more difficult. Further, it was noted that the play materials used by other pupils of higher-level standard were the same as those used by pre-class and standard one pupil. Moreover, it was noted that the playgrounds used were also shared among these different groups. One of the head schools made the following statement:

“The preschool syllabus encourages us to use the play-based learning, but the current school environment presents challenges that hinder its effective implementation. As a school, we don’t have the essential play materials necessary for effective play-based learning. This shortage has resulted in limited scope for teachers to integrate play-based teaching methods into only a handful of topics”.

Besides, pre-class teachers noted that a lack of playing materials such as a swing set, slides, climbers, and spring riders are posing a threat of pupils dropping out and limiting children to improving and increasing their vocabulary words. All interviewed pre-class teachers believe that the availability of play tools is a stimulus for preschool children to attend school willingly and develop a love for it. One teacher made this statement:

“The children who attend pre-English medium schools have a variety of play tools. That is why many children love going to school, and sometimes they cry if they don't. A good example is my child who loves going to school every day, and sometimes when I ask why she loves school, she simply says, I love swings and swimming”

Shortage of and exposed pre-primary teachers. The study found that most teachers who teach pre-school classes have not specifically trained to teach at this level. They have usually been hired from other classes such as standard one, three and five based on their long-serving in teaching. It was noted that since the majority of preschool teachers are not trained for this purpose, they also have little competence in using play as a teaching approach at this level of education. Besides, only two out of ten pre-class teachers interviewed had attended capacity-building training for preschool teaching. In addition, it was noted that these two teachers possess good practical knowledge of using the play-based teaching and learning approaches. One of the two teachers made the following statement:

“I have a class of about 100 pupils, and always I like to start my lesson by playing or singing songs that are related to the topic of that day. I find this approach makes it easier for the children to learn and stay focused. If they sing, they feel more relaxed and become more engaged in the lesson. I simply tell them that there will be no more songs if they disturb my class”.

There were consensus between the interviewed pre-class teachers that, preschool teachers should be those who were trained for that purpose. It was further noted that the majority of teachers in pre-classes rely on their experience as long-time standard-one, two and three teachers in teaching the pre-class levels.

However, in responding to the question of challenges faced by teachers in using a play-based learning approach, parents have divergent views. Overall, it was revealed that the play-based learning is impossible to use in pre-primary classes because of overcrowded classes, shortage of teachers to watch the individual play of children, inadequate teacher basic skills and lack of playing tools. One parent commented:

"I live near this school and am also a member of the teacher-parent- association. I saw what is taking place in this school. Some teachers have limited competence in providing a variety of playful activities in the classroom, but the main problem is the time allocated to play for pre-children classes and the shortage of play tools in public schools compared to private ones"

Another parent made the following statement:

"I have a child in the pre-class at this school, but I am concerned about him returning home at 12:00 p.m. One day, I asked about this to the head of the school. She told me that the pre-class session ends at this hour. When I suggested allowing them to stay and return home at regular hours alongside older students, she mentioned the necessity of constant supervision for pre-class children during their play and the lack of teachers to match individual children"

Besides, one parent contrasts with fellow parents by putting the blame on their side by providing the following statement:

"At some point, we parents are the source of discouraging teachers from incorporating play into their teaching approach, as we put more pressure on teachers for our children to master reading, writing, and arithmetic skills ahead of the designated curriculum pace. We tend to prioritize written work as the sole measure of child learning, inadvertently limiting teachers from utilizing alternative activities."

The overall consensus of the interviewed parents is that teachers' beliefs on the use of the play in the classroom should be the preference of parents and the government. Also, parents should promote and enhance their understanding of age-appropriate aspects of the education of pre-class children.

Discussion

Today the play has received significant attention from researchers and academia in education disciplines in many countries. The play has emerged as an important strategy to promote pupils' engagement, inclusion, and holistic skills development. Psychologists, consider the play in early childhood to be an attribute of appropriateness and significance in children's development (Mardell et al., 2023; Parker et al., 2022; Karuppiyah, 2022; Gura et al., 2022; Burghardt, 2011; Smidt, 2011). Children display different behaviours like creativity, sense of humour, and problem-solving that are associated with play which signifies developmental benefits for children as linked to play theories (Mardell et al., 2023; Parker et al., 2022; Gura et al., 2022; Kejo, 2017; Seager, 2010). Research reveals that child play is branded into various aspects such as object play which helps the child with object manipulation, and promotes physical and motor development; Social play helps the child to develop interaction skills with

others, enhances social relationships and symbolic play helps to strengthen imagination, enhances language and literacy development (Parker et al., 2022; Gura et al., 2022; Ta, 2021; Yee et al., 2022; Kejo, 2017; Mgonja, 2014).

The study discussion highlights the benefits of incorporating play pedagogies in pre-class education. The study suggests that including the play in the school syllabus can result in beneficial outcomes, but it needs to be carefully integrated by considering the requirements of a structured curriculum in the school setting. Studies conducted in Tanzania acknowledge the influence of the play on children's early development of mathematics and science skills, language and literacy skills, and social and self-regulatory skills. Despite being included in the curriculum guidelines of pre-primary schools, the play is often overlooked (Shukia & Marobo, 2022; Kejo, 2017; Mgonja, 2014). This study has revealed that the use of play as a teaching tool is not effective due to the curriculum demands, parents' expectations, and underqualified teachers, which hinders the provision of appropriate education through play pedagogies to pre-class children in Tanzania. Also, the findings show that teachers are stressed due to the expectations placed on them by the government as they are required to ensure that no child is left behind without knowing how to read, write and account or face consequences such as punishment or demotion. As a result, teachers often have to prioritise academic instruction over play-based pedagogy. These findings align with previous literature which shows that teachers regularly receive contradictory information from top-down management such as the Ministry of Education and educational administrators. While these leaders encourage research on the contribution of play to the learning process, school administrators expect teachers to use more traditional approaches to demonstrate children's learning, such as success criteria, learning goals, and anchor charts. (Ta, 2021; Yee et al., 2022; Lynch, 2015). These studies further demonstrated that emphasising academic curriculum can hinder teachers, who may feel obligated to prioritize activities that enhance academic performance overplay and other activities that are not mandated (Ta, 2021; Lynch, 2015). For example, a study conducted by Parker and Thomsen (2019) revealed that teachers in the United States feel pressured by academic expectations to prepare their pupils for the next grade level. Another study in the U.S. conducted by Jachyra and Fusco (2016) found that teachers in Ontario state felt responsible for teaching their students strategies for attempting standardized testing. Furthermore, a study conducted in Kenya by Onditi et al. (2018) showed that many schools have reduced time committed to recess, creative arts, and even physical education in an effort to focus on reading, writing and arithmetic. These authors suggest that changes in play activity may have implications for children's ability to store new information, as their cognitive capacity is enhanced by clear-cut and significant changes.

Although many teachers hold positive beliefs about the play as a fundamental right that aids in their growth and is something that cannot be separated from child development and learning, other teachers did not support the inclusion of the play in pre-classrooms. The rejection of the play by some teachers as pedagogies was viewed by the researchers as be lack of experience with progressive teaching methods and inadequate knowledge of the role of play in child growth. These findings concur with the literature which shows that rejection of play-based pedagogy in pre-classes is the pervasive norm (Ta, 2021; Yee et al., 2022; Lynch, 2015). Resistance to incorporating play-based pedagogy in the classroom extends beyond parents as many of them view the play as a waste of time that could be spent on learning. This view concurs with the work of Ezati and Odele (2022) who revealed that the majority of parents in Adjumani and Yumbe districts in Uganda view the play as disruptive to learning but only 12 out of 32 associated plays with learning. However, this view contradicts the literature suggesting that play should be enjoyable and children should be free to choose their activities and materials. The literature also, suggested that playful pedagogies can be more effective in fostering social, emotional,

physical, cognitive and creative skills than traditional or more highly guided pedagogical approaches used in the primary school classroom (Parker & Thomsen, 2019; Ta, 2021; Parker et al., 2022).

There is no doubt that the lack of clear guidelines and directives for pre-primary teachers regarding the incorporation of play-based learning poses a significant barrier to implementing this teaching pedagogy in schools. Despite the fact the Tanzania pre-primary syllabus recognises the play-based learning as the main approach to teaching at this level, it has been given less priority than academic subjects in their timetables. The findings align with literature that notes frequent directives from the Ministry concerned with education and the expectation to implement new pedagogical practices every few years reduce teachers' confidence in implementing play in a meaningful way (Ta, 2021; Onditi et al., 2018). Besides, the study found that creating and engaging in interactive play activities in the pre-classroom requires trained and skilled teachers. However, the majority of teachers in pre-classes are not trained to teach at this level and they have little competence in using the play-based learning as a teaching approach at this level of education. This finding aligns with the work of Baker (2015) and Blucher et al. (2018) who found that teachers in preschools may experience difficulties in integrating the play-based learning in their classrooms, especially with pupils who struggle to identify appropriate play behaviours and contexts due a lack of prior experience in managing such situations.

Embedding the play-based learning in pre-classes in Tanzania faces significant challenges due to a lack of playing materials and space due to over-crowdedness. The study found that there was a shortage of playing materials such as a swing set, slides, climbers, and spring riders posing a threat of pupils dropping out and limiting children to improving and increasing their vocabulary words. This finding aligns with the Treasure (2020) which shows that the play is more an engaging activity for enjoyment or recreation rather than a serious purpose. However, this perception of viewing play as non-serious or non-work-related can be a challenge in schools, where teachers are accustomed to more rigid curriculum structures and attainment targets. The absence of playing materials in pre-classes creates a loophole for inexperienced teachers who are not able to improvise play materials to reduce the time of child-free play and prioritise instruction.

Conclusion and recommendations

In Tanzania, the pre-primary level serves as the foundation of the education system. The future academic and personal achievements of the younger generation are heavily influenced by their experiences during pre-primary education. Unfortunately, it has been noted that many teachers are not adequately equipped with the instructional methods needed to properly teach preschool children in a way that will benefit their future education and life. Considering the significant role played by pre-primary education in preparing children for the next level, teachers at this level must adopt a friendly approach that includes play-based learning to foster confidence and promote brain development in children. Unfortunately, the decline in the use of the play as a teaching method for pre-class pupils may negatively affect their cognitive and socio-emotional development as play activities promote problem-solving, emergent literacy, conceptual understanding, creativity, and improved social skills. It is vital to understand the various geographic regions, tribes, and social groups within Tanzania in order to comprehend the beliefs and practices related to pre-primary children's play and learning in schools. The study recommends the government provide schools with sufficient play tools and improve playgrounds as they are doing in classes that would allow children to become children. To improve the quality of the pre-primary education level, it is recommended that the government invests in training and employing specialised preschool teachers nationwide. At present, unqualified teachers who are teaching in pre-classes are not providing promising results in pre-primary education. Moreover, the government should

consider establishing specific colleges devoted to training high-quality pre-primary teachers instead of relying only on teacher colleges and universities.

Suggestions for Future Research

As previously noted, this qualitative study aimed to explore teachers and parents perceiving of the play as a significant aspect of child development and its integration into their teaching and learning activities. While the findings provided comprehensive coverage of the identified topics, further research would benefit school leaders and preschool teachers in understanding the potential benefits of play-based learning in the classroom for children's mental and cognitive development. The study recommends expanding the scope of research to include a comparison of the beliefs and practices of teachers in pre-primary public schools and private schools in urban and rural parts of Tanzania. A comprehensive study comparing the effectiveness of traditional games and newly invented ones is crucial to understanding the impact of play on a child's brain development and emotional intelligence by examining the cognitive and emotional benefits of play, including its ability to enhance memory, problem-solving skills, creativity, and emotional regulation. Additionally, a study should be carried out in order to explore the potential risks associated with excessive screen time and the use of technology in play by identifying strategies for optimising play-based learning and promoting healthy habits among children. Moreover, a study should be conducted on pupils of lower classes aged between 7 and 10 to assess how play can significantly impact their learning. As mentioned in the study results, most of the interviewed teachers lacked relevant training on using the play as a teaching method in preschool children. Therefore, a study could determine the efficacy of teaching methods in Teacher Education Colleges in preparing pre-primary school teachers.

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DOI: <https://doi.org/10.57125/FED.2023.12.25.12>

How to cite: Alorki, I., & Ali, C. A. (2023). Attitudes Coded as Measures of Determining Students' Performance in Mathematics. *Futurity Education*. 3(4). 198-216. <https://doi.org/10.57125/FED.2023.12.25.12>

Attitudes Coded as Measures of Determining Students' Performance in Mathematics

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Received: September 14, 2023 | **Accepted:** November 7, 2023 | **Available online:** November 15, 2023

Abstract: The poor performance is even a major problem in rural areas, hindering a country's economic competitiveness and development of human capital. In the school classroom, mathematics students lack the needed culture to read, understand, perform and apply tasks associated with the tasks. The aim of this study was to explore the various attitudes that measured students' performance and find relationships among the factors. Exploring the pragmatic paradigm, the researchers used the descriptive design involving structured questionnaire of four-point Likert scale. This scale suitably combined both purposive and simple random sampling procedures to select 315 participants. The instrument was structured as Strongly Agree, Agree, Disagree and Strongly Disagree to simplify responses and yield faster and higher retrieve rate. Immediately after the data collection, the responses were coded in closed form to ease data analysis. Having perused many tools of data analysis, the researchers came to the

conclusion that a combination of Pearson Product Moment Correlation Coefficient, T-test, means, standard deviation and percentages were the most appropriate. While means, standard deviations and percentages were mostly used to determine the attitudes, Pearson Product Correlation Coefficient explored the relationships among the various variables. Consequently, the results revealed that the positive attitudes of parents, teachers and schools influenced students' performance in mathematics. In fact, nearly 94% of the respondents' attribute mathematics attitudes to parents and closed to 95% attributed mathematics success to teachers. There were also positive relationships among parents, teachers and school environment in determining students' performance in mathematics. This means students with positive attitudes towards mathematics outperformed those with negative attitudes. It is recommended that parents, teachers and school heads thrive towards minimizing negative attitudes and rather maximising positive attitudes into school mathematics. We suggested that any replication of a future study should include private schools.

Keywords: attitudes coded, mathematics; measures; Pearson Product Moment Correlation Coefficient; students' performance.

Introduction

The culture of mathematics is necessary to achieve the teaching and design of life due to its vast relevance in all social contexts (Nasamu, 2021). In addition to its obvious educational value, ability to think critically and reason logically is a vital life skill that necessitates familiarity with mathematics. Learning mathematics helps one cultivate the accuracy, consistency, and mental discipline necessary for making good decisions and addressing problems in a responsible manner (Živković et al., 2022). Importance of mathematics has been emphasised by several disciplines in higher education, including the technical fields, engineering, economics, finance, agriculture, pharmacy, and health sciences (Oliver & Jorre de St Jorre (2018).

The main aim is to learn foundational as well as analytical and computational skills essential for their field of study. However, most children still find studying mathematics at the lower school levels to be extremely difficult, leading to poor or average performance as compared to other disciplines (Bernacki et al., 2021).

While students in developed countries are outperforming their male counterparts, the case of developing countries is still a misnomer (Mullis et al., 2020). The consistent demonstration of underachievement in mathematics over many years adds weight to this notion, as does the widespread acknowledgement of the value of mathematical knowledge (Rodriguez, 2023). For instance, in many developing countries, less than 32.9% of students pass mathematics examinations. Most students in the Ghana's junior high schools lack the ability to apply logic to the solution of mathematical problems, which negatively impacts their grades in the subject (Yahaya, 2021).

Iwu et al. (2019) posit that an attitude is a propensity that prepares a person to behave towards something. This propensity has some perceptual, cognitive, and behavioural components. Iwu et al. (2019) find that the students' attitudes towards Mathematics vary by gender, field, and Mathematics score, but not by grade. The teachers' approaches and activities impact on students' attitudes towards Mathematics. This suggests that students' perspectives are shaped by the type of instruction they receive from teachers (Moussa & Saali, 2022). Mathematics aversion may have been characterised in a variety of ways. Cognitive, emotional, and behavioural reactions to an item all contribute to an

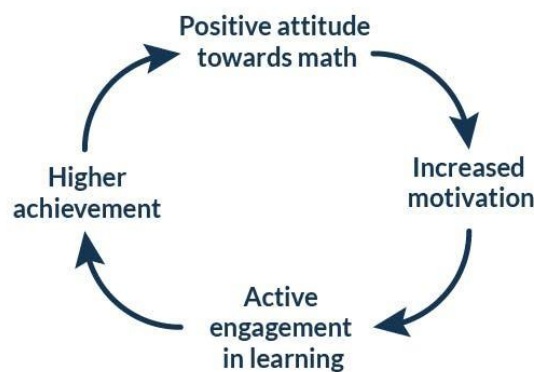
individual's attitude towards. Students' attitudes towards mathematics learning can be shaped by teachers and peers (Eccles & Wigfield, 2020).

Poor performance in mathematics is a persistent canker in rural areas, hindering the country economic competitiveness in the global market (Kiwanuka et al. 2022). Examinations bodies such as the West African Examinations Council estimated that students' mathematical abilities are much below expectation. The performance of students in the primary levels has been abysmal. The results indicate a pass rate of 25% in 2018, 30% in 2019, and 28% in 2020 (Ministry of Education, n. d.).

Closed observations and Chief Examiners reports show that the attitude of students significantly contributes to the low decline. Ogbeche et al. (2021) argue that developing countries want to succeed in today's technology-driven global economy, they must heavily invest in science, technology, engineering, and mathematics education.

Figure 1

Conceptual Framework



Source: Prodigy Education (2019).

Figure 1 suggests that the theory of attitudes can be determined by positive behaviour, increased motivation, active engagement and higher achievement influence mathematics performance. Students with positive attitudes are more confident, build self-motivation, solve mathematics tasks and attain higher achievement. The opposite can be said of students with negative attitudes (Prodigy Education, 2019).

Students are more motivated to put in effort when they have a positive outlook on mathematics learning. Positive attitudes towards Mathematics are crucial because they influence students' motivation to study the subject and can lead to a greater likelihood of majoring in Mathematics or pursuing careers in related fields (Jiang et al., 2020). Students' views towards Mathematics are a significant predictor of their enrolment in upper-level Mathematics courses.

Much of children's enjoyment and development in mathematics depend on the engagement and experience children have at home. Parents and the school can form strong synergies to enhance and foster a good mathematics learning atmosphere for the child. Poor collaboration lead to low mathematics achievement (Samuels, 2020). Adu-tutu Bofah and Ntow (2017) have demonstrated how social support of parents and teachers provide panacea to improving children' attitudes towards mathematics and achievement.

Research Problem

The poor performance has been traced to many causes. According to (Nasamu, 2021), mathematics students lack the revisit culture to understand the concepts and perform the tasks associated with the tasks. The poor performance is even pervasive in the rural areas, where students lack many requisite resources to undertake effective mathematics learning (Kiwanuka et al. 2022). This definitely led to poor or lack of application of the mathematics knowledge (Yahaya, 2021).

Another problem is the attitudes of stallholders. These stallholders are parents, teachers and students themselves. Stakeholders put little investment and resources into the teaching and learning of mathematics. It is no gain saying that very few students have the requisite books, computers and software to solve complex mathematics problems. In cases where some stakeholders secure the mathematics resources, there is little collaboration with other stakeholders. This breeds low relationship among the stakeholders (Ogbeche et al. 2021).

Research Aim and Research Questions

The aim of this study was to explore the relationships that existed between parents, teachers, schools and students in measuring performance and attitudes in mathematics. The following research questions guided the study's aim:

1. How do parents' supports improve upon students' attitudes towards mathematics?
2. What do teachers' attitudes propel students' performance towards mathematics?
3. Why does school climate promote students' attitudes towards mathematics?

Research Methodology

General Background

The researchers informed the administrators before commencing data collection. This determined when the researchers would visit their individual schools to gather the required information. At the point when the researchers showed up at the schools, they provided a letter to the relevant authorities as an indication of approval sought and granted for the data collection exercise to be undertaken in each of the selected schools. The purposive sampling procedure was first utilised to select participating schools, and a simple random sampling was employed in selecting participating students.

The present study employed both descriptive and inferential research designs. The researchers themselves designed the questionnaires based on the research questions, and thereafter derived three research hypotheses. The questionnaire items were centred on attitudes of parents, teachers and schools. Apart from students' personal information items, the questionnaire contained about 41 items, out of which six were declared redundant. The items were ranked on a five-point Likert scale, ranging from 1 (Strongly agree) to 5 (strongly disagree).

Sample and Participants

With approval from the Headteachers of the schools, the teachers invited the researchers to distribute the research instruments and to clarify certain unclear and difficult items in the instruments. Overall, two schools were chosen. The study accommodated a sample of 315 students (189 male and 128 female students), with an average age range of 14–17 years old. Students were found in their intact classroom settings while learning as we employed the simple random sampling technique. In this technique, students were first assigned numbers from 001 to 320. Then the computer was used to

generate numbers. Students whose numbers were generated were included in the sample. Out of the population of 1,500 students, the 320 was representative (Kiwanuka et al. 2022).

Instruments and Procedures

The data collection procedure was split into two phases: quantitative and qualitative. The quality phase of data is dependent upon the researcher. The researchers used field assistants to collect comprehensive and in-depth data for the study. Field assistants were given extensive training on ethical considerations and the data collection procedure.

The procedure for collecting data for the quantitative phase was carried out with the aid of field assistants. Before the researchers started collecting data, the heads of the schools in the study area were sent and shown an introduction letter obtained from the Director of Education. Thereafter, the researchers discussed informed consent, privacy, anonymity, confidentiality and voluntary participation issues with the selected participants before the commencement of data collection.

The researchers then administered the questionnaire to randomly selected students. The researchers carefully administered the questionnaire, gave the participants time to complete it, and then collected it the next day. The questionnaire was distributed to a total of 320 participants, and once they completed it, the collected questionnaires were gathered for further analysis. Five participants' resources could not be retrieved due to absence from school.

In the qualitative phase, accurate data on each student's performance from each student's performance on assessments in their end-of-term scores were obtained. These records were accurately reviewed, documented, and recorded. This helped the researchers learning more about the student's academic performance and determine whether or not it was possible to link their academic performance to students' attitudes towards mathematics.

Data Analysis

Qualitative data with numbers to represent Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) were coded. Then, data with means, standard deviations, percentages and Pearson product moment correlation coefficient were analysed. The frequency tables were used for the background of students based on gender, class, age, parental status and places of living. Also, the homoscedasticity assumption was used to ensure the validity of statistical tests of Pearson Product Moment Correlation Coefficients in measuring the strength and direction of the linear relationship between continuous variables to determine the significance of the association between any two dichotomous factors.

Validity and reliability of instruments

Creswell and Creswell (2017) define the validity as the degree to which research findings properly assess the social phenomenon under examination. The construct validity determined how well the constructs were designed. The content validity determined how accurately the constructs were measured. The criterion validity measured how the same variables were compared with standard external examinations. In order to further improve the study's validity, the instrument was forwarded to highly esteemed researchers and knowledgeable academic professionals for evaluation and scrutiny. These experts were university professors, senior lecturers and graduate students in mathematics education. The Cronbach reliability coefficient was .81, far higher than the recommended 0.70. We followed and strictly abided by their wise counsel and recompilation of the instruments. This allowed for smooth and speedy implementation in the field.

Results of a Pilot Test

The instruments were pilot-tested in a neighbouring District, having similar population characteristics as the study area. In the pilot test, thirty respondents were employed for a quantitative phase, while six for the qualitative interview. The main goal of the pilot test was to evaluate the instrument's consistency, accuracy, and applicability in the context of female students' attitudes in mathematics. A test-retest technique was employed to evaluate the dependability of the quantitative instrument. In order to verify for similarities, a questionnaire was delivered to respondents to answer, and then two weeks later, the same respondents were given same questionnaire to complete. The internal consistency of the test items was then determined using the Cronbach's alpha. The values ranged between 0.78 and 0.85, which were considered to be highly reliable (Mohajan, 2017).

In the qualitative phase, six students were purposefully selected to test validity in the qualitative interview. A duration of 10–15 minutes was allotted for each interview session. For the interview protocol preparation, the researchers adapted Castillo-Montoya's (2016) method to address the following issues:

- The original questions were too wordy, convoluted, unclear, and hard for the respondents to comprehend. So, more comprehensive/concise interview questions were redesigned.
- The researchers found that some of the respondents' statements still required translation into the local dialect for clarity and explanation of unfamiliar words. So, people who could speak and write the local dialect were invited to interpret the items.
- The data collection at the research area was conducted prior to reviewing the interview questions

Ethical consideration

This study adhered to the research ethics policy, ensuring compliance with aspects such as permission, confidentiality, anonymity, informed consent and voluntary participation. Owing to the time constraints nature of data collection activities, how the researchers obtain permission from those in charge of the study area determines how reliable the research is (Ezer & Aksüt, 2021). Permission from the authorities in the study area were required in order to carry out a comprehensive analysis of the case. However, prior to collecting data, the researchers were advised to obtain consent from study participants. The following metrics were used to evaluate approval of permission as a pre-data collection requirement:

- The University's Institutional Review Board was consulted for ethical approval.
- The Municipal Director of Education was consulted for approval.
- The Headteachers/mistresses of the selected schools were asked for permission.

Informed consent

The research participants needed to be properly informed about the procedure, goals, risks, and benefits of the study as the basis for their decision to participate or not to provide informed consent. Before being enrolled in the study, research participants were given an informed consent form to sign (or verbally obtain assented to, as needed) after agreeing to participate in the study.

Confidentiality

The researchers took precautions to protect the identities and responses of the research subjects (Saunders et al., 2015). While data was being collected, the researchers ensured that no information was

directly linked to or traced back to any specific study participant, protecting the participants' identities at all times. Participations were cautioned not to write their names, addresses, phone numbers and any person identifiers on the questionnaire. Participants were assured that the data would only be used solely for academic purposes.

Anonymity

According to Feng and Wang (2019), anonymity refers to a participant's right to remain anonymous throughout a study. To help keep study participants' identities anonymous, the researchers ensured that group data were presented during the study rather than individual data. The participants' identities were duly protected except the serial codes we used in the data.

Voluntary participation

Students had to agree voluntarily to participate in the research before being given questionnaires. Students were free to ask questions before and during the filling out of the questionnaire. Students provided answers for only the questions based on their attitudes towards mathematics, effects of teachers' attitudes, /effects of parents' attitudes, and effects of classroom attitudes towards mathematics.

Research Results

Attitudes of parents, teachers and schools

This part sets up statements and measures how parents, teachers and schools influence attitude of students' performance in mathematics. In each of the three tables, there are at least ten items in each table. Parents were required to secure for their wards learning resources, inspiration, affection and conducive learning environment at home as well as emotional support and encouragement. Table 1 shows the respondents' responses to how parents' attitudes affect their performance in mathematics.

Table 1

Parental Attitudes Towards Students' Performance

S/N	Statement	SA (%)	A(%)	D(%)	SD (%)	Mean	SD
1	My parents inspire me to study mathematics	52.4	41.3	4.1	2.2	3.43	0.68
2	My parents help me to overcome mathematics fear	41.6	44.4	10.2	3.8	3.41	2.34
3	My parents have high expectations in me	49.5	42.2	6.7	1.6	3.39	0.69
4	My parents giving me praise and reward	47.9	38.7	10.8	2.5	3.32	0.77
5	My parents monitor my studies at home	46.3	41.3	8.9	3.5	3.30	0.78
6	My parents discuss mathematics with me	42.5	47.3	7.0	3.2	3.29	0.73
7	My parents provide learning materials for me	43.8	42.9	11.1	2.2	3.28	0.75
8	My parents develop mathematics in me	40.3	50.8	4.8	4.1	3.27	0.74

9	My parents motivate me to study mathematics	37.1	38.4	19.4	5.1	3.07	0.87
10	My parents counsel me to learn mathematics	30.1	27.0	19.4	23.5	2.64	1.14
11	My parents secure mathematics textbooks for me	25.4	25.4	32.1	17.1	2.59	1.05
12	My parents allow me enough time to study	25.1	26.0	21.0	27.9	2.48	1.15
13	My parents monitor my studies at home	21.0	31.1	22.5	25.4	2.74	1.09
14	My parents make me feel loved in mathematics					3.10	0.98
	Means of mean					3.10	0.98

On Table 1, majority of respondents (93.7%) strongly agreed or agreed that if parents make them aware that, they want the best education for them and make them feel loved, it will inspire them to study hard to perform well in mathematics. Only 6.3% of the respondents strongly disagreed or disagreed. This demonstrates that parents showing their wards adequate affection and making them know that they want the greatest education for them greatly affect their positive attitudes towards performance in mathematics.

Also, an overwhelming (86.0%) agreed that such a love from their parents to encourage them to overcome mathematics anxiety and only 14% dissented. This shows that the majority of students believe they will be able to overcome their mathematics anxieties if the necessary assistance and needs are met. Another high percentage (91.7%) assented to the statement that “my parents showing me that, they have high expectations of me to perform well in mathematics will increase my interest in learning mathematics”. High positive expectation from parents is a catalyst that positively affects female students’ performance in mathematics.

The other positive parental attitudes that promote female students’ performance in mathematics are praises and rewards (86.6%), discussing importance of mathematics (89.8%), encouraging and providing mathematics resources (86.7%), setting high academic goal (91.1%), guidance and counselling services (75.5%), motivation (57%), providing conducive home (51%), and monitoring studies at home (47.9%). Based on these responses, it was evident that parental attitudes positively influence female students’ performance in mathematics.

The influence of teachers’ attitudes towards mathematics

This section provides the students’ responses on the effects of teachers’ attitudes towards their performance in mathematics. The attitudes are expanded to include the teachers’ competencies, knowledge and skills. The findings have been summarised on Table 2.

Table 2

Teacher Attitudes Towards Students’ Performance in Mathematics

Statement	SA (%)	A (%)	D (%)	SD (%)	Mean	SD
1. My teacher always encourages me to learn	54.6	38.4	5.4	1.6	3.46	0.67

2. My teacher is knowledgeable in mathematics	55.6	39.0	3.8	1.6	3.48	0.65
3. My teacher takes time to summarize facts	50.5	34.6	10.8	4.1	3.43	2.38
4. My teacher is friendly and approachable	61.0	27.3	4.7	7.0	3.42	0.87
5. My teacher praises my correct answers in class	50.8	34.6	12.4	2.2	3.33	0.78
6. My teacher marks our exercises on time	46.0	40.0	11.1	2.9	3.29	0.77
7. My teacher revises mathematics	44.1	42.5	9.8	3.5	3.27	0.78
8. My teacher makes me feel comfortable	43.8	39.4	12.4	4.4	3.22	0.83
9. My teacher does not scare me in class	32.1	28.9	21.0	18.1	2.74	1.09
10. My teacher is active in class	22.2	20.3	29.8	27.6	2.37	1.11
Means of mean score					3.20	1.10

The results on Table 2 reveal that 93% of the respondents agreed that teacher always encourages and motivates them to learn. This implies that female students yearn for encouragement and motivation from their teachers. This positively develops their attitudes towards learning and performing well in mathematics. Knowledgeable mathematics teachers (94.6.0%) make the learning simple, practical and applicable to all human contexts. Knowledge demonstrates that teachers are competent in exposing the female students to modern contemporary innovative techniques, worthy of likely imitation and improved mathematics performance.

In addition, summarising the main ideas (85%) has the propensity to increases female students' understanding better, faster and rapidly. This is supported by friendly and approachable attitudes (88.3%) so as to enable female students easily consult teachers for further and better clarification. Another positive attitude of teachers is giving praises and correct answers in class (85.4%). This encourages female students to pay rap attention and actively participate during mathematics instruction.

The other positive attitudes of teachers' worthy of emulation are marking exercises and giving feedbacks on time (86.0%), appending adequate time with female students (86.6%), making female students feel comfortable in class (83.2%), and filtering out fear in mathematics instruction (60.9%). It was revealed that even though corporal punishment has been abolished in public schools, some teachers still come to mathematics classes with canes and other gadgets that indirectly hinder mathematics learning.

The influence of classroom attitudes towards mathematics

This section investigated how classroom activities or atmosphere influenced students 'performance in mathematics. About 11 items were used to analyse the influence on Table 3.

Table 3

School Attitudes Towards students' Performance in Mathematics

Variable	SA	A	D	SD	Mean	SD
	(%)	(%)	(%)	(%)		
1. My school ensures that we understand mathematics	64.1	31.1	4.1	0.6	3.58	0.60
2. My school secures real-world examples	55.6	33.7	7.90	2.9	3.41	0.75
3. My school helps me see math as simple						
4. My school allows us to explain our answers or ideas	49.2	41.0	8.3	1.6	3.37	0.70
5. My school enable my understanding	49.2	38.4	8.3	4.1	3.32	0.79
6. My school values my ideas and suggestions	42.5	41.6	12.7	3.2	3.23	0.79
7. My school is eager to answer questions in class						
8. My school gives feedbacks about the answers	39.0	46.7	12.1	2.2	3.22	0.74
9. My school enjoys mathematics lessons	41.0	43.5	10.5	5.1	3.20	0.82
10. My school prefers working in groups	40.3	38.7	14.9	6.0	3.13	0.88
11. My school frequently get us confident	25.7	31.1	25.1	18.1	2.64	1.05
Means of mean score					3.23	0.79

The results on Table 3 show that 95.2% of respondents strongly agreed and agreed that teachers who ask prompting and probing questions help students to understand mathematics concepts and subsequently perform well. A whopping 89.3% strongly agreed and agreed that real life examples appeal more to their cognitive, affective and psychomotor consciousness and performance in mathematics. It must be emphasised that real life practical examples really assist female students in grasping, comprehending and tackling mathematics problems related to home activities. Moreover, majority of respondents (90.2%) agreed that when class teachers allow them to explain solutions, answers or ideas, they tend to understand and perform better in mathematics. It was noticed that whenever female students are even probed more by their teachers to arrive at the best solutions, they become more motivated to solve much more challenging tasks (87.6%). It could be inferred that when teachers have excellent command of the mathematics content, and willing and able to explore different strategies in teaching, female students become better beneficiary.

The other attitudes are teachers' values of mathematics towards female students' knowledge and skills in mathematics (83.1%), enjoyment, play and fun in mathematics lessons (84.5%), group collaboration and discussion in lesson study form (79.0), and striking down on female students who are stuck during mathematics problem solving phases (56.8%). It can be concluded that the classroom itself is a mathematics catalyst to mathematics performance and must be structured, re-examined and remodelled in a mathematics friendly atmosphere.

Relationships between parents, teachers and schools

The study tested the following research hypothesis:

1. H_0 : There is no significant relationship between parental attitudes and female students' performance towards mathematics.
2. H_0 : There is no significant relationship between teacher attitudes and female students' performance towards mathematics.

3. H_0 : There are no significant classroom attitudes and female students' performance in mathematics.

In this section, the investigators examined the relationship between the respondents' attitudes towards the study of mathematics as a topic and how it affects their mathematical achievement. Hence, Pearson Moment Correlation test was used to determine the type and degree of correlation that exists between the two variables, Attitude, and Achievement (see Table 4).

Table 4

Parents Attitudes and Mathematics Performance

Correlated variable		M	SD	Students attitude	Mathematics scores
Student's attitude	Pearson correlation	3.31	0.433	1	.229**
	Sig. (2-tailed)				.000**
	N			315	315
Mathematics scores	Pearson correlation	3.31	0.433	.229**	1
	Sig. (2-tailed)				.000**
	N			315	315

Table 4 shows that the correlation coefficient (r) between students' attitudes towards mathematics and their mathematics scores is 0.229. This indicates a positive correlation, meaning that as students' attitudes towards mathematics improve, their mathematics scores tend to increase as well.

Nasamu (2021) suggests that, depending on the student's environment and cultural background, there may be a link between parental engagement and support and student attitudes towards learning mathematics. Due to this, the researchers chose to investigate whether there was a strong relationship between parental involvement and support and improved children's attitudes towards mathematics. To analyse the connection between parents' support and students' achievement in mathematics, Person Product Moment Correlation Coefficient was employed for the analysis. With the assumption that all variables were measured continuously, the PPMCC was utilised. The degree and direction of the link between the two variables were assessed using the correlation (r) coefficient in the analysis: parental involvement/support and students' attitudes towards mathematics (SA). The relationship was investigated at a 0.01 level of confidence, two-tailed. Using the Statistical Package Service Solutions program (version 27.0), all of the questionnaire items evaluating these variables were combined into a single item to generate scores for parental involvement/support and children's attitudes towards mathematics.

Table 5

Teacher Attitudes and Mathematics Performance

Correlated Variable		M	SD	Teacher attitude	Student attitudes
teacher competence/ attitude	Pearson Correlation	3.27	0.637	1	.244**
	Sig(2tailed)				.000**

	N			315	315
student attitudes towards mathematics	Pearson Correlated	3.27	0.637	.244**	1
	Sig(2tailed)				.000**
	N			315	315

Table 5 reveals a moderately significant but positive relationship between teacher attitudes and students' performance towards mathematics in the Ghanaian context. $r = .244^{**}$, $M = 3.27$, $SD = 0.637$, $sig. = .000^{**}$ $p < 0.01$, $n = 315$, 2-tailed. The difference between the two variables (teacher competence/attitude and student attitudes towards mathematics) is .244. In terms of percentages, it is translated as 24.4%. This implies that the variables predict themselves at a rate of 24.4%, which explains why teacher competence/attitude at the Junior High level is most likely to influence the development of positive students' attitudes towards mathematics. This simply means that a teacher who is highly competent (skills-oriented) and possess an optimistic attitude towards the subject are more likely to instil a positive attitude in his students.

According to the researcher's hypothesis, the teacher/learning environment in the classroom may aid students in developing positive attitudes towards mathematics. To collect empirical evidence, the researchers sought the possibility or otherwise of correlation between Ghanaian students' attitude towards mathematics and classroom instruction/climate. PPMCC was used with the assumption that all variables (classroom instructions/climate and student attitudes towards mathematics) were computed on a continuous scale (Likert scale questionnaire).

Table 6

School Climate and Mathematics Performance

Correlated variable		M	SD	Classroom instruction/climate	Students' attitude towards mathematics.
Classroom instruction/Climate	Pearson Correlation	3.24	0.402	1	.416**
	Sig. (2-tailed)				.000**
	N			315	315
Students' attitude towards mathematics	Pearson Correlated	3.24	0.402	.416**	1
	Sig.(2-tailed)				.000**
	N			315	315

Table 6 demonstrates a moderately significant and positive relationship between classroom instruction/climate and student attitude towards mathematics in the Ghanaian context. $r = .416^{**}$, $M = 3.24$, $SD = .402$, $sig. = .000^{**}$ $p < 0.01$, $n = 315$, 2-tailed. The difference between the two variables (classroom instruction/climate and students' attitudes towards mathematics) is .416 points, which translates to 41.6% in terms of percentage. Thus, the variables are self-predicting at 41.6%, which effectually explains why classroom instruction/climate is likely to influence students' attitudes towards mathematics learning at the Junior High level. It can be concluded that a conducive classroom climate coupled with students centred instructional method may positively affect the attitude students towards mathematics learning and performance.

Discussion

The findings from the research are discussed in this section. As in the study a quantitative method of design was used, the researchers intend to run PPMCC to measure the cause and effect, degree of significance as well as the relationship between the various variables in the study (Ali, 2021). In order to help the readers to examine how each theme reflects the interpretation used during data analysis, Ali (2021) affirm that the discussion of findings should be done separately. The primary purpose of the research was to determine the significance of association between students' attitudes towards mathematics. The findings were discussed in the following subsections.

Parents' support/involvement on students' attitudes towards mathematics

This section focuses on how parents' involvement and support can affect their children's attitudes towards mathematics. The literature concerning parental support/involvement influences students' attitudes towards learning mathematics was used to discuss and justify the findings. The findings of the study revealed considerable evidence that active parental support in children's education brings to students the tendency to develop a positive attitude towards mathematics and, as a result, such learners are more likely to earn higher grades and test scores and enrol in higher-level programs than those whose parents are not supportive (Kiwanuka et al., 2022). The study yields significantly positive outcomes, suggesting that parental involvement is beneficial, since the students' responded to the statement, "my parents' encouragement and provision of math learning materials would motivate me to learn the subject" with a high percentage of agreement that their parents supporting them with learning materials and also encouraging them have a great influence on their attitude towards learning the subject. As regards the statement "I would be able to overcome my fear of learning mathematics if my parents provide me with my needs and demands as well as the assistance I require from them" the respondents indicated that parental support/involvement in their educational life do indeed influence the attitude of theirs (students) towards learning mathematics which in turn affect their performance (Ogbeche et al., 2021).

Again, the study showed that when parents or guardians are proactive in terms of their support or involvement in their children's educational lives, students are more likely to develop positive attitudes and stay focused towards their studies in mathematics. The current findings confirm the observations by Nenty et al., (2016) that, parents' support in their ward's mathematics education has a significant influence on the students' attitudes towards the subject. The study found that, students whose parents provided them with their educational needs and are more concerned and supportive would develop good attitude towards mathematics and subsequently perform better than students whose parents are non-supportive. Thus, Supportive /involved families are more likely to work together with teachers to improve their wards attitude towards learning math as well as providing learning materials to their wards, encouraging them, motivating them, advising and monitoring them and allowing them enough time for their studies at home.

In the same vein, Nenty et al. (2016) supposed that, unfavourable attitudes towards mathematics among junior secondary school students may suggest a lack of parental involvement in their children's education in the subject. This implies that students with highly supportive/involved parents are more likely to develop a positive attitude towards the subject and thus strive harder to achieve high performance. These findings and other related research, indicate that whether or not students develop a positive attitude towards their studies is dependent on the level of parental involvement and support. A significant association is found between parental involvement and intrinsic motivation, and the development of positive attitudes in junior high school students and academic performance.

Finally, the quantitative data supported the hypothesis that parental involvement in or support of their children's education is an important determinant of junior high students' positive attitude towards mathematics in Ghana. Additionally, the findings support previous research that suggested that when parents actively participate in their children's learning, they put forth more effort, are more focused and attentive, are more drawn to the learning process, and perceive themselves as more competent, which subsequently leads to children developing a positive or good attitude towards mathematics, which is an essential factor for academic success in mathematics as well as other subjects (Lee et al., 2019).

Teachers' attitudes and students' performance towards mathematics

This section examines how teacher competence in mathematics influences students' attitudes towards mathematics learning. To discuss and support the findings, the literature concerning teacher competence/attitude influences students' attitudes towards learning mathematics was used. The researchers hold the view that teachers encouraging and motivating students to learn in the classroom and possibly being knowledgeable about the subject's content is essential to both teaching and learning. Again, it was found that teachers who spend a little more of their time summarising their lessons improve students understanding of what has been taught, which gives them the joy and confidence to learn the subject.

Also, teachers being friendly or approachable to students motivate learners to have the confidence to approach their teachers for further explanations on topics they do not understand. It was widely observed that teachers' attitudes could aid students in cultivating a positive attitude towards their lessons, therefore developing interest in their subject. This is confirmed by empirical research by Mishiwo (2022), and Slavin (2018) who reported a statistically strong correlation between teachers' mathematical competence and students' positive attitudes towards mathematics. According to the quantitative data, marking students' exercises on time, assisting them with corrections, and possibly spending more time revising with students are factors that influence students' attitudes towards math because it improves their understanding of the concepts taught.

According to Mishiwo (2022), teacher competence/attitude significantly influence the attitudes of students towards the study of mathematics. The findings are consistent with Mishiwo (2022). So, teacher's perspective and delivery style are critical determinants of the effectiveness of mathematics teaching and learning, as well as enhancing the teacher's decision-making, which in turn influences students' attitudes and interest towards the subject. Similar to the findings above, Slavin (2018) found that a teacher's competency or attitude has a substantial influence on students' attitudes towards learning mathematics. According to his findings, if teachers provide students with a lot of support and allow them being a big part of the learning process, learners can develop a more positive attitude towards their mathematics classes, which may lead to higher math scores (Slavin, 2018).

The hypothesis clearly indicated that there was a significantly moderate positive relationship between teacher attitude/competence and student attitude towards mathematics learning in the Ghanaian context. The results were reported as $r = .244^{**}$, $M = 3.27$, $SD = 0.637$, $sig. = .000^{**}$ $p < 0.01$, $n = 315$, 2-tailed, $n = 315$, 2-tailed. The two correlated variables (teacher competence/attitude and student attitudes towards mathematics) share a variance of .244. Simply put, a highly competent (skill-oriented) teacher with a positive attitude towards the subject is likelier to instil a positive attitude in his students. Overall, this research finding is supported by a previous study that found that teachers' displays of confidence during math lessons inspire learners to develop a positive attitude towards math and thus perform better in math (Hartwig & Schwabe, 2018).

School climate and students' attitudes towards mathematics

There is growing evidence that positive classroom climate has an impact on students' behaviours towards learning mathematics. According to the findings, when teachers use real-world examples in their lessons, students' attitudes or behaviours towards learning mathematics improve. It was also discovered that teachers asking students questions during class hours allows students to share their problems with their teachers, which, when addressed, improves students' understanding of the topic taught and thus increases their interest in learning the subject. This implies that junior high school teachers who use real-world examples to introduce and teach their students are more likely to instil positive behaviours or attitudes in their students, making them confident and enjoying learning the subject (Kiwanuka et al., 2022).

Respondents indicated that teachers allowing them to explain their answers or share their opinion and possibly using various or different approaches to explain a concept to them makes understanding easy for them and also makes them very confident about the subject. The results for both statements were 90.2% and 87.6%, respectively.

The data obtained from the research hypothesis tests indicates that there **was** a substantial positive association between classroom instruction/climate and students' attitudes towards studying mathematics in Ghana.

The results were reported as $r = .416^{**}$, $M = 3.24$, $SD = .402$, $\text{sig.} = .000^{**}$ $p < 0.05$, $n = 315$, 2-tailed. The two associated variables (classroom instruction/climate and students' attitudes towards mathematics) share a variance of .416. This implies that the more conducive a classroom environment is to learning, the more likely students are to develop a positive attitude towards the subject. The findings indicate that classroom instruction/climate is critical when it comes to students developing positive attitudes towards mathematics learning. These results support earlier studies that indicated that, students have a tendency to engage in learning more if they perceive the classroom climate as a loving and supportive environment where everyone is valued and respected. Furthermore, the results of Table 8 show that respondents stated, "I have generally enjoyed math lessons in school," yielding a mean score of 3.20 ($SD = 0.82$). This could be the result of students being exposed to a positive classroom environment. It was contended that the classroom environment can be determined by the teacher's choices, pedagogical methods, interactions with students, and teaching style.

The majority of students indicated that they preferred working in groups to working alone in mathematics class, a claim that received significant support in 80.0% of the recorded replies. This finding supports the study by Fisher et al. (2020) that, although instructors have their place, it has been found that when students are given the opportunity for discussion, conversation, asking questions, joking, and hands-on experiences, they are more engaged in the learning process. As a result, the researchers hold that teachers who promote and reward their students' thoughts and proposals enhance their students' confidence and delight from inside. Consequentially, such pupils will be eager to participate in class by asking or answering questions.

Conclusion and Recommendations

It can be concluded that parental engagement and support had a substantial influence on students' attitudes towards studying mathematics, especially at home.

The findings revealed that teachers' competence/attitude towards teaching mathematics significantly influenced students' attitudes towards mathematics learning. Students, on the other hand, claimed that competent and well-behaved teachers inspire and motivate them to emulate them.

Again, the findings discovered that a positive classroom environment or instructions significantly impacted students' attitudes towards mathematics learning.

The implications were that attitudes of students towards mathematics significantly impacted their performance in the mathematics. Students with a positive attitude towards mathematics outperformed those with a negative attitude.

It was therefore recommended that parents, teachers and school heads thrive towards minimising negative attitudes and rather maximising positive attitudes of mathematics students.

Suggestions for Further Research

The researchers assumed that the theory of attitudes can be determined by positive behavior, increased motivation, active engagement, and higher achievement influence mathematics performance. However, the findings proved that students with positive attitudes were not more confident, self-motivated, and attained higher achievement. The researchers needed a much more robust conceptual framework that could compel students' motivation and engagement. The theory of attitudes did not achieve the desired goal as expected. Any further research should involve more participation and experiential learning rather than self-motivation.

The students were selected from public schools. Since most people in the research area lived in rural and suburban areas and rarely attended private schools, the study did not include private schools. However, in the last ten years, the area has been dominated by an influx of many private schools whose contributions to students' performance cannot be ignored. Thus, any replication of this study should take into consideration the private schools. This would enable stakeholders to obtain a comprehensive understanding and provide long-term solutions to the menace.

Literature showed that parental support/involvement influences students' attitudes towards learning mathematics. It was discovered that active parental support in children's education develops their positive attitudes towards mathematics learning and more likely higher performance. However, the Likert scale and the statements emanated from the researchers' encounters with other studies and literature. It would have been more prudent to take these statements from the students themselves. The researcher-made items must have influenced the ways they understood and responded to the questions. We believe that whenever students are allowed to talk about the problems themselves the issues of reliability and validity can be much more improved.

Parents and guardians were proactive in supporting their wards' educational pursuits and helping them to learn mathematics at home and in school. This helped the students to stay focused and more challenged. However the researchers could have gone further by bringing both parents and students in a focus group interview. The reader would have gotten more information about the lived experiences of parents and students in support of the learning of mathematics. The independent reports of the parents and students could have minimized biases and self-gratification. Further research should bring the two groups to the same table and make them discuss areas of mathematics that need more home support and those that require school attention.

The researchers found that teachers' encouragement and motivation boosted students' teaching and learning. However, apart from the repetitions of the items for parents and teachers, it was realized that many teachers whose environment was a disadvantage to mathematics teaching had little course to motivate students to learn mathematics. The inability of some teachers to motivate students has been ignored to enhance the relevance and goal of this study. Further studies on this area should pay more

attention to students' ability to work in harsh environmental conditions and with teachers with low morale to handle mathematics.

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DOI: <https://doi.org/10.57125/FED.2023.12.25.13>

How to cite: Borysova, S., Zadorina, O., Kotiash, I., & Bukoros, A. (2023). Digital Competencies in Ukrainian Education of the Future: Teaching and Assessment. *Futurity Education*. 3(4). 217-231. <https://doi.org/10.57125/FED.2023.12.25.13>

Digital Competencies in Ukrainian Education of the Future: Teaching and Assessment

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Received: September 24, 2023 | **Accepted:** November 11, 2023 | **Available online:** November 22, 2023

Abstract: The acquirement of digital competencies in the times of global digitalisation of society is an urgent task for the educational system. Being a part of the globalised world Ukraine needs to further improve the learning process based on digital technologies. The aim of the study was to determine the state of digital competencies in Ukrainian education by analysing the learning and assessing the skills of students. Quantitative and qualitative analysis were used in this paper. 120 students from different educational institutions of Ukraine were involved in the study, representing different professional fields. The students were selected based on pre-developed criteria: a student of a higher education institution, a combination of participants from different specialities and different educational levels, and experience in using digital technologies. A random sample was used in the study. Subsequently, it was stratified based on education levels and age groups in order to ensure proportional representation. The results indicated a high level of awareness of the importance of developing digital competencies for professional growth among modern students. The results showed that modern digitalisation processes have become a factor in the introduction and development of innovative teaching methods. For this reason, it is important to introduce methods of individualised learning using adaptive technologies, the use of virtual and augmented reality to improve learning. Such tools as a PC, laptop, smartphone, interactive whiteboards that have become commonplace for Ukrainian students. The conclusions noted that more than half of the respondents stated that their educational institutions created necessary conditions for digital competencies development. Forty-two percent considered that such conditions were not sufficient, which may be due to insufficient funding, lack of developed technical infrastructure. The implications influence the development of curricula in Ukrainian education, prompting the integration of digital competencies as a core component.

Keywords: digital competencies, digital skills, digital technologies, empirical research, learning, students, Ukraine

Introduction

Digital competencies of Ukrainian students are an urgent and important issue in the context of the development of the education of the future. In the era of rapid technological progress and globalisation, digital skills become a key factor for the successful functioning of society. Ukraine, based on its European integration, must meet the challenges of present time by actively introducing digital technologies into the educational process (Gryshkova, 2020). Therefore, this issue is important because digital competencies is a necessary means for students and teachers not only as a learning tool but also as an integral part of personal and professional development. Teaching digital skills will help ensuring the competitiveness of Ukrainian youth in the international labour market, as well as making the educational process more interactive and adaptive to modern requirements.

Ukraine has great potential in the development of digital education, but to do so, its role in shaping the future society needs to be reasonably defined. This study is an important contribution to improving educational strategies and shaping the readiness of the educational system for the challenges of the digital age.

Modern researchers have characterised various aspects of digital literacy. Particularly, Tytova and Mereniuk (2022) identified the main components of competencies. The researchers also described the main problems of digital competencies formation through the prism of analysing the educational process that takes place during war. According to Bondarenko (2022) and Wong et al. (2021), modern technologies allow for the implementation of learning that provides flexibility for students and teachers in choosing the time and place for learning. At the same time, teachers have access to a variety of e-

courses and resources for their professional development and skills updating. These changes in education define a new context for learning and require constant adaptation (Slukhenska et al., 2019; Topuzov et al., 2021). Therefore, given the active digitalisation of education, the development of digital competencies is an important area of innovative education of the future.

The study by Almås et al. (2021) determined that digital competencies implies the ability of a person to effectively use various digital technologies in professional activities. The key role in this process is played by the introduction and application of innovative methods and forms of organising the learning space. However, the works of contemporary researchers emphasise that there are various obstacles in Ukraine that limit the full implementation of digital technologies in the educational process. Some of them include limited access to equipment, as many educational institutions may face limited access to modern computers, laptops, and other devices, which limits the use of digital technologies in education (Curry & Docherty, 2017; Rak-Młynarska, 2022; Rani et al., 2022). At the same time, the existence of different approaches and the lack of common standards can complicate the integration of digital technologies into the educational system (Bulakh & Shandruk, 2022; Kharazishvili et al., 2021). This aspect is also highlighted in Bondar et al. (2021) and Haidabrus (2022). Other researchers state that a global problem affecting the effective use of digital technologies is the lack of methodological support (Cavalcanti et al., 2021; Hesse, 2021). At the same time, according to Hillier (2018), the increasing use of digital technologies requires addressing data security issues, especially when it comes to storing and processing the personal information of current students. The results of Gregory et al. (2020) demonstrate that the use of artificial intelligence technologies is an important aspect of innovative educational development. According to the authors, the effective use of AI can solve a number of the above problems.

At the same time, contemporary studies have shown that untimely adaptation of the educational system to the requirements of the digital society can lead to a loss of competitiveness and lagging behind global trends.

Research Problem

Despite numerous studies concerning digital competencies in Ukrainian education, issues such as determining the attitude of Ukrainian students to digital competencies and the level of digital skills remain unresolved. In addition, there is a need for a thorough description of the main conditions for the development of digital competencies in modern Ukrainian education and the identification of other problems on the way to the innovative development of Ukrainian education and the formation of digital literacy of future specialists.

This led to the choice of the research topic, which is an in-depth analysis and identification of the main tools used in modern educational institutions to teach digital competencies based on the analysis of empirical data obtained from questionnaires and interviews. The paper also aimed to characterise the popularity of certain digital tools used in modern Ukrainian educational institutions. In addition, this study also aimed to identify the factors that influenced the effective implementation of digital technologies in the educational process and the formation of digital skills of Ukrainian youth. A separate important issue that requiring detailed analysis was to identify the main aspects of improving the development of digital competencies based on the obtained data.

Research Focus

Based on the analysis of modern works on the issue, digital competencies are the ability of a person to confidently use various digital technologies in professional educational activities (Almås et al.,

2021). According to Khan and Vuopala (2019) and Tsankov and Damyanov (2019), the main components of this competence are the ability to find and process information, skills in analysing and creating multimedia content, technological competence, and the basics of computer skills in the educational process. Therefore, this competence is an important part of the education of the future, i.e., it influences the formation of specialists in various fields of the future. It has been proven that in the future, specialists with extensive knowledge and skills in the use of digital technologies will be in demand in the labour market (Bondar et al., 2020). Accordingly, the main objective of this article is to determine the level of digital skills of teachers and students in Ukrainian educational institutions.

Therefore, the main focus of the paper was to analyse the state of digital competencies in Ukrainian education based on a comparison of qualitative and quantitative data obtained from surveys and interviews.

Research Aim and Research Questions

The purpose of the study was to characterise the state of digital competencies in Ukrainian education based on the analysis of learning and assessment of students' skills. This study was implemented gradually, and the following issues were covered in the process.

1. To determine the attitude of Ukrainian students to digital competencies and the level of digital skills.
2. To analyse of the main tools used to develop digital competencies
3. To characterise of the main conditions for the development of digital competencies in modern Ukrainian education.

Research Methodology

General Background

The study was based on a combination of quantitative and qualitative data. Initially, it was collected using such tools as questionnaires and interviews and then processed through quantitative and qualitative analysis of the received information.

Sample / Participants / Group

The study involved 120 students from different educational institutions in Ukraine. These students represented different professional fields in order to get a more detailed answer about the state of digital competencies of Ukrainian students.

Inclusion criteria.

1. Participants must be students of Ukrainian educational institutions.
2. The combination of participants with different educational levels (bachelor's and master's degrees).
3. Participants with different age ranges were included to cover a comprehensive perspective of digital competencies across different age groups.
4. Participants should have different levels of digital competencies to represent a broad spectrum.

The study used random sampling to create a representative sample. First, a list of potential participants was obtained from the educational institutions and the required number was randomly selected. Subsequently, the sample was stratified based on education levels and age groups to ensure proportional representation (see Table 1).

Table 1

Participant Data

Age of applicants			
17-18 years old	19-20 years	21-22 years old	Over 22 years
12%	43%	19%	26%
Education			
Level: Incomplete basic	Level: Bachelor	Level: Incomplete higher education	Level: Master
None	47%	21%	32%
Gender.			
Male - 39% of respondents		Women - 61% of the population	

Source: Compiled by the authors.

Formal invitations to potential participants were sent via email or institutional channels. All participants were given a brief overview of the study.

Instrument and Procedures

Quantitative information was collected through a survey conducted in October 2023. The survey was designed to include both closed and open-ended questions. Some data related to digital competencies, learning, and assessment preferences were collected on a 5-point scale. The survey consisted of 4 parts. The first part collected demographic information. The second part collected data about the understanding digital competencies in education. This part consists of the following questions:

1. How important do you think it is to develop digital competencies in modern education?
 - a) Very important
 - b) Important.
 - c) I see it as something in between
 - d) No matter
 - e) It doesn't matter at all
2. How do you rate your digital skills?
 - a) High
 - b) Medium
 - c) Low

The next part “Digital competencies training” consist of the following questions:

3. Where do you mainly learn digital skills: at home, at school, or in courses?
4. What tools for teaching digital competencies are used in modern educational institutions?
 - a) Computers and laptops
 - b) Tablets and smartphones
 - c) Interactive whiteboards
 - d) Electronic textbooks
 - e) Internet resources and online platforms
- f) Does your educational institution have all the conditions for developing digital competencies?

The last part of survey consisted of one summary question: What measures are effective in improving the development of digital competencies?

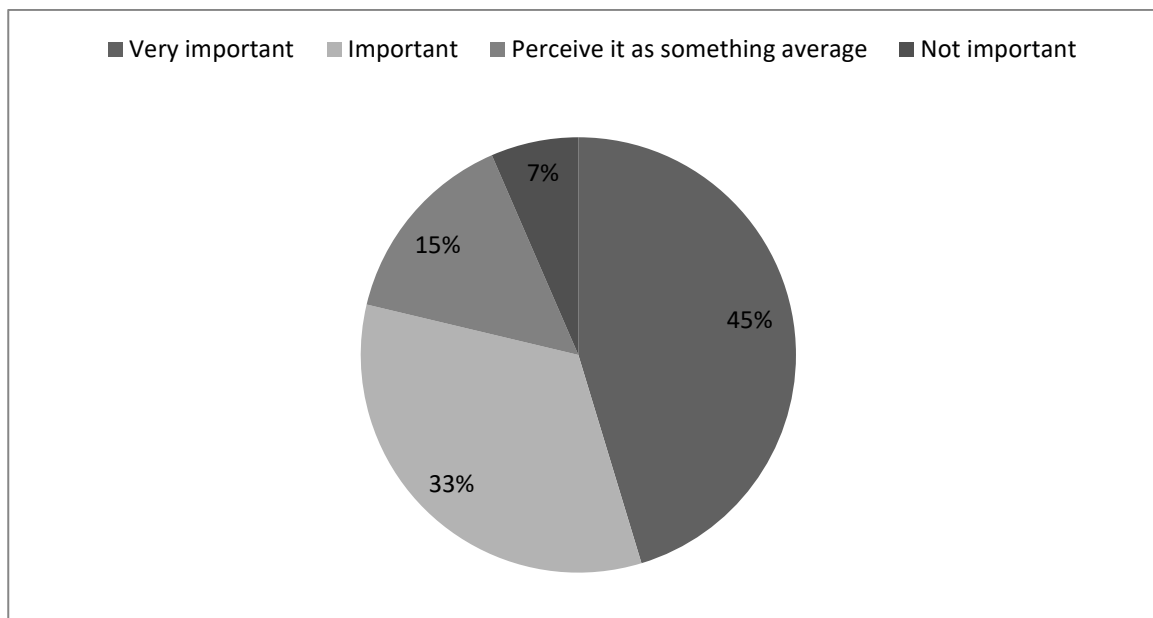
Therefore, the main instrument of this research was a questionnaire. First, demographic data were collected, later the students' attitude to digital technologies and the state of their digital communication were found out.

Research Results

Modern students are clearly aware that the development of digital competencies is important for professional growth. The frequency analysis showed that 49 respondents indicated that this process is very important, 48 respondents - important, 16 students - perceived digital skills as something not clear, only 7 students indicated that they are not important to them. Figure 1 shows a pie chart to assess the importance of digital skills development in %.

Figure 1

Pie Chart of the Importance of Developing Digital Competencies



Source: Data obtained from the survey.

When asked how modern students assess their level of digital literacy, the following data were obtained (see Table 2).

Table 2

Digital Skills Assessment Table

How do you rate your digital skills?		
Level	Number of respondents	%
High	41 respondents	26.4%
Medium	70 respondents	45.2%
Low	9 respondents	5.8%

Source: Survey data.

It has been identified that students can acquire digital skills in different places, such as at home, in an educational institution, or on courses. It depends on the individual student's choices and the availability of resources. Many universities and colleges offer special courses in digital competencies development, graphic design, where students can learn how to use certain digital tools or learn how to work with Adobe editors and other tools (Marner & Örtengren, 2014; Matei, 2022). Adobe also provides online resources and trainings for users of its products, where students can gain practical skills in using Photoshop, Illustrator, and InDesign.

In addition, some educational institutions provide access to computer labs and laboratories where students can use specialised software to develop digital skills. Students can develop digital skills on their own through online platforms such as Coursera, Udemy, or Skillshare, which offer courses in graphic design and Adobe editors. Separately, creating your own projects such as logos, posters, or illustrations can be part of self-study (Anggraini & Handayani, 2022). The theoretical analysis of the obtained data can provide insight into the trends in the use of digital competencies teaching tools in modern educational institutions. These data indicate certain priorities and the popularity of different tools.

Modern educational institutions use various means and tools that influence the development of digital competencies in students (see Table 3).

Table 3

Tools for Teaching Digital Competencies

What tools for teaching digital competencies are used in modern educational institutions?		
Tools	Number of respondents	%
Computers and laptops	117 respondents	97.5%
Tablets and smartphones	99 respondents	82.5%
Interactive whiteboards	56 respondents	46.7%
Electronic textbooks	80 respondents	66.7%
Internet resources and online platforms	105 respondents	86.7%

Source: Survey data.

According to the survey, computers and laptops are the most popular, with 97.5% of respondents using them. The use of tablets and smartphones also plays an important role. At the same time, modern educational institutions place great emphasis on the use of special online learning platforms (see Table 4).

Table 4

Table of Popularity of Digital Tools

Name of the institute	Popularity	Conclusion.
Computers and laptops	According to the analysis, computers and laptops are used in 97.5% of cases. This indicates	Computers and laptops are key tools for teaching digital competencies, integrated into

	their high popularity and widespread use in the educational process.	almost all modern educational institutions.
Tablets and smartphones	The high level of use (82.5%) indicates that tablets and smartphones are important tools for teaching digital competencies.	The increase in usage may be due to the development of mobile technologies and their increased accessibility for students.
Interactive whiteboards	The 46.7% use of interactive whiteboards may indicate that interactive whiteboards, although less popular, are still significant tools for learning. They were mostly appreciated by secondary education students.	Depending on the growing popularity of these devices among students, usage may increase.
Electronic textbooks	According to the analysis, e-textbooks are used in 66.7% of cases, which indicates their importance. However, their importance was assessed mainly by higher education students.	With the availability of electronic textbooks, students can learn the material conveniently and effectively.
Internet resources and online platforms	The high usage rate (86.7%) underlines the importance of access to online resources and online learning platforms.	Given the rapid development of technology, we can expect further growth in the use of online resources.

Source: Survey data.

The findings confirm that computers, laptops, and interactive technologies have already become standard learning tools. At the same time, the importance of mobile devices and online resources cannot be underestimated, and further development of their use in education can be expected.

The acquisition of digital competencies is extremely relevant given the emergence of new opportunities to work with design tools. Graphic design, as a separate component of art education, is developing extremely actively today, as there are a number of serious technological opportunities for this (Machiavelli & Cavalcante, 2022). Among them is the use of software from Adobe (Photoshop, Illustrator, InDesign), which makes it possible to use the potential of information technology in both distance and on-site learning. This allows for a full cycle of training, which gives future specialists the advantage of acquiring the necessary skills to gain further knowledge or a professional career. The gradual integration of artificial intelligence into design education should be emphasised. The use of various programmes (ChatGPT, Midjourney) allows students to get acquainted with the possibilities of the creative digital environment, develop specific skills in video and image processing, and reflect on and reflect on the creative sphere.

To the question “Are there conditions for the development of digital competencies in your educational institution?”. The number of respondents who answered “Yes” was 69 (57.5%), while the number of respondents who answered “No” was 51 (42.5%). Let's calculate the percentage of the data obtained.

Thus, according to the data, more than half of the respondents consider that their educational institution has the necessary conditions for the development of digital competencies. However, 42.5%

still believe that such conditions are insufficient. It is worth mentioning that not all Ukrainian educational institutions have a developed technical infrastructure, and there may be problems with access to the Internet. At the same time, insufficient funding for educational institutions is an important problem. This affects the fact that not all educational institutions are equipped with modern digital tools.

For this reason, improving the development of digital competencies for students in Ukraine requires a comprehensive approach and the implementation of various measures in the educational system. Table 5 highlights the main approaches and aspects of this process.

Table 5

Aspects of Improving the Development of Digital Competencies in Future Professionals

Area 1: teacher training	
Professional training of teachers and educators	Providing teachers with basic skills in digital technologies and methods of their use in the educational process (Borysova, 2023; Laufer et al., 2021; Lengetti, 2020).
Systematic trainings and seminars	Regular trainings, scientific and methodological seminars, and conferences for teachers to learn about new digital technologies and their effective use (Bashynska et al., 2021; Passey, 2021).
Area 2: access to hardware and software	
Providing educational institutions with modern equipment	Investing in the technical infrastructure of educational institutions, including computers, laptops, tablets, and other digital devices.
Licensed software	Providing access to licensed software and learning tools, including development and creativity platforms.
Area 3: development of digital learning materials	
Creating digital textbooks and resources	The development of modern digital learning materials that meet the requirements of the modern educational environment and take into account interactivity (Mathew et al., 2021).
Area 4: expanding access to the Internet	
Measures to improve the Internet infrastructure	Developing and implementing strategies to ensure a stable and fast Internet connection in all regions of Ukraine.
Area 5: support for independent learning	
Development of self-learning platforms	Creating and supporting online platforms that allow students to learn digital skills and expand their knowledge independently (Pinheiro & Santos, 2022; van der Merwe & Pedro, 2022).
Area 6: partnership with industry	
Cooperation with IT companies and industry	Developing partnerships between educational institutions and industry to provide students with internship opportunities and real-world experience with digital technologies (Lund & Aagaard, 2020).
Area 7: security and confidentiality measures	
Education on Internet safety	Introducing digital security training that includes aspects of privacy and online security rules (Safonov et al., 2022).

Source: Compiled by the authors.

Thus, the above measures are aimed at expanding the access to digital technologies, improving teacher qualifications, and creating incentives for the development of digital competencies among students in Ukraine.

Discussion

The study concerning the state of digital competencies of Ukrainian students confirmed the conclusions about the importance of its development in the future. In this context, it is worth agreeing with the views of scientists that the development of digital literacy, which includes the professional use of digital electronic sources, is an important task, especially in the context of the Russian-Ukrainian war (Tytova & Mereniuk, 2022). As part of the conclusions of this study, the opinions of domestic researchers on this topic are of great importance Klenin et al. (2020), who determine the importance of information and communication technologies in the system of training specialists of the future. Given the latest results of Stephanidis and Antona (2022), digitalisation will also lead to innovative teaching methods: the introduction of individualised learning methods using adaptive technologies, the use of virtual and augmented reality to improve the learning.

The findings also coincide with the assertion that uneven access to the Internet is an important challenge to the further use of digital technologies, and thus to the formation of digital literacy within an educational institution (Murphy et al., 2022; Rossikhina et al., 2019). Particularly, not all regions of Ukraine have uniform access to fast and stable Internet, which makes it difficult to use online resources and interactive platforms.

At the same time, it should be borne in mind that an important challenge to the development of digital competencies among students may be the qualification of teaching staff. It is worth agreeing with Klenin et al. (2020) and Zdanevych et al. (2020) that not all teachers are ready to use technology. For example, some teachers may lack the skills or confidence to use digital technologies effectively in the classroom. This aspect is also emphasised by other researchers, such as Jena et al. (2021).

In general, each of these domestic researchers, namely, Borysova (2023), Klenin et al. (2020), Rossikhina et al. (2019), Tytova and Mereniuk (2022), and Zdanevych et al. (2020), emphasise the need to develop digital competencies among future professionals.

In addition, these researchers also state that Klenin et al. (2020), Tytova and Mereniuk (2022), Zdanevych et al. (2020), and with overcoming of some obstacles (better training of teaching staff, solving problems with technical support), Ukraine can ensure more effective and innovative use of digital technologies in the education system. At the same time, it should be noted that ensuring more effective and innovative use of technology in the education system requires a comprehensive approach, including technological, organisational, and cultural changes (Safonov et al., 2022).

Thus, in this context Zdanevych et al. (2020) mention that teachers of new specialities should have a high level of computer literacy in order to effectively transfer relevant knowledge and skills to their students. On the other hand, reservations can be expressed about the thesis of this researcher regarding the implementation of new approaches to teaching and computerisation of educational technologies (Zdanevych et al., 2020). The researcher emphasises the widespread introduction of these technologies. For this reason, it is believed that new approaches can be important, but they need to be implemented in a pedagogical and balanced way, as disproportionate use of technology can have a negative impact on learning and, consequently, on the outcomes of students.

In this context, the transformation of infrastructure and access to the Internet, the provision of high-speed Internet in all educational institutions, and the expansion of access to digital resources for students and teachers are urgent tasks. The next step may be the wider use of educational platforms and tools. First and foremost, it is about creating and implementing digital learning platforms that will include interactive tools, open courses, and online resources, and providing training for teachers to use new technologies and integrate them into the learning process. This will lead to the wider use of electronic textbooks and resources, the transition from traditional textbooks to electronic formats to reduce costs and ensure the relevance of materials, and the development of open educational resources to support access to innovative and effective education. The last element will be transformations in the assessment system: developing and implementing digital assessment systems that take into account students' competencies and skills, not just knowledge of facts, promoting the use of portfolios and project-based assessment methods. These transformations will take time and effort but will improve the situation in Ukraine's education system in the coming years.

Conclusions and Implications

This study concerned with the state of digital competencies of students has led to the following conclusions.

1. Today's students in Ukraine consider the development of digital competencies important for their professional growth. The data confirm a high level of awareness of the importance of digital skills, with the majority of respondents identifying them as very important or important.
2. With regard to the use of digital technologies in education, the findings show that computers, laptops, and interactive technologies have already become standard tools for learning. At the same time, mobile devices and online resources are also important, and their use may be expected to develop further in education. The importance of acquiring digital competencies is especially relevant in the context of developing design skills using Adobe software. The integration of artificial intelligence into design education is also noted, and the use of various programmes enables students to get acquainted with the technological environment and develop creative skills.
3. Regarding the conditions for the development of digital competencies in educational institutions, it is worth noting that more than half of the respondents considered that such conditions exist in their institution. However, problems with technical infrastructure, Internet access, and limited funding point to the need for additional measures to improve infrastructure and ensure access to digital technologies in all educational institutions.

Suggestions for Future Research

The study was not aimed at a comprehensive study of digital literacy in future professionals, given the limited period of this research. A separate aspect for further study of the topic is the analysis of changes and transformations in the development of digital competencies in students over a longer period of time. For example, future research could focus on a comparative analysis of the data obtained from this study. Such work could provide insight into the long-term impact of digital education on the future learning space.

In addition, a separate important aspect may be the assessment of digital literacy among employees of Ukrainian educational institutions. To this end, a comprehensive and thorough assessment of modern teachers' digital literacy level should be conducted through a questionnaire or survey. In this direction, it is worthwhile determining the effectiveness of teacher training programmes for integrating digital competencies into their teaching methods and forms. This will make it possible to effectively assess the impact of professional development on teaching practice. Consequently, such a study will

demonstrate the state of teachers' digital skills, their attitude to modern digitalisation processes, and will help to understand possible ways to improve digital competencies in general.

The third important area is the comparative analysis of teaching methods and the impact of mobile learning on the development of digital competencies. In this area, it is worth comparing the effectiveness of different teaching methods and assessment strategies in the development of digital competencies. This may include comparing traditional methods with more innovative, technological approaches and forms of delivery. This area will also explore the integration of artificial intelligence tools into educational institutions, especially in the context of digital competencies development. This will allow evaluating and researching the effectiveness of AI-driven educational tools and their impact on student outcomes. In this context, the specific impact of mobile learning on the development of digital competencies can also be explored. This area will help to understand how mobile devices and apps facilitate the learning process and whether they offer unique advantages.

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DOI: <https://doi.org/10.57125/FED.2023.12.25.14>

How to cite: Renau Renau, M. L. (2023). Exploring Methodological Approaches in Secondary Education in Castellón, Spain: A Comparative Analysis of Traditional, Blended, and Innovative Teaching. *Futurity Education*, 3(4). 232-254. <https://doi.org/10.57125/FED.2023.12.25.14>

Exploring Methodological Approaches in Secondary Education in Castellón, Spain: A Comparative Analysis of Traditional, Blended, and Innovative Teaching

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Received: October 2, 2023 | **Accepted:** November 19, 2023 | **Available online:** November 28, 2023

Abstract: The traditional model of teaching-learning process, concerned with the knowledge acquisition within the confines of a classroom, has long prioritised exam preparation and measurable academic success through standardised tests. In contrast, hybrid education integrates in-person teaching with online learning, leveraging Information and Communication Technologies (ICTs) in order to create adaptable and comprehensive learning environments. This paradigm shift acknowledges students individuality, tailoring instruction to their unique learning needs. This research investigated the methodologies employed by secondary education instructors in the province of Castellón (Valencia, Spain), drawing insights from the experiences of 45 master's students specialising in Language and Literature and Language Teaching. Participants were prompted to share their experiences, focusing on identifying whether their supervisors utilised traditional, hybrid, or innovative teaching methodologies. The Padlet platform was employed in the research to collect qualitative data through open-ended responses, providing a rich source of information on the teaching and learning processes observed during 200-hours of internship. Data analysis revealed intriguing insights into the methodologies employed by supervisors. The results indicated a spectrum of teaching methodologies in Castellón's secondary schools, emphasising the importance of considering both traditional and hybrid approaches, while also promoting innovation in educational practices. In conclusion, the findings not only offered a

picture of current teaching methods but also provided valuable insights for future discussions on curriculum development, teacher training, and the overall enhancement of the teaching-learning experience.

Keywords: blended learning, innovative methodologies, traditional methodologies, secondary education

Introduction

The understanding the essence of education involves revisiting Vygotsky's (1978) perspective, emphasising on learning as a result of social interaction and symbolic mediation rather than as simple information transmission. The zone of proximal development underscores the teacher's role as a facilitator, promoting collaborative and cooperative learning. The research highlights a gap in understanding students' perspectives on teaching methodologies, accenting on the importance of considering their experiences for a comprehensive understanding of the teaching-learning process. The literature review contrasts Vygotsky's (1978) collaborative approach with the traditional model, demonstrating a shift from teacher-centric to student-centric methodologies. Hybrid education, blending in-person and online components, is explored as a transformative strategy to address diverse student needs in the digital era. The exploration of innovative methodologies, such as cooperative learning, underscores the transformative impact of social collaboration in education. Notably, the cooperative learning is distinguished from mere group work, emphasising its role in developing interpersonal skills and enhancing narrative paragraph skills. The study introduces a novel dimension by exploring the methodologies of secondary education teachers in Castellón, shedding light on diverse teaching approaches. The need for a balanced consideration of traditional, hybrid, and innovative methods is considered, the research contributes valuable insights for curriculum development, teacher training, and overall improvement in the teaching-learning experience in secondary education. The findings advocate for a nuanced approach, promoting an adaptive and personalised learning environment for students and guiding future discussions in education.

Literature review

In the traditional model of the teaching-learning process, the primary objective is for students to acquire knowledge. The effectiveness of teaching is measured by the extent of students' learning. Typically confined within the classroom setting, traditional teaching methods involve students passively receiving and absorbing the information presented by the teacher. This approach places the teacher at the core of the educational process, while classrooms operate in a regulated manner. Group learning and collaborative activities are often limited, with students primarily relying on lectures for their learning. The main focus of traditional teaching is often directed towards preparing students for examinations and achieving favourable academic outcomes. Within this teacher-centered instructional model, educators hold the central authority, utilising standardised tests and evaluations to assess student learning with an emphasis on objective scoring systems.

Hybrid education, also known as blended learning, is an instructional strategy that merges traditional in-person classroom teaching with online learning. By incorporating Information and Communication Technologies (ICTs) into the educational framework, institutions can create adaptable and all-encompassing learning spaces that accommodate the varying requirements of students, promote digital proficiency, and equip them with the necessary skills to navigate the complexities of the digital era. Blended learning, a pedagogical approach amalgamating traditional in-person teaching with online

learning components, has garnered substantial researchers attention. Notable contributors include Graham and Dziuban (2007), focusing on the design of blended learning environments. Christensen et al. (2008), explore the potential impact of disruptive innovation on the education system. They argue that traditional education models are not effectively meeting the diverse needs of students and that disruptive technologies, such as online learning and blended learning, have the potential to transform the educational landscape. The authors propose a student-centric approach that leverages technology to provide customised learning experiences, catering to individual learning styles and paces. Bonk and Graham (2005) wrote a comprehensive guide in the realm of blended learning. Targeted at training and HR professionals and designed to provide a broad understanding of blended learning methodologies, with a focus on both global perspectives and locally tailored designs. Garrison and Kanuka (2004) explore the transformative possibilities associated with blended learning within the context of higher education. In this work, the authors likely discuss how combining traditional face-to-face instruction with online learning elements can lead to innovative educational experiences. They may address how blended learning approaches have the potential to enhance student engagement, cater to diverse learning styles, and provide flexibility in the educational process.

The implementation of novel teaching approaches within the educational system is fundamentally reshaping the way learning and teaching are approached. Emphasising the uniqueness of each student, these approaches customize instruction according to the individual needs of each learner.

According to Escudero (2006), the essence of Educational Innovation lies in challenging the status quo, the mechanical and routine, and the formidable influence of existing facts and inertia. It necessitates a collective commitment to what is deemed desirable, a cultivation of creative imagination, and the transformation of the current state of affairs. This approach requires the creation of a utopian breach within systems such as education that tend to uphold tradition and perpetuate the past. Essentially, innovation must foster an environment throughout the entire educational system, from administrators to teachers and students, that encourages investigation, discovery, reflection, criticism, and ultimately, change. Imbernón (1996) stated that educational innovation is the active pursuit and process of exploring novel ideas, collaborative propositions, and collective contributions, aimed at resolving practical challenges. This pursuit results in transformative changes within educational contexts and institutional practices. Rimari (2009), on the other hand, identifies nine objectives for educational innovation that extend beyond enhancing the quality of education. These objectives include fostering positive attitudes, establishing platforms for disseminating new concepts, formulating adaptable curricular changes, implementing relevant theories, processes, methods, and techniques aligned with institutional requirements. Additionally, the objectives involve encouraging research into the professional development of educators, sharing innovative educational experiences, and establishing an enduring framework where innovative practices become an inherent cultural aspect of the organisation. Bonal (2017) stated that innovation encompasses more than just technology; it involves a shift in methodologies, social dynamics, work structures, and ultimately, the entire fabric of society. In the publication by Instituto Politécnico Nacional, Mexico, authors including Ortega Cuenca et al. (2007) asserted that educational innovation operates as a strategic approach to advancing institutional objectives. They accentuated the contextual significance, highlighting that innovation within one educational setting might not necessarily hold the same innovative value elsewhere. This recognition of contextual influence underscores the inherent nature of an innovative experience.

As per UNESCO (2014), "educational innovation entails a purposeful and systematic approach to problem-solving, striving to enhance the quality of student learning by surpassing traditional methods. It necessitates a shift beyond conventional academic knowledge, emphasising active student engagement and interaction as the cornerstone of the learning process. This perspective by UNESCO

underscores the importance of collaborative learning over individual learning, positioning the latter as passive and the former as interactive." Robinson (2015) suggests that educational innovation encompasses fostering a culture of creativity and experimentation within educational institutions, promoting a climate that encourages risk-taking and collaboration among teachers, students, and other pertinent stakeholders within the educational ecosystem. García-Peñalvo (2016) asserts that any educational reform must be approached holistically, considering the various components within the system to ensure balance and coherence among them. Meanwhile, Fullan (2016) argues that effective educational leadership should be intentional, transparent, and cultivated over an extended period. He states the necessity of fostering a culture of change founded on a well-defined vision, common objectives, and collaborative innovation. Mosquera Gende (2022, 2023) highlights the misconception of equating educational innovation solely with the integration of ICT resources within the classroom. According to the author, the utilisation of robotics, dronotics, programming, or 3D printing, although introducing novelty, does not inherently signify innovation on its own. Furthermore, she emphasises that the implementation of methodologies like the flipped classroom, gamification, or neuroeducation must be coherent and well-structured to qualify as innovative practices. Mosquera Gende (2023) underscores the error of pursuing the novelty for its own sake, cautioning against the superficial adoption of trending educational approaches, underlining the crucial role of adaptation, asserting its significance in the educational context as a fundamental element in effective teaching practices.

Macanchí Pico et al. (2020) expound on the multifaceted nature of the term "innovate," linking it with synonymous terms like "change," "renovation," "transformation," and "reform." Their research underlines the importance of a deliberate and calculated process of decision-making as a crucial element in fostering the integration of new knowledge, technology, and resources. They state that innovation stems from the application of theoretical or scientific ideas in practical contexts, leading to tangible advancements. The authors' analysis is complemented by empirical research, affirming the significance of readiness, effective communication, collaboration, and organisational structure in promoting teacher engagement within innovative processes. According to Olivé (2020), the pursuit of methodological innovation is driven by a genuine desire to transform the teaching approach in a meaningful and authentic manner. Reflecting on his own teaching journey, the author acknowledges the potential for extracting greater capabilities from his students by igniting their inner curiosity and nurturing their critical thinking. For him, the key lies in attentively listening to his students and striving to cater to their genuine educational needs. He considers that the joy of learning should be an organic, infectious experience rather than a forced one. Renowned for his adaptability, particularly in the context of language and literature, Cristian tailors his curriculum to align with the present realities and diverse backgrounds of his students. Furthermore, the valuable feedback from his students serves as a constant source of motivation, prompting him to remain informed and actively foster a culture of critical thinking.

Mosquera Gende (2019), Imbernón (1996), and Macanchí Pico et al. (2020) have provided definitions that, when examined dialectically, intertwine key concepts essential for discussing innovation in the education sector. On the one hand, Mosquera Gende (2019) stresses "adaptation to circumstances", the need to relate to the team and the students with emotional intelligence, that is, being empathetic and constructive with others and with oneself, and the relevance of sharing learning and committing to a process of constant training. In this context, Imbernón (1996), proposes a definition close to these concepts, adds that innovation also consists of proposing a change in the face of prior observation of problematic situations in learning, which is essential for entering into the aforementioned process of constant improvement: practising, evaluating and modifying. Finally, Macanchi et al. (2020) state the importance of teamwork (making the organisation more dynamic) and the implementation of knowledge or technology. Authors insist on the fact that prior to implementation

there is a whole body of research work on the part of the teacher. Torres Ramírez (2023) defines educational innovation as a comprehensive integration of technology, didactics, pedagogy, processes, and individuals. It denotes a substantial transformation in the teaching-learning process, necessitating modifications in materials, methods, content, and the instructional settings. Contrary to the perspective of Mosquera Gende (2019), while technologies often play a role, they are not imperative, as innovation encompasses a broader spectrum of elements.

Building on Vygotsky's (1978) emphasis on collaborative learning, the exploration of innovative methodologies, particularly the cooperative learning, further underscores the transformative impact of social collaboration in education. Through practices rooted in the Social Interdependence Theory and pioneered by influential figures like Johnson and Johnson (2017a, 2017b), Slavin (1991), Aronson (1978), and Kagan (1994), the cooperative learning emerges as a powerful strategy that enhances student engagement, fosters positive interdependence, and establishes a dynamic approach to education based on shared objectives within a collaborative framework. When dealing with innovative methodologies, it is mandatory to mention cooperative learning. In this study, examples of best practices emerge where teachers use group work and cooperative learning. Cooperative learning, an instructional strategy wherein students collaborate in small groups to attain shared objectives, has been shaped by the pioneering work of influential figures in educational theory. Johnson and Johnson (2017a, 2017b) have championed the Social Interdependence Theory, stressing positive interdependence and individual accountability in models like "STAD" and "Jigsaw." Slavin (1991), advocating for Student Team Learning since the 1980s, underscores group goals and individual accountability to enhance student engagement. Aronson (1978), with the Jigsaw Classroom technique from the 1970s, encourages small groups to become subject "experts" and teach their peers. In 2021, Aronson applied the jigsaw method with fifth-grade students, achieving success as the students gained an appreciation for each other's differences, fostered friendliness, and developed a positive attitude toward the school. Kagan (1994) offered specific interaction frameworks like "Round Robin" and "Numbered Heads Together" to foster positive interdependence. Sharan and Sharan (2021), active from the 1970s to the 2000s, contributes to Cooperative Learning in Small Groups, emphasizing positive interdependence and social skill development. Collectively, these theorists have significantly influenced the landscape of cooperative learning in educational settings, recognizing its dynamic nature with potential for continued evolution and additional contributors in the future.

The cooperative learning is commonly recognised as the educational application of group work; however, it is important noting that not all group work is synonymous with cooperative learning (Baines et al., 2016; Ghahraman & Tamimy, 2017; Kutnick & Blatchford, 2014). Currently, instructional approaches centered on collaboration are increasingly employed to promote teamwork, enabling students to acquire collaborative skills, enhance performance, and foster interpersonal development (Baena-Morales et al., 2020; Del Barco et al., 2015; Gaudet et al., 2010; Gottschall & Garcia-Bayonas, 2008; Mendo-Lázaro et al., 2021). A highly sought-after skill is the ability to work effectively in teams (Cavazotte et al., 2012; Dyson et al., 2021). According to the dominant social interdependence theory, regarded as the most influential cooperation theory (Johnson & Johnson, 2017a, 2017b), "...the manner in which interdependence is organised shapes individual interactions, and these interaction patterns dictate the outcomes of the situation" (Johnson and Johnson, 2017b, p. 286). In this sense, Mendo-Lázaro et al. (2021) assert that cooperative learning fosters the cultivation of interpersonal skills and stimulates heightened engagement from students in the educational process and also, cooperative learning enhances narrative paragraph skills, emphasises the understanding, leading to improved learning and positive behavioral change is observed (Khair et al, 2021). According to Sudirman et al. (2023), cooperative learning effectively fosters the incorporation of democratic ideals, attitudes, and principles

in writing contexts. It serves transformative purposes, enhancing global writing competence and facilitating the expression of transformational values through in-class activities, contributing to global cooperative learning. Cooperative learning is defined as “work together in small groups that are typically self-selected, self-managed, and loosely structured” Davidson (2021, p. 12). Despite having distinct objectives and priorities, cooperative learning methods all tend to structure group interactions to ensure equal participation and individual accountability (Bruffee, 1995, 1999; Oxford, 1997; Sharan & Sharan, 2021).

By exploring the methodologies employed by secondary education teachers in Castellón, this research introduces a novel dimension to the discourse, shedding light on the diverse spectrum of teaching approaches, including traditional, hybrid, and innovative methods. The findings fill a crucial gap by emphasising the need for a balanced consideration of these approaches, thereby contributing valuable insights for future discussions on curriculum development, teacher training, and the overall improvement of the teaching-learning experience in secondary education. The findings from this research significantly impact the future educational landscape by advocating for a nuanced approach that embraces a spectrum of teaching methodologies, thus fostering a more adaptive and personalised learning environment for students and offering crucial guidance for shaping future discussions on curriculum development, teacher training, and the continual improvement of the teaching-learning experience in secondary education.

Research Problem

The education system in Spain confronts various challenges. Notably, the decentralised nature of education led to significant regional disparities in policies and resources, creating inequalities in the quality of education and opportunities for students across different areas. Issues such as a historically higher rate of early school leaving than the European Union average, difficulties in aligning education with labour market demands resulting in youth unemployment, and challenges associated with bilingual education, including teacher training and resource allocation, were prominent. Additionally, economic challenges impacted education funding, essential for the infrastructure maintenance, resource provision, and teacher support. The debate over the emphasis on standardised testing as well as the ongoing efforts to fully integrate students with disabilities into mainstream classrooms also contributed to the complexities of the education landscape. It is crucial to acknowledge that educational issues evolve, and new policies and methodologies should be implemented to face these challenges.

Research Focus

Having observed the prevailing patterns in the education teaching-learning process, the focus was to examine the methodology employed by secondary education instructors in the province, leveraging the insights provided by the students' experiences. The prime objective was to gain direct insight, derived from the real experiences of the students, into whether teachers employed traditional, hybrid, or innovative methodologies.

Research Aim and Questions

The objective of this research was to illustrate the specific methodologies employed by teachers in the secondary schools within the province of Castellón (Valencia, Spain), where the master's students completed their internships. Based on the research problem and aim, 2 Research Questions arose:

1. How do secondary education instructors in Spain approach the teaching-learning process, and to what extent do they utilise traditional, hybrid, or innovative methodologies?

2. How do teachers visualise and implement specific methodologies during the teaching-learning process in the context of secondary schools in the province of Castellón, ?

Research Methodology

General Background

The research methodology employed in this study was primarily qualitative, aiming to gain direct insights into the teaching methodologies used by secondary education instructors in the province of Castellón, Spain. The qualitative approach was chosen to explore the nuances and real-life experiences of students during their internships, allowing for a deep understanding of the methods employed by teachers. The qualitative data collection method involved gathering rich, descriptive information from the students' perspectives, allowing for a nuanced understanding of the teaching methods employed in the observed educational settings, undergoing to ensure its validity and relevance to the research objectives. The open-ended nature of the questions enabled students to share their perceptions, observations, and insights, providing a comprehensive view of the teaching-learning process.

Sample / Participants / Group

The study focused on 45 students who were currently enrolled in the course SAP405 (Teaching Innovation and Introduction to Educational Research) within the master's program for teaching in Compulsory Secondary Education, Baccalaureate, Vocational Training, and Language Teaching. These students were specialising in Language and Literature and Language Teaching, with the majority falling within the age bracket of 23 to 25 years. The student cohort included individuals specialising in English, Catalan, and Spanish. During the 200-hour internship, the students undergo a comprehensive observation phase to familiarise themselves with the organisational dynamics of the educational community. This initial stage, guided by their assigned supervisors, paves the way for their active involvement in classroom interventions.

Instrument and Procedures

Upon the completion of their 200-hour internship at a secondary school, students were requested to provide their feedback through an open-ended question. Specifically, they were prompted to reflect on their experiences within the educational centres, examining the role of their supervisor (the teacher leading the class) in the context of traditional, hybrid/blended learning, and innovative methodologies. During students' 200-hour internship at the secondary school, they were asked to reflect on their experiences within the educational center.

1. General Feedback:

- How would you describe your overall experience during the internship?
- What aspects of the educational center positively contributed to your learning experience?

2. Role of the Supervisor:

- Describe the role of your supervisor (the teacher leading the class) during your internship.
- To what extent did your supervisor facilitate a positive and engaging learning environment?

3. Teaching Methodologies:

- Traditional Methodologies:

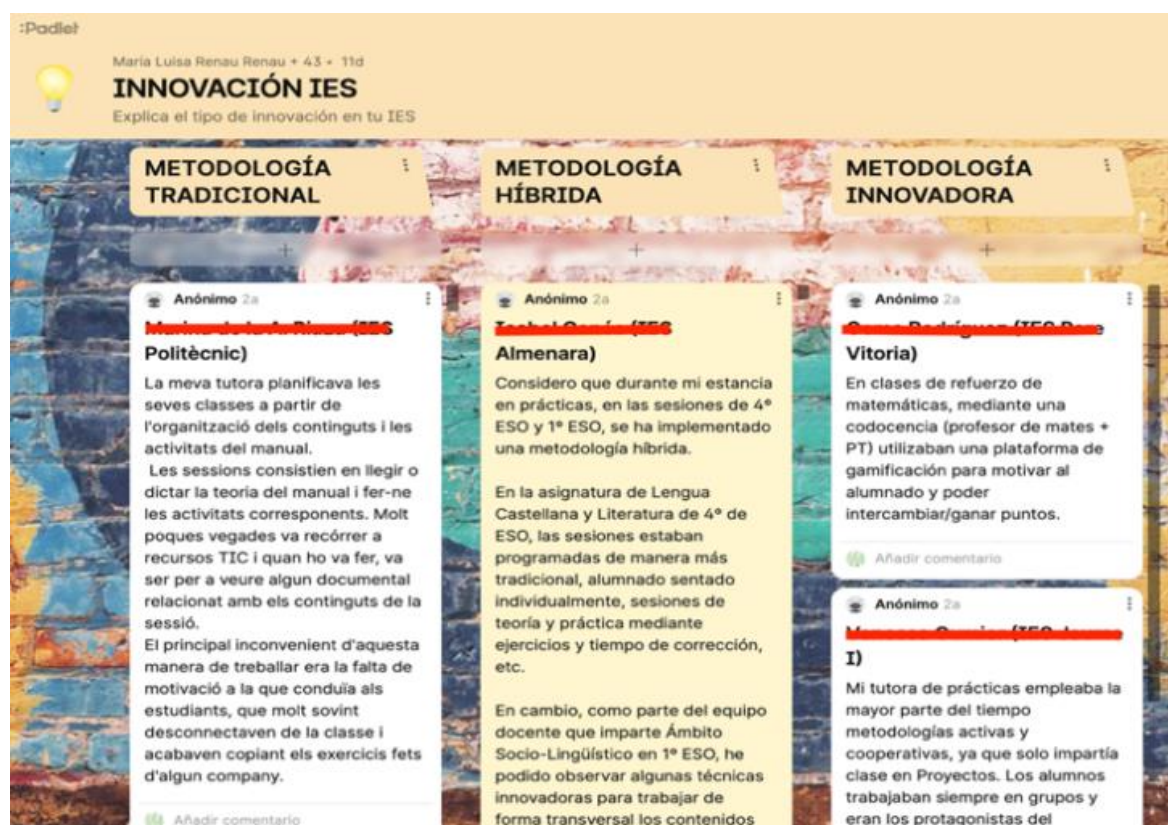
- Can you identify instances where traditional teaching methods were employed during your internship?
- How effective did you find traditional teaching methods in enhancing the learning experience?
- Hybrid/Blended Learning:
 - Were there any instances where hybrid or blended learning approaches were integrated into the teaching process?
- Innovative Methodologies:
 - Were there any innovative teaching methods or approaches used during your internship?
 - In your opinion, how did these innovative methodologies contribute to a deeper understanding of the subject matter?

Data Analysis

A Padlet platform was established in order to aggregate the exchanges among the students. Padlet, acting as a digital canvas, allowed students sharing their experiences within the secondary school setting while also enabling them to engage with the contributions of their fellow peers. This tool proved highly beneficial as it fostered an active response culture within the student community, ultimately facilitating the collection of valuable materials pivotal to the culmination of this study's results. The students responded on Padlet in Spanish, Catalan, or English. Here we can see a screenshot of the platform with their answers.

Figure 1

Students' Responses on Padlet



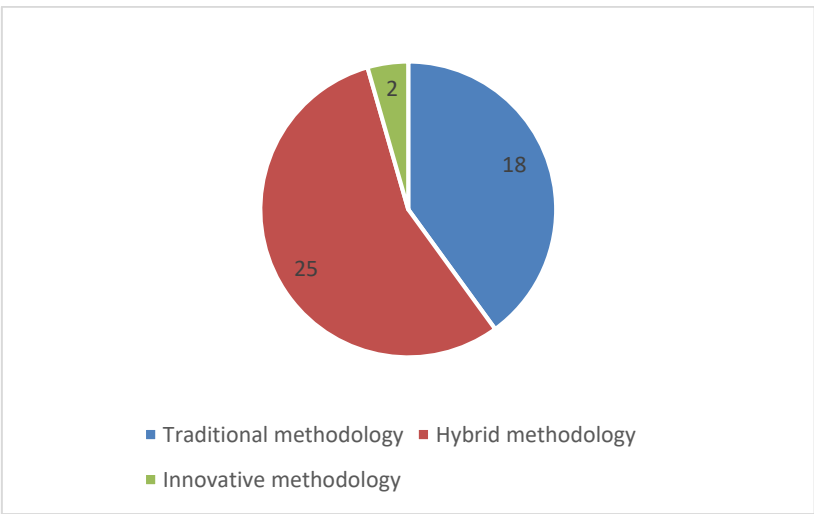
Research Results

The results of the study comparing different methodologies revealed interesting insights. Out of the total 45 analysed answers, the traditional methodology demonstrated steady performance with an average success rate of 18. On the other hand, the hybrid methodology, blending traditional and contemporary approaches, exhibited a higher success rate, effectively delivering 25 successful projects.

Surprisingly, the innovative methodology, though promising, yielded only 2 successful projects, indicating the need for further research and refinement to fully harness its potential. These results underscore the importance of striking the right balance between established practices and cutting-edge strategies to ensure consistent project success and innovation.

Figure 2

Results of Supervisors' Methodology



Source: author's own development.

The subsequent three tables display all the feedback provided by our students following their assessment of the methodology employed by their supervisors.

Table 1

Comments on Supervisors' Traditional Methodology

TRADITIONAL METHODOLOGY	
1.	The sessions consisted of reading or dictating the theory of the manual and doing the corresponding activities. Very few times did she resort to ICT resources and when she did, it was to watch a documentary related to the contents of the session.
2.	My teacher followed a traditional methodology, based on lectures. Her explanations of the contents were not bad per se, but she also did not dedicate time to the students who required it. The classes were boring and only a few students participated in them.

3. The teacher used a traditional methodology following the book and explaining on the blackboard. His explanations were quite clear and adapted to the educational level of the group, but he did not use any extra resources or prepare additional exercises.
4. The class was organised on an individual basis; no group or pair work or projects were carried out.
5. The textbooks were the basis for all the classwork.
6. Most of the classes were based on explanation, exercises, and correction. The book was quite up to date, and this allowed the activities to be quite dynamic. Sometimes the book was left aside, but only when the timing of the program allowed it.
7. Master class, in which he did not pay attention to those who did not follow the explanation, the same people always participated in class, sometimes, he badly answered the students.
8. The supervisor explained the English grammar on the blackboard, asked the students to do the exercises and then corrected them out loud. Then she would send them exercises from the workbook to do the same activity the next day.
9. My supervisor used a completely traditional methodology. Book, exercises, homework, listening and writings, all the same as when I started having English classes at school more than 15 years ago. The explanation on the blackboard in a moment, the class completely silent. At no point did he deviate from the master class, even to the point of rather sadly wasting resources like having a Philippine conversation assistant in the classroom.
10. My supervisor used the Burlington materials on the computer and projected the book and activities on the classroom whiteboard. The students followed the lectures quite well as the teacher had a lot of energy and they didn't have a moment to wander off or chat.
11. My supervisor, although she put a lot of effort and tried to motivate her students, used almost exclusively the textbook in class, doing the exercises of each unit and correcting them by projecting the book in digital format.
12. My supervisor during the internship used a traditional methodology. Although she combined the online book (Student's Book) and the physical book (Workbook), the exercises and worksheets to be completed by the students were traditional (fill in the gaps, correct the sentences, write the sentences in the correct order...).
13. My supervisor was a very good teacher and was able to get her students to learn without any problem. However, her methodology was not innovative in any way, nor was she able to motivate the students.
14. The sessions were scheduled in a more traditional way, students seated individually, theory and practice sessions with exercises and correction time, etc.
15. The main dynamic was to follow the book without any kind of preparation, which led to a demotivation of the students towards the subject.

16. In most of her classes, the teacher used the master class methodology, where she explained the topic to be covered and then sent activities from the book to the students.
17. Even she used the textbook in all the sessions, the students paid attention and followed the classes in silent.
18. Students followed the textbook, completed the exercises and then, the supervisor said the correct answers.

As table 2 shows, the comments from students regarding the traditional methodologies indicate a reliance on conventional teaching methods, such as lectures, blackboard explanations, and textbook-based activities. 5 key themes emerge:

Table 2

Key Main Themes on Supervisors' Traditional Methodology

No Use of ICT Resources	Individualistic Approach	Textbook-Centric Instruction	Master Class Methodology	Demotivation of Students
Several supervisors were observed to infrequently incorporate ICT resources, such as documentaries or computer-based materials, into their sessions	A prevalent characteristic was the individualised nature of the classes, with minimal group or pair work, and a lack of projects or collaborative activities	The textbooks were consistently identified as the primary resource, forming the basis for classwork, exercises, and homework	A common observation was the use of the master class approach, where the supervisor primarily delivered content with limited interaction and engagement	The reliance on traditional methods, such as following the book without additional preparation, was associated with student demotivation

Figure 3

Results of the table transformed into percentages.

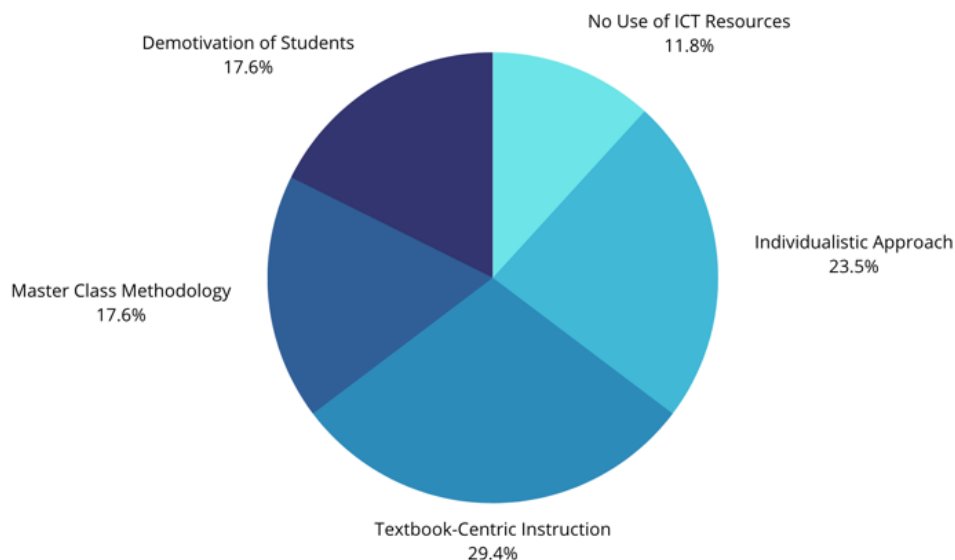


Table 3

Comments on Supervisors' Hybrid Methodology

HYBRID METHODOLOGY	
1.	During my internship I have seen that my tutor applies a hybrid methodology in her classes. She usually uses lectures as a methodology in the classroom. However, it is worth mentioning the implementation of oral projects every Friday in the first cycle. These projects are creative and innovative, making the students the protagonists since they are dynamic group exercises. One example is the creation of an invention, which they then had to present to see if their classmates would buy it.
2.	Sometimes used digital platforms to encourage student motivation, as well as educational videos, games or platforms such as Padlet or Quizlet.
3.	In my case, I have been fortunate to be able to enrich myself with two teachers, because I have had a tutor assigned to me, but in a way she has shared my tutoring with another teacher. Marta is a teacher who has not lost her vocation and her desire and enthusiasm for her students to learn. She uses ICT and has developed together with other teachers the material for the students. In addition, she is the head of the department and is constantly trying to learn from both teachers and students. The classes have a certain traditional form, because although she constantly asks the students to find out what their previous knowledge is and to expand it (she questions them), the structure is to explain the theory and then do exercises. However, the students are very motivated and sometimes they are rewarded with songs.
4.	My supervisor is the spitting image of a young teacher who is eager to make a change and to meet the real needs of the students. He knows the curriculum he has to teach, but he sees that sometimes it does not meet the needs of the students and that, in the traditional way, many

students are left behind or do not feel motivated. He constantly implements activities that require group discussion, dialogical discussions, cooperative groups, so that all students are very motivated and eager to go to class.
5. The projects themselves are quite an innovative methodology, the students always work in cooperative groups and often use ICT. However, in general, the classes were very traditional.
6. My tutor could be said to employ a hybrid methodology. Although he used the textbook to do exercises daily in a traditional way, he also used innovative techniques in: - presenting the grammar using info-graphics and involving them in the explanation - collecting the most common mistakes in the essays and projecting them on word clouds to discuss them in class - look for videos related to the topic studied in the class readings - expanding vocabulary by offering different uses of the same word or other related expressions.
7. My experience during the practicum was very good and profitable. I had a splendid tutor, with 30 years of experience and it showed. He did project-based learning (for example, in one project the students had to contact certain authors of books around to interview them and the professor knew some of them and offered the students advice to achieve it: contact by private message through social networks, send them an email to ask them the relevant questions, meet with them if they were willing. ...), cooperative learning (not now, because of the pandemic), co-teaching (last year in English because he is also specialized in this discipline) and active learning (if he ever used texts or exercises from the book, he did it in such a way that the students participated). He always adapts to the needs of the students and accompanies and guides them in a way that always gives them feedback. He promotes critical thinking in the classroom through routines or thinking skills. He is very open methodologically (he goes more towards the innovative side, although at times he is conservative, using a little bit the book but with a different approach).
8. In the subject of World Literature, the center's tutor used a hybrid methodology. They did not have books and she looked for the material in different sources. In addition, the readings of classical works were active and dynamic.
9. My internship tutor used a hybrid methodology, since the textbook was a fundamental tool and, in many cases, served as a guide during the sessions, but he also resorted to other more interactive and dynamic tools. This is the case of audiovisual material, such as music, videos or films, and of debates initiated in the classroom.
10. The tutor used more innovative practices, such as collaborative learning when speaking and some exercise or review game, where students were put in pairs or groups, or more communicative classes where students had to practice oral skills spontaneously, in addition to using ICT in an interactive way in all her classes.
11. My internship supervisor was predisposed to the practice of a more innovative methodology, but in practice she resorted to traditional methods in most cases. On occasion, she used technology in her classes, projecting some images related to the contents of the subject. The book was a resource, not an indispensable one.

12. My tutor used a traditional methodology, making use of the textbook, together with ICT resources and gamification. On the other hand, depending on the course the methodology changed, i.e., for the 1st ESO students she focused more on vocabulary and grammar, although sometimes she used games like Kahoot or Quizizz, while for the 4th grade students the textbook was more secondary and she was the one who created or used other resources. In this case the students used the space of the class, it was not a class in which they had to sit for the whole hour.
13. In my case, the tutor used a hybrid methodology, since sometimes she did rely on activities from the book, but when she wanted to review a specific content, she designed different activities so that students could learn through play.
14. My tutor combined the book with innovation. Although she followed the order of the topics set out in the textbook, her explanations were alternatives to it and she simply used it to do some review exercises.
15. In general, her teaching was based on group learning and, on many occasions, it was the students who deduced the rules through dialogue.
16. The teacher gave traditional classes in which he explained the theory, but then, in order to put it into practice, he used ICT and made them work in pairs or groups. Normally the application of the theory was based on doing some work, such as creating/analyzing a poem that they had to choose themselves.
17. She used a hybrid methodology. In many of the classes she explained following the book and then the students did activities, but she also used some more active methods. For example, she would have dialogical discussions to work on the reading books, group work using new technologies and social networks, etc.
18. As for my secondary school, I consider that my internship tutor had a hybrid methodology, since although most of the time she used the book and lectures, at specific times she did use technology to achieve some of the concepts that had been reviewed in class. For example, they used Canva to create comics and review some specific verb tenses.
19. The center's tutor combined both. In the lectures, especially for literature content, she gave an explanation accompanied by an outline/summary. However, she also used project-based learning and cooperative work.
20. The main dynamic of the classes was traditional but combined innovative techniques such as gamification or project-based learning.
21. Although my supervisor focused on the textbook, I also used innovative methodologies: ICT, cooperative learning or gamification. I adapted the methodologies to the needs of the students and the type of content.
22. My tutor did a mix: she followed the thematic structure of the textbook, but she elaborated and renewed the materials every year according to the group. Thus, the learning process was effective, because she adapted to the profile of the students, but most of the classes were master classes. Occasionally he did carry out different and innovative activities (Kahoot, active and cooperative learning...).

23. My supervisor used the book. However, in high school she focused more on a flipped classroom where she would send them the visual material and they had to watch it at home and in class they would solve doubts and do the exercises. I also combined some gamification but not much.
24. The combination of textbook with cooperative group work, pencils in the center, students as teachers, learning line, dialogic gatherings, creative projects (reading passport, interviews with elderly people, theatrical representation of a Roman myth, oral presentations).
25. Though the textbook was her main support, she tried to get her students involved by working in cooperative groups.

Table 4 presents feedback related to supervisors employing a hybrid methodology, combining traditional and innovative elements. The comments suggest a variety of approaches, incorporating digital platforms, group projects, and diverse teaching techniques:

Table 4

Key Main Themes on Supervisors' Hybrid Methodology

Innovative Projects and Activities	Utilization of Digital Platforms	Mix of Traditional and Innovative Practices	Flexible Adaptation to Student Needs
Many supervisors incorporated innovative projects, such as oral presentations on inventions and group discussions, providing students with dynamic and engaging learning experiences.	Some supervisors incorporated digital platforms, educational videos, and games to enhance student motivation.	Several supervisors integrated traditional methods with innovative practices, such as using info-graphics, word clouds, and videos to supplement textbook exercises.	Notable were instances where supervisors demonstrated flexibility, adapting their methods based on the needs of the students and the specific content being taught.

Figure 4

Results of the Table Transformed into Percentages

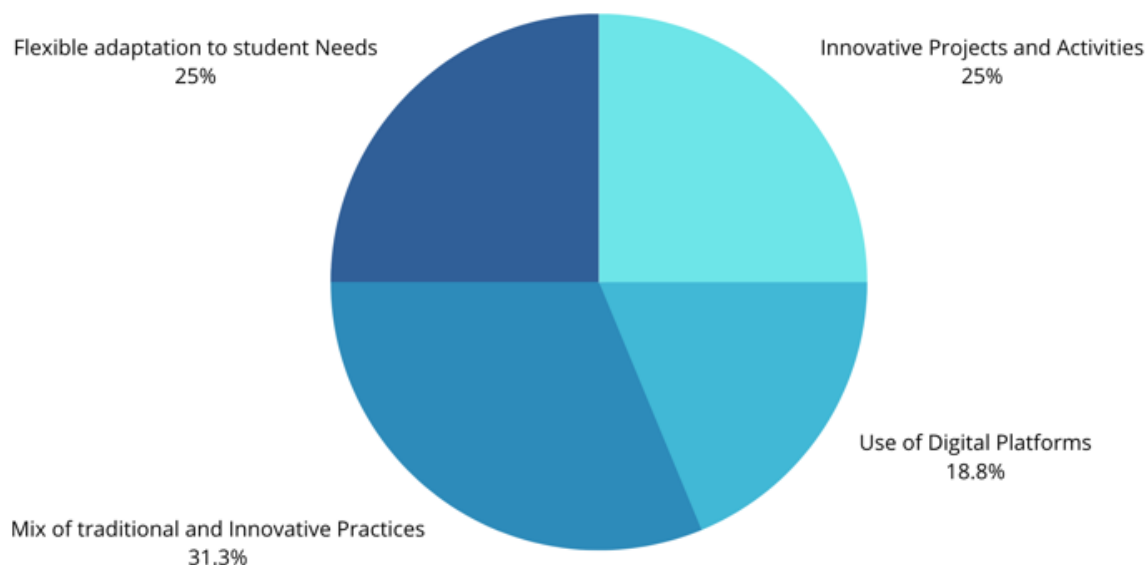


Table 5

Comments on Supervisors' Innovative Methodology

INNOVATIVE METHODOLOGY	
1.	In the reinforcement classes, through a co-teaching (Math teacher + English teacher) they used a gamification platform to motivate the students and to be able to exchange/earn points.
2.	My internship tutor used active and cooperative methodologies most of the time since she only taught in Projects. Students always worked in groups and were the protagonists of their learning: they researched the contents that were part of the project and developed final projects.

Table 6 captures feedback on supervisors employing innovative methodologies, with an emphasis on active and cooperative learning. Key observations include:

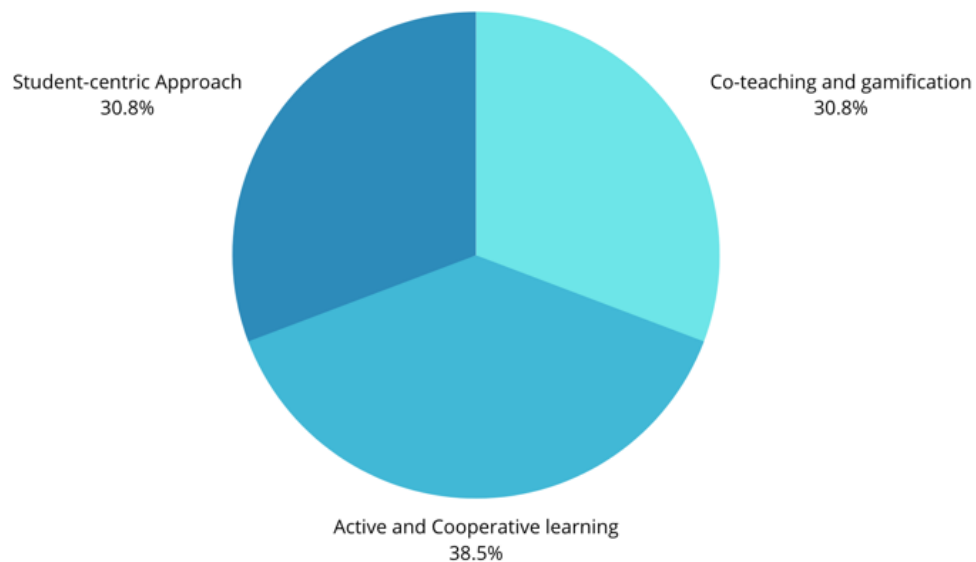
Table 6

Key Main Themes on Supervisors' Innovative Methodology

Co-Teaching and Gamification	Active and Cooperative Learning	Student-Centric Approaches
Some supervisors engaged in co-teaching scenarios and employed gamification platforms during reinforcement classes, fostering student motivation and participation .	Supervisors utilizing innovative methodologies predominantly employed active and cooperative learning methods, where students actively participated in projects, group work, and research.	The innovative methodologies often focused on making students the protagonists of their learning, involving them in research, project development, and collaborative activities.

Figure 5

Results of the table transformed into percentages



These findings highlight the diversity in teaching approaches among supervisors, ranging from traditional methods to hybrid and innovative practices. The feedback emphasises the importance of incorporating engaging and student-centric strategies in pedagogical approaches.

Discussion

The results showed a common thread of traditional teaching methodologies employed by various supervisors. The predominant features included reliance on textbooks, blackboard explanations, limited use of ICT resources, and a lack of innovative or interactive approaches. The classes were primarily organised as lectures, with little to no group or project work. Despite some teachers demonstrating clear explanations, the overall learning experience was often characterised as dull and demotivating for students. Most classes followed a pattern of explaining the subject matter and assigning exercises from the textbook for practice and correction. The essence of the teaching style remained largely conventional and did not incorporate modern or dynamic approaches to engage students. All comments express dissatisfaction or drawbacks related to the traditional teaching methodology. Common negative aspects include a lack of student engagement, boredom, minimal use of technology, limited interaction, and a predominant reliance on textbooks and traditional exercises. Some comments highlight demotivation among students due to the repetitive nature of the classes and the exclusive use of traditional methods. Although it is important to note that the comments reflect the opinions of the respondents and may not represent the experiences of all students. The use of a hybrid teaching approach, incorporating both traditional and innovative methods to enhance the learning experience showed that the use of textbooks and lectures remained prevalent, but additionally these supervisors integrated a range of techniques such as ICT tools, gamification, project-based learning, and cooperative group work. There were instances of collaborative learning, dialogical discussions, and a focus on active learning, catering to different learning styles. These educators demonstrated a willingness to adapt their methodologies, incorporating both traditional and modern techniques to create a more dynamic and engaging classroom environment. The 80%, regarding the use of the hybrid methodologies, were positive comments highlighting the use of innovative and creative projects, making students protagonists in dynamic group exercises. Some supervisors were recognised for their efforts to implement activities that foster group discussion, cooperative learning, and active participation. Mention of the incorporation of digital platforms, educational videos, games, and interactive tools like Padlet or Quizlet to enhance student motivation. Positive feedback on supervisors who adapt to students' needs, promote critical thinking, and constantly implement activities that require group

discussion. Some negative comments suggested that while there are innovative elements, the overall class structure remains somewhat traditional. Occasional comments noted a mix of traditional and innovative methods, but with a leaning towards traditional approaches in certain instances. Instances where the textbook remained a fundamental tool, and activities from the book were used alongside more interactive and dynamic tools. The majority of comments expressed a positive view of the hybrid methodology, emphasising the incorporation of innovative elements, group activities, and the use of technology to enhance the learning experience. The negative comments often acknowledged a blend of traditional and innovative methods but still highlighted the positive aspects of the hybrid approach. Finally, the employed innovative teaching methodologies showed the use of gamification platforms and cooperative learning strategies aimed at motivating students and encouraging active participation. Additionally, there were instances of project-based learning where students took on an active role in researching and developing final projects, fostering a student-centred approach to education. These innovative practices aimed to enhance student engagement and promote a deeper understanding of the subject matter through interactive and collaborative learning experiences. The use of innovative methodologies in education is crucial for keeping students engaged and enhancing their learning experiences. In the presented context, supervisors have implemented various strategies to make the learning process more dynamic and student centric. Delving into the key themes highlighted, concerning co-teaching and gamification, it can be affirmed that the incorporation of co-teaching involving both Math and English teachers, along with the use of gamification platforms, is commendable. This approach not only diversifies the teaching styles but also provides a holistic learning environment. Gamification adds an element of fun and competition, motivating students to actively participate and earn points. While the idea of co-teaching is excellent, there may be concerns about the effectiveness of gamification for all students. Some students may be more motivated by traditional teaching methods, and the reliance on gamification might inadvertently leave certain individuals feeling left out or disinterested. About active and cooperative Learning, the emphasis on active and cooperative learning methodologies is a significant step towards fostering critical thinking and teamwork skills. The involvement of students in projects, group work, and research ensured a hands-on learning experience, making education more practical and relevant. However, one might argue that active and cooperative learning might not suit every student's learning style. Introverted students, for example, may find it challenging to express themselves effectively in group settings, potentially hindering their academic performance and finally, about student-centric approaches, the results show the focus on making students the protagonist of their learning is highly commendable. Involving students in research, project development, and collaborative activities not only enhances their understanding of the subject matter but also promotes a sense of ownership over their education. On the flip side, the practical implementation of student-centric approaches might be challenging in larger class sizes. Providing individualized attention to each student in research and project development can be time-consuming, potentially leading to variations in the depth of understanding among students. Innovative methodologies, such as gamification platforms and cooperative learning strategies, directly address the challenges identified in the Spanish education system by aiming to motivate students, encourage active participation, and provide interactive and collaborative learning experiences. These approaches, as highlighted by scholars like Davidson (2021), Mosquera Gende (2019, 2022, 2023), Olivé (2020), Torres Ramírez (2023), and Mendo-Lázaro et al. (2021) offer a departure from the predominant traditional teaching methods characterised by textbook reliance and limited use of ICT resources.

Providing a critical evaluation of the two research questions, regarding the 1RQ: How do secondary education instructors in Spain approach the teaching-learning process, and to what extent do they utilise traditional, hybrid, or innovative methodologies? It is mandatory to mention the predominant teaching methodology observed among secondary education instructors in the province

of Castelló is traditional, characterised by textbook reliance, blackboard explanations, limited use of ICT resources, and a lack of innovative or interactive approaches. Classes primarily followed a lecture format with minimal group or project work. The students feedback indicated dissatisfaction and demotivation, citing a lack of engagement, boredom, minimal technology use, and a predominant reliance on textbooks. Hybrid teaching approaches, combining traditional and innovative methods, were also prevalent. While textbooks and lectures remained common, supervisors integrated ICT tools, gamification, project-based learning, and cooperative group work. Positive feedback highlighted innovative projects, group exercises, and the incorporation of technology to enhance engagement. However, some comments noted a mix of traditional and innovative methods, with occasional reliance on traditional approaches. Innovative teaching methodologies, such as gamification platforms and cooperative learning strategies (Sharan, 1980, 2021), aimed at motivating students and encouraging active participation, were also identified. The project-based learning, where students took an active role in research and development, was observed. Innovative practices aimed to enhance student engagement and promote a deeper understanding of subjects through interactive and collaborative learning experiences. Regarding the 2RQ: How do teachers visualize and implement specific methodologies during the teaching-learning process in the context of secondary schools in the province of Castelló? Teachers predominantly visualised and implemented traditional methodologies, including lectures and textbook-based activities, as evidenced by student feedback. The hybrid approach, incorporating both traditional and innovative methods, received positive comments for its dynamic and engaging nature, with an emphasis on student participation and the use of technology. Innovative methodologies, such as co-teaching involving multiple subjects and gamification, were commendable for diversifying teaching styles and creating a holistic learning environment Mosquera Gende (2022, 2023), Olivé (2020) and Torres Ramírez (2023). Active and cooperative learning methodologies, focusing on critical thinking and teamwork skills, were positively highlighted by Davidson (2021) and Mendo-Lázaro et al. (2021). Involving students in projects, group work, and research fostered a hands-on learning experience. However, concerns were raised about the effectiveness of gamification for all students, potential challenges for introverted students in group settings, and the practical implementation of student-centric approaches in larger class sizes.

In summary, the research findings illustrated a diverse landscape of teaching methodologies in Castelló's secondary schools, ranging from traditional to hybrid and innovative approaches. The results emphasise the importance of considering the individual needs of students and the potential challenges associated with implementing certain methodologies in varying educational contexts.

Conclusions and Implications

In conclusion, while traditional teaching methods persist, the incorporation of a hybrid and innovative approach demonstrates a progressive mindset among educators. By embracing a diverse range of teaching techniques, educators can create a more stimulating and inclusive learning environment that nurtures critical thinking, creativity, and active engagement among students. This shift towards a more dynamic pedagogical approach holds the potential to enhance overall learning outcomes and foster a more holistic educational experience for students. The potential implications of this study can lead to a deep reflection on the current methodologies used in secondary schools and for educational practice. The insights gained from our students inform and provide information to future teacher training or instructional practices and also leads them to reflect on whether they want to follow the examples they have seen in the classrooms or not."

The novelty and importance of this study lie in its exploration of a hybrid and innovative teaching approach as a progressive mindset among educators. Traditionally, teaching methods have often

followed conventional practices, but this study advocates for a shift towards a more dynamic pedagogical approach. This innovation involves incorporating diverse teaching techniques to create a stimulating and inclusive learning environment. The significance of this study is underscored by its potential to enhance overall learning outcomes. The adoption of a more diverse range of teaching methods can nurture critical thinking, creativity, and active engagement among students. The study suggests that this approach fosters a holistic educational experience, acknowledging that education is not just about imparting information but also about developing essential skills and fostering a love for learning. Furthermore, the implications of this research extend beyond individual classrooms. The study prompts a deep reflection on the prevailing methodologies in secondary schools and educational practices. It challenges educators and institutions to reconsider their approaches, encouraging them to embrace change and innovation. The insights gained from students' experiences offer valuable information for future teacher training and instructional practices. In essence, this study contributes to the ongoing discourse on educational reform by advocating for a more dynamic and inclusive approach. Its findings can serve as a guide for educators and policymakers, prompting them to reevaluate and adapt their methods to meet the evolving needs of students in a rapidly changing world. The study opens the door for further research and exploration into innovative teaching methods and their impact on the overall quality of education.

Suggestions for Future Research

In the upcoming year, the commitment to advancing educational research in secondary schools will remain steadfast. It is vital to actively delve into the dynamic landscape of teaching methodologies, aiming to understand and incorporate emerging approaches that can enhance the overall learning experience for students. To ensure the effectiveness of the research, the importance of closely monitoring the integration of these new teaching approaches within the secondary school environment is recognised. This involves continuous assessment, feedback loops, and adaptability to address the evolving needs of both educators and students. It is crucial to acknowledge that while our primary focus may be on a specific province and a particular master's program, there is an awareness that this could potentially limit the generalisability of the findings to a broader educational context. As such, the key insights and principles from the research are extrapolated. It can be applicable and beneficial beyond the confines of the immediate study scope. In outlining the main prospects for further research on the identified problem, it is aimed to contribute to the development of a robust framework that can be adapted and implemented in diverse educational settings. This broader perspective will not only enhance the relevance of the findings but also foster a more comprehensive understanding of the challenges and opportunities associated with the integration of innovative teaching methodologies in secondary schools. By maintaining a focus on adaptability, scalability, and transferability of the research outcomes, it is aimed to create a foundation for educational improvements that can resonate across various regions and educational programs. This approach aligns with the commitment to advancing the field of education and ensuring that the proposed research has a meaningful and lasting impact on the broader educational landscape.

Acknowledgements

GRESKA research group (Universitat Jaume I)

IULMA institute (Universitat Jaume I)

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DOI: <https://doi.org/10.57125/FED.2023.12.25.15>

How to cite: Zeng, J., Li, Z., & Li, B. (2023). The Role of Learning Environments in Shaping Prospective Teachers' Thinking Styles. *Futurity Education*, 3(4). 255-268.
<https://doi.org/10.57125/FED.2023.12.25.15>

The Role of Learning Environments in Shaping Prospective Teachers' Thinking Styles

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Received: September 29, 2023 | **Accepted:** November 24, 2023 | **Available online:** December 1, 2023

Abstract: Prospective teachers' thinking styles might impact their attitudes and behaviors in the teaching profession. However, there is limited knowledge regarding the influence of the learning environments in teacher training programs on the thinking styles of prospective teachers. This research aimed to investigate the correlation between these two factors, using a constructivist learning environment theory and a threefold model of thinking styles as the theoretical framework. Questionnaires were administered among 1,062 year 4 prospective teachers (aged $22.74 \pm .65$) from a teacher training program in Chinese mainland. Demographics including gender and subject taught were controlled for. Stepwise multiple linear regressions were run and findings indicated that peer morale and constructive learning in learning environment significantly contributed to these prospective

teachers' creativity-favoring (Type I) thinking styles, whereas assignment and assessment positively predicted their norm-favoring (Type II) thinking styles. Implications for key stakeholders of teacher educations were discussed and suggestions for future studies were provided.

Keywords: learning environments; thinking styles; prospective teachers

Introduction

Thinking styles encompass a favoured approach to thinking and the expression or utilisation of one or more abilities (Sternberg & Grigorenko, 1997). Over decades, thinking styles have garnered special interest across different fields (e.g., identity development, organisational and vocational psychology, and teacher education). However, most existing studies have focused on socialisation of thinking styles among adolescents or students (Doménech-Betoret & Gómez-Artiga, 2014; Hammad & Awed, 2022; Kuan, 2023), whereas relatively little research attention has been given to teachers' thinking styles development.

Sternberg (1997) argued for self-government theory, he proposed that individuals have preferred styles of dealing with daily tasks, similar to how different sectors in government have differing functions. Sternberg (1997) brought forward 13 thinking styles, including, for example, the legislative (solving problems in one's own fashion), executive (preferring following command), judicial (being inclined to offering judgment), liberal (looking for novel approaches to solving problems), and conservative (conforming to conventional rules) styles. Following this mental self-government theory and drawing on empirical evidence, Zhang and Sternberg (2005) constructed a threefold model of thinking styles. Grounded in this model, all existing thinking styles can fall into three types: Type I, Type II, and Type III. Type I styles (e.g., legislative and liberal styles) are more creativity-favouring, suggesting an inclination toward tasks that feature high autonomy and level of the cognitive complexity. Conversely, Type II styles (e.g., executive and conservative styles) exhibit a preference for norms, indicating a proclivity towards authoritative, structured approaches and lower levels of cognitive complexity. Type III styles, such as external and internal styles, represent an oscillating pendulum, displaying features akin to either Type I or Type II styles. Over almost twenty years, Zhang and Sternberg's (2005) threefold model has been intensively and extensively examined relative to various constructs such as identity development, occupational commitment, creativity, and academic performance (Fan, 2020; Kuan, 2023; Li & Li, 2021).

Many prior studies (Kuan, 2023; Li & Li, 2021; Muhammad et al., 2020; Zhang, 2004) have consistently indicated that Type I styles are in strong association with desirable outcomes such as creativity and optimism, whereas Type II styles are more connected with undesirable outcomes such as conservativeness and pessimism. For example, through a thorough review of then existing studies over decades in the literature, Zhang (2015) found that Type I styles were more favourable than Type II styles in that the former were consistently found to be positive predictors of such variables as high intelligence, creativity, and benign developmental outcomes. Most recently, Liu et al.'s (2023) study among 530 Chinese college students found that thinking styles of interconnection (featuring Type I styles) had a significant positive impact on these participants' creativity.

Learning environments, particularly those of the university-based teaching training programs, are the starting point of one's teaching career. It is widely acknowledged that learning environments play a central role not only in fostering prospective teachers' teaching expertise, but also in contributing to the development of the teaching profession as a whole (Çetin et al., 2022). Albeit variations in constructivism (e.g., radical constructivism and social constructivism), learning is universally held as an

active process of knowledge construction (Fan & Zhang, 2013). Accordingly, constructivist learning environments should feature learner centeredness, knowledge-centeredness, assessment-centeredness, and community-centeredness (De Corte et al., 2004; Tekin-Sitrava et al., 2022). In line with these four centeredness, Fan and Zhang (2013) summarised four emerging educational principles for constructivist learning environments. These four principles are: constructivist learning, student autonomy, interaction and cooperation, and clear goals and coherence of curricula.

Evidence has indicated that learning environments are in strong connection with thinking styles. For example, Wilson and Fowler (2005) conducted a 13-week longitudinal study between two cohorts of students enrolled in a conventional course (with lectures and tutorials) and an action-based course (with project work and learning groups that represent constructivist learning and interaction and cooperation), respectively. Lately, Huang and Liu (2023) investigated 247 courses involving 69,823 learners in an online learning platform in China. They found that different learners have different learning styles (one type of thinking styles) as a function of their prior knowledge which, in turn, impacted their different perceptions of the online learning environments

The last decade has seen a growing body of studies investigating the relationship between learning environments and thinking styles from the perspective of Sternberg's (1997) theory on thinking styles. A good number of these studies have attended to the association between learning facilities and thinking styles (Fan & Zhang, 2013; Göloğlu Demir & Çetin, 2022; Xenofontos & Hizli Alkan, 2022). For example, in Zhang and He's (2003) study of 193 university students from Hong Kong, findings showed that those who reported to prefer Type I creativity-generating thinking styles were inclined to favour the use of computer and information technology. Consistent findings were reported in Santiago and Nakayama's (2006) study among 86 university students in the United States. The results indicated that the e-learners who were enrolled in an on-line computer science course showed a greater preference for the Type I legislative style than did those in traditional Health Science and Education courses. However, performance of the students in the education course was found to be positively related to their Type II executive style. Later, Fan's (2012) study in Mainland China indicated again that the research participants in a hypermedia instructional group (N=131) reported a significant increased use of the liberal Type I style, whereas those in a traditional instructional group (N=107) tended to increasingly use the Type II executive and conservative styles. Moreover, a most recent study (Cheng et al., 2023) among 297 preschool teachers in China found that the participants in different learning contexts featuring differentiated degrees of interpersonal sharing and internet sharing predicted differentiated degrees of Type II executive thinking styles and Type I legislative thinking styles.

A handful of studies have focused on the interaction and cooperation in learning environments relating to thinking styles. For example, Yu and Chen's (2012) study of 247 Hong Kong secondary school students suggested that the Type I liberal style was negatively correlated with student-centred teacher-student interrelationships, whereas the Type II conservative and executive styles were positively correlated with teacher-centred interrelationships. Zhu's (2013) study generated similar findings. The research participants were made up of 325 students and 146 teachers from secondary schools in Mainland China. The results revealed that the Type I legislative and liberal styles were likewise in positive associations with such teacher-student relationships as characterised by helpfulness and understanding. In contrast, the Type II executive and conservative styles were mainly connected with teacher-student relationships featured by dissatisfaction and strictness.

There are two comprehensive studies providing further evidence. In the first study, Zhang et al. (2012) compared the thinking styles of 408 Tibetan students and 920 Han Chinese students. These researchers found that Tibetan students, whose learning environments were predominantly

examination/instruction-oriented (i.e., traditional and rigorous assignment and assessment) and teacher-centred (i.e., less learner autonomy, less teacher-student interaction, and less student-student cooperation), scored significantly higher on the Type II thinking styles than did their Han counterparts whose learning environments were the opposite. In the second study, Fan and Zhang (2013) conducted a survey among 752 Chinese university students and found that Type I thinking styles were mainly positively associated with constructivist learning, learning facilities, and peer morale in the learning environments. Type II thinking styles, however, were mainly connected with goal-oriented curriculum and assignment and assessment.

Ample evidence has lent support to the argument for the role of learning environments in thinking styles. Among the aspects of learning environments, learning facilities, interaction and cooperation, and constructivist learning have been identified as major positive correlates with Type I thinking styles. By contrast, goal-oriented curriculum and assignment and assessment are mainly associated with Type II thinking styles.

Research Problem

Building on the review mentioned earlier, it was found that most prior studies have focused on the socialisation of thinking styles among the student populations, either at the school level of the university level. However, little research attention has been paid to the development of thinking styles among the teacher population. Thinking styles are significant in terms of impacting teachers' classroom instructions and management, teachers' identity development, teachers' commitment to the teaching profession, and so on (Kuan, 2023; Li & Li, 2021). In this connection, exploring the socialisation of teachers' thinking styles merits attention.

Much extant research (Li & Li, 2021; Meihami, 2022; Saini et al., 2022; Yu & Chen, 2012) has highlighted the development of in-service teachers' thinking styles, arguing that these teachers are mostly influenced by a myriad of factors (e.g., work-family conflict, work/school context, and teachers' own professionalism). The socialisation of pre-service teachers' thinking styles, however, is under-documented in the literature. Recently, some researchers have begun investigating thinking styles among prospective teachers (Güner & Erbay, 2021; Juniati & Budayasa, 2022; Saini et al., 2022). Findings have indicated that pre-service training is a critical period where prospective teacher may have shaped or reshaped their preferred approaches to dealing with daily activities or teaching-related tasks, that is, their thinking styles. Unfortunately, more empirical evidence is still warranted to further support these findings.

It is also important to note that, in addition to family background, SES, or individual motivators, learning environments characterising the university-based teacher training program might also play an equally significant role in the socialisation of thinking styles among prospective teachers (Clarke et al., 2010; Güner & Erbay, 2021; Li & Li, 2021). However, the literature is limited in such research and more should be done to explore the relationship between prospective teachers' learning environments and their thinking styles.

Research Focus

Most prior studies have mainly focused on how the thinking styles of the general student population are influenced by their learning environments. Research on learning environments specific to prospective teachers, by contrast, is limited. Furthermore, learning environments in existing studies are mostly manifested through one or more specific courses that last for at most one semester. An in-

depth understanding of the association between thinking styles and learning environments calls for research examining the latter from a holistic perspective.

Thus, this study focused on exploring the role of learning environments in shaping prospective teachers' thinking styles. Zhang and Sternberg's (2005) threefold model of thinking styles and Fan and Zhang's (2013) theorisation of constructivist learning environments were drawn upon.

Research Aim and Research Questions

The principal goal of this study was to explore whether or not, and to what extent if yes, prospective teachers' thinking styles would be influenced by the learning environments of the teacher training program. Therefore, the main research question for this study was: Are prospective teachers' perceived learning environments predictive of their thinking styles, and, if yes, to what extent? To address this research question, a hypothesis grounded in the literature review was made: The way prospective teachers perceive their learning surroundings would have a substantial effect on their thinking styles. Specifically, the existence of constructivist features in learning environments such as conducive learning spaces, constructivist learning approaches, and student autonomy was anticipated to be indicative of Type I thinking styles, marked by cognitive complexity and autonomy. Conversely, the lack of constructivist elements, such as curriculum with explicit goals and specific assignment and assessment methods, was expected to be associated with Type II thinking styles, characterised by conformity and cognitive simplicity.

Research Methodology

General Background

This study was the baseline part of a big study using a simple two-wave prospective panel design within a 1-year interval. This study was carried out among year 4 prospective teachers from the Program of Free Education for Future Teachers (PFEFT). PFEFT was jointly launched by the Ministry of Education, the Ministry of Finance, and the Ministry of Human Resources in the People's Republic of China. The principal goal of the PFEFT was to entice top high school graduates into the teaching profession and to teach in hard-to-staff schools. An attractive package of monetary benefits was provided for enrolled students, including a monthly stipend, free accommodation, free textbooks and supplementary materials, as well as tuition exemption. In return, enrolled students must teach in their hometowns, mostly in rural areas, for at least 6 years (The Ministry of Education of the People's Republic of China, 2018).

Albeit with good intentions and strong economic incentives, the PFEFT is not without problems. For example, Wang and Gao's (2013) study revealed a conflict between PFEFT students' desire for social transformation (e.g., improving family financial status and passion for upward mobility) and the reality of constraints (e.g., low salary and disadvantaged working conditions). In Zhou's (2010) study of 1,800 PFEFT students, over 80% of the research participants demonstrated their strong desire to break the 10-year work contract and leave for other occupations. Therefore, findings from this research may offer some practical suggestions with respect to the PFEFT and the reported problems.

It should be noted that permission for the present research was granted by the Human Research Ethics Committee for Non-Clinical Faculties, the University of Hong Kong. All the participants were aged above 18, whose participation in the present research was legitimised through their endorsement on a consent form (see Appendices 1 and 2 for English and Chinese versions, respectively). This consent form provided the participants with a thorough knowledge about their benefits and rights upon participation,

as well as about the intent and the duration of the present research. Moreover, the participants were reassured of safety concerns (e.g., how the inventories would be stored and how their responses would be kept confidential). Finally, it was also articulated that participation in the present research was totally voluntary; as such, the participants' decision to withdraw at any time would cause no consequence at all.

Participants and Procedure

Participants were 1,062 (358 males and 704 females) year 4 prospective teachers, aged $22.74 \pm .65$ years, from the PFEFT (as noted above) in Mainland China. By then, all these participants had obtained their teaching certificates awarded by the Ministry of Education. Data were collected during June 1st-15th, 2023, upon the participants' completing their training in the PFEFT. They were invited to respond to a set of paper-and-pencil inventories either through class units or regular faculty meetings. On average, participants took approximately 10 minutes. As a result, 1,062 of the 1,136 returned copies were found valid for further analyses. The valid response rate reached 93%, much better than acceptable according to Nulty (2008). The profile of the participants can be seen in Table 1.

Table 1

Profiles of Participants

Demographic		N	%
Gender	Male	358	33.7
	Female	704	66.3
Subject taught	humanities and social	620	58.4
	Sciences	442	41.6
Total		1,062	100

Instrument

To measure university-based learning environments, the Inventory for Students' Perceived Learning Environment (ISPLE) was adopted in the present research (Fan, 2014; Fan & Zhang, 2013). This inventory helped to collect retrospective data on eight dimensions of university-based learning environments: 1) goal-oriented curriculum; 2) student autonomy; 3) assignment and assessment; 4) teacher-student interaction; 5) student-student cooperation; 6) peer effect; 7) learning facilities; and 8) constructivist learning. Each dimension was measured by four statements. The participants' responses were rated on a seven-point Likert scale, where "1" represented "not at all well", and "7", "extremely well". High scores in the eight dimensions indicated highly constructivist learning environments. Two sample items were: 1) "The teaching helps me to think about the evidence underpinning different views" (constructivist learning); and 2) "The courses are well organised in a way that makes sense to me" (goal-oriented curriculum). The ISPLE demonstrated good reliability and validity. For example, in Fan and Zhang's (2013) study conducted in Shanghai and Nanjing in Mainland China, the theoretically proposed eight-factor structure was confirmed, while reliability ranged from .63 (learning facilities) to .79 (student-student cooperation).

Thinking styles were evaluated by the Thinking Styles Inventory-Revised II (TSI-R2) (Sternberg et al., 2007). In this study, only two Type I (i.e., the legislative and liberal; 5 items each) thinking styles and two Type II (i.e., the executive and conservative; 5 items each) thinking styles were selected totalling 20 items. Reasons were twofold: on the one hand, the four styles form two contrast pairs and are thus more comparable than all the 13 styles put together; on the other hand, the shortened inventory could help maintain the participants' concentration and thus ensure the validity of their responses. The

participants indicated the degree to which they agreed with all the items following a 7-point Likert scale, with “1” denoting “not at all” and “7” implying “extremely well”. Two sample items were: 1) “I like situations where I can use my own ideas and ways of doing things” (liberal); and 2) “When faced with a problem, I like to solve it in a traditional way” (conservative). The TSI-R2 has demonstrated sound internal consistency in previous studies across cultures with Cronbach’s alphas well above .80 (Kuan, 2023; Sternberg & Grigorenko, 1997)

Data Analysis

Data were analysed using SPSS and AMOS. First of all, data were cleaned to deal with missing data, outliers, and multicollinearity (Berry, 2000). For data accuracy, descriptive statistics of all the items were calculated in terms of means and ranges. For missing data, means of series were set a priori as replacements. Secondly, the two utilised inventories were validated. Internal consistency was checked with Cronbach’s alpha coefficients. Using AMOS, confirmatory factor analysis (CFA) was run to test validity. Thirdly, to estimate demographic differences in the key variables, one-way MANOVA was performed. In *post hoc* analyses, Bonferroni correction (α/n) was employed to control the family-wise error rate, as suggested by many researchers (Berry, 2000). To explore the relationships among the key variables, zero-order correlations and multiple hierarchical regressions were executed.

Research Results

Psychometric Properties

The seven-factor model of the ISPLE fitted the data well, $\chi^2(329, N=1,062) = 1294.27, p < .001$. Modifications were performed post hoc as suggested, where error covariance of three pairs of items (i.e., Items 1 and 2; Items 7 and 8; Items 21 and 22) were set free to reduce the χ^2 values. This re-specified model yielded better fitting results, $\chi^2(326, N=1,062) = 1048.27, p < .001$, GFI=.95, RMSEA=.05, CFI=.95, and NFI=.93 (see Figure 5.1). Cronbach’s alpha coefficients were: .85 (goal-oriented curriculum), .76 (student autonomy), .84 (assignment and assessment), .85 (teacher-student interaction), .90 (peer morale), .78 (learning facilities), and .86 (constructivist learning). These CR values indicated sound reliabilities.

As for the TSI-R2, original results of the CFA were: $\chi^2(164, N=1,062) = 1120.28, p < .001$, GFI=.90, RMSEA=.07, CFI=.92, and NFI=.91. Out of theoretical connections, we slightly modified this model following Meyers et al.’s (2013) approach by freeing the error covariance of four pairs of items to reduce χ^2 values. Better fits were resulted, $\chi^2(160, N=1,062) = 844.01, p < .001$, GFI=.92, RMSEA=.06, CFI=.94, and NFI=.93. The TSI-R2 had sound internal reliability with Cronbach’s alpha coefficients were .84 for the legislative style, .91 for the liberal style, .82 for the executive style, and .89 for the conservative style.

Demographic Difference and Correlation

Statistically significant differences in learning environments and thinking styles were found grounded in the two demographics (e.g., gender and subject taught). For brevity’s sake, gender-based differences were took as an example: learning environments ($F_{7, 1054} = 4.71$; Wilk’s $\lambda = .97$; $p < .001$; partial $\eta^2 = .03$) and thinking styles ($F_{4, 1057} = 9.36$; Wilk’s $\lambda = .97$; $p < .001$; partial $\eta^2 = .03$). In terms of learning environments, the female participants tended to score higher than did their male counterparts on six scales: goal-oriented curriculum, student autonomy, teacher-student interaction, peer morale, learning facilities, and constructivist learning. These results were in line with existing findings (e.g., Fan & Zhang, 2013). Regarding thinking styles, the male participants scored higher on the Type I liberal style ($M_{\text{difference}} = .23$; $t_{1060} = 3.29$; $p = .001$), but lower on the Type II executive style ($M_{\text{difference}} = -.16$; $t_{1060} = -2.67$;

$p=.007$). Similar results had been reported in previous studies (e.g., Fan & Zhang, 2013; Sternberg & Grigorenko, 1995).

Table 2 shows that, as expected, learning environments on the whole were in strong positive associations with thinking styles. In comparison, learning environments were in stronger relations with Type I styles than with Type II styles. The associations were found between Type I styles and three dimensions of learning environments: constructivist learning, learning facilities, and peer morale. These findings were compatible with the results in the relevant literature (Fan & Zhang, 2013).

Table 2

Pearson Correlation Coefficients Between Learning Environments and Thinking Styles

	1	2	3	4	5	6	7	8	9	10	11
1. Goal-oriented	1.00										
2. Student autonomy	.59*	1.00									
3. Assignment and	.44*	.39*	1.00								
4. Teacher-student	.52*	.44*	.40*	1.00							
5. Peer morale	.48*	.49*	.41*	.55*	1.00						
6. Learning facilities	.37*	.35*	.35*	.40*	.40*	1.00					
7. Constructivist learning	.55*	.54*	.46*	.51*	.51*	.57*	1.00				
8. Legislative (I)	.34*	.24*	.36*	.40*	.38*	.51*	.44*	1.00			
9. Liberal (I)	.30*	.25*	.27*	.28*	.41*	.26*	.42*	.58*	1.00		
10. Executive (II)	.33*	.25*	.41*	.34*	.34*	.35*	.33*	.44*	.22*	1.00	
11. Conservative (II)	.23*	.24*	.26*	.26*	.24*	.21*	.25*	.14*	.00	.58*	1.00

Note. I=Type I styles; II=Type II styles; * $p < .05$ (2-tailed); Listwise $N=1,062$.

Multiple Regression

As it can be seen in Table 3, the results of multiple regressions indicated that, in general, learning environments uniquely contributed to 11-35% of the variance in thinking styles. Based on β coefficients, learning environments had a larger impact on Type I styles than on Type II styles. Six scales of learning environments significantly contributed to the Type I legislative style; and so, did two scales to the Type I liberal style.

Consistent with anticipations, the scales of learning environments that are more characterised by constructivism were found to be the major positive contributors to Type I styles. Peer morale and constructive learning, for example, were the strongest positive contributors to the Type I liberal style ($\beta=.26$ and $.26$, respectively), whereas learning facilities were the strongest positive contributor to the Type I legislative style ($\beta=.33$). By contrast, the less constructivist scales were in stronger positive associations with Type II styles. Task and assessment, for example, had the strongest positive impact on the Type II executive style ($\beta=.26$) and on the Type II conservative style ($\beta=.13$). The only exception was the negative relationship, though minor in strength, between student autonomy and the Type I legislative style ($\beta=-.13$).

Table 3*Predicting Thinking Styles from Learning Environments*

Learning environments	Thinking styles			
	Legislative (I)	Liberal (I)	Executive (II)	Conservative (II)
R^2_{total}	.36	.25	.25	.12
$R^2_{\text{gender+taught subject}}$	.01	.01	.01	.01
$R^2_{\text{learning environments}}$	.35	.24	.24	.11
F	64.18***	39.24***	38.53***	15.84***
df	9, 1052	9, 1052	9, 1052	9, 1052
$\beta_{\text{goal-oriented curriculum}}$			.08*	
$\beta_{\text{student autonomy}}$	-.13***		.07*	
$\beta_{\text{assignment and assessment}}$	.11***		.26***	.13***
$\beta_{\text{teacher-student interaction}}$	.12***		.09*	.10**
$\beta_{\text{peer morale}}$	.10**	.26***	.10**	
$\beta_{\text{learning facilities}}$	.33***		.17***	
$\beta_{\text{constructivist learning}}$	.15***	.26***		

Note. R^2_{total} =variability in thinking styles explained by demographic factors (gender; taught subject) and learning environments; $R^2_{\text{gender+taught subject}}$ =contribution of demographic factors (gender; taught subject) to thinking styles; $R^2_{\text{learning environments}}$ =the unique contribution of learning environments to thinking styles; I= Type I styles; II=Type II styles; legislative=legislative thinking style; liberal=liberal thinking style; executive=executive thinking style; conservative=conservative thinking style; * $p<.05$, ** $p<.01$; *** $p<.001$.

Discussion

In line with the hypothesis asserting that prospective teachers' perceived learning environments would statistically contribute to their thinking styles, the results of the study indicated that the prospective teachers' perceived learning environments were significantly related to their thinking styles.

In concert with findings obtained previously (Fan, 2012; Fan & Zhang, 2013; Zhang & He, 2003), constructivist aspects of learning environments (particularly learning facilities, constructivist learning, and peer morale) were major positive contributors to the Type I legislative and liberal thinking styles, while less constructivist aspects (particularly assignment and assessment) were primary positive contributors to the Type II executive and conservative thinking styles (Wilson & Fowler, 2005). The current findings lent essential support to the argument for an environment-style congruence that students tend to "develop or strengthen the kind of intellectual styles that...the learning environment requires" (Zhang, 2013, p. 154). Based on this congruence, the prospective teachers would have a tendency to be open-minded and to deal with tasks or problems from multi-lateral perspectives (liberal thinking style) when: 1) teacher educators placed heavy emphasis on knowledge construction and encouraged critical or lateral thinking; or 2) classmates and friends showed strong interest in knowledge building and applying proactively what they have learned. Likewise, when the prospective

teachers perceived their learning environments as providing affluent facilities for learning on their own (e.g., resourceful libraries for independent knowledge building, or well-equipped labs for knowledge application), they would be comfortable with and confident in making use of these facilities to deal with unstructured tasks (the legislative thinking style). However, given that high achievers in the Program of Free Education for Future Teachers (PFEFT) were generally defined by high scores in examinations, as is the case elsewhere in Mainland China, assignment and assessment would more often than not demand rote learning, memorisation, or systemic review that characterise Type II thinking styles. Therefore, the prospective teachers who took seriously the outcomes of assignment and assessment would tend to rigidly adhere to detailed instructions (the executive thinking style) or existing rules that guarantee satisfying scores (the conservative thinking style). Similar findings could also be found in Santiago and Nakayama's (2006) study.

One unexpected finding needs explanation: the student autonomy allowed in the prospective teachers' learning environments was negatively related to the Type I legislative thinking style. There is a great possibility that assignment and assessment in the PFEFT were highly examination- and score-oriented, so the prospective teachers would have to compromise their preference for creativity and cognitive complexity (the legislative thinking style) and take advantage of the available autonomy to prepare for examinations by means of memorization or adherence to so-called focal points for examinations. In so doing, those prospective teachers might have, as a matter of fact, turned away from the legislative thinking style to the opposite (i.e., the executive thinking style) which was found in significant positive relationship with student autonomy.

Conclusions

The principal objective of this study was to explore the role of learning environments in prospective teachers' thinking styles. The findings indicated that prospective teachers' learning environments were significantly associated with their thinking styles. Specifically, constructive parts of learning environments were positively connected with Type I styles, whereas less constructive aspects were relatively in stronger positive relationships with Type II styles. Therefore, we can conclude with confidence that this principal objective has been accomplished. Theoretically, the findings from this study have enriched our understanding of contextual factors (i.e., learning environments) in the socialisation of thinking styles. This study has also provided empirical evidence suggesting that Fan and Zhang's (2013) configuration of constructivist learning environments could hold true for teacher training programs. Finally, evidence generated from this study has done justice, at least partially, to the robustness and reliability of Zhang and Sternberg's (2005) threefold model of intellectual styles.

Apart from theoretical contributions, this study had three practical implications. First, for those interested researchers, this study provided two inventories with improved validity and reliability measuring perceived learning environments and thinking styles. For example, two scales of the Inventory for Students' Perceived Learning Environments (ISPLE) were aggregated to overcome multicollinearity.

Second, for teacher educators, the implication was provided from two aspects. One was that teacher educators should cultivate constructivist learning environments in or outside classrooms, where building, sharing, and applying tacit knowledge, rather than instilling or memorising explicit knowledge, were emphasised and practiced. Given their modelling role for prospective teachers, teacher educators must walk the talk, demonstrating how to give feedback, how to interact with colleagues and students, how to encourage and respond to improvised questions in class, or how to think and teach creatively. The other is that teacher educators should be mindful of prospective teachers' potential style

differences arising from personal (e.g., demographic factors) and environmental factors (e.g., class, faculty, or dorm). Then teacher educators could allow for diverse styles, use diverse instructional approaches and evaluation methods, and, in particular, encourage Type I thinking styles among prospective teachers that may breed Type I teaching styles in their future teaching career.

Third, for prospective teachers, they were expected to make the most of available resources for teacher preparation (e.g., library, micro-teaching labs, and discussion forums) and to participate in activities that involved the peer sharing, knowledge construction, and knowledge application.

Limitations of Research

Despite the contributions and implications, this study could benefit from some enhancements. First, this study relied too heavily on self-report data. However, self-report data have long been criticized for their credibility, in that respondents to self-report questionnaires may tend to give socially desirable answers or even lie, while respondents to interviews may lack adequate introspective ability or strong verbal skill. Second, generalizability of this study is limited because of the sampling bias. This weakness manifests itself in two aspects. On the one hand, all the prospective teachers of the present research were recruited from one single Program of Free Education for Future Teachers (PFEFT) university; as such, the representativeness of the sample is a bit questionable. On the other hand, the participants of this study were dominated by females (66.3%) so much so that results generated might be distorted and generalizability might be affected. Thus, interpretation of the findings from this study should be careful with such gender bias taken into account. Third, this study was situated in the Chinese mainland characterized by the Confucius heritage. Therefore, a caveat is cast on understanding the current findings if without a full account possible thinking style differences across varying cultures of regions.

Suggestions for Future Research

To overcome the first limitation as mentioned the above, two remedies are recommended for future research. One remedy is to collect data from multiple sources. For example, to measure the construct of teaching styles, data can be collected from both first-year teachers and their students; to measure the construct of work environments, data can be collected from first-year teachers, their superiors, and, at the same time, their colleagues. The other remedy is to use multiple methods in addition to self-report questionnaires and interviews. These methods include, for example, observation, videotaping, reflective journal, and intervention. In so doing, researchers are able to triangulate emerging findings for improved credibility and reliability.

As regards the second limitation concerning the sampling bias of this study, it is suggested that, for future studies, participants can be selected from other PFEFT universities or non-PFEFT universities with teacher training programs. In addition, internet-based methods such as online survey and email survey can be employed to minimise the attrition rate.

In addition, it is suggested that future studies can explore further the mediating or moderating roles of other constructs (e.g., SES, gender, and motivation) in the relationship between learning environments and teachers' thinking styles. Also, cross-lagged effect of learning environments on thinking styles can be examined to identify the casual relations between the two constructs so much so that we could better understand whether it is teachers' thinking styles that impact their perceived learning environments or the reverse.

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DOI: <https://doi.org/10.57125/FED.2023.12.25.16>

How to cite: Torchynska, T., Tsynova, M., Kravets, H., Borysov, V., & Kornieva, I. (2023). The Future Pedagogical Landscape: The Impact of Augmented Reality on the Development of Education and Teaching Methods. *Futurity Education*, 3(4). 269-285. <https://doi.org/10.57125/FED.2023.12.25.16>

The Future Pedagogical Landscape: The Impact of Augmented Reality on the Development of Education and Teaching Methods

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Received: October 9, 2023 | **Accepted:** November 25, 2023 | **Available online:** December 6, 2023

Abstract: Modern digitization processes allow the use of augmented reality technology for pedagogical purposes. The practice of this tool, given its novelty, will require additional reasoning. The purpose was to study the future pedagogical landscape through the prism of the use of augmented reality. Methods: a mixed research design was used, attracting 50 teachers of different educational institutions who agreed to participate in the discussion. The sample provided a diversity according to various parameters: age, years of teaching experience, teaching of academic disciplines. The inclusion criteria: current teaching faculty with experience using digital and augmented reality technologies. Data collection was carried out during the first semester of the 2023-2024 academic year. The use of mixed research methods, analysis of collected data, and the identification of the main factors that influenced the successful implementation of these technologies into the educational process, made a unique contribution to this issue understanding. The results confirmed that the use of augmented reality technologies had numerous advantages in the educational process. They created an interactive environment, attracting students' attention and making learning interesting. The findings of the questionnaire of pedagogical staff testified to the widespread use of these technologies, with 40% of teachers who continuously used them, and 30% who used them 2-3 times a week. The obtained data analysis indicated the positive perception of augmented reality in the educational process and a high level of teacher satisfaction from their use. The positive feedback from educators regarding the effective integration of AR suggests a potential shift in teaching paradigms. This implication underscores the need for ongoing research to delve deeper into the long-term impact of AR on student learning. The exploration of the scalability of AR implementations across diverse educational settings and subjects for future studies, could provide valuable insights into its broader applicability.

Keywords: augmented reality, technology, efficiency, surveys, terms of use

Introduction

In today's ever-changing world of technology, the field of education is experiencing significant transformations as a result of the influence of augmented reality (AR). This technology opens up new perspectives and opportunities for education, creating an innovative learning environment. The relevance of the problem lies in the fact that AR provides an opportunity to interact with virtual objects in real-time and space, expanding the boundaries of traditional learning.

This technology creates unique opportunities for the pedagogical process, helps engaging students and enrich their experience. The use of AR in teaching methods can increase students' interest, promote their activity, and develop critical thinking. Thus, the study of the impact of augmented reality on education is a key area that opens up new horizons for the effective implementation of modern technologies in the educational process.

Modern researchers are interested in this topic mainly because of the possibilities of using modern educational technologies. The analysis of the scientific literature shows that the use of augmented reality technologies offers many advantages in various fields. In education, they create an interactive environment that attracts students' attention and makes learning fun (Ruiz-Ariza et al., 2020). Particularly, augmented laboratories allow for safe experiments, and virtual museums expand cultural experiences by providing opportunities to visit historical sites and study art (Lichty, 2020; Paramita et al., 2021; Saez-Lopez & Cozar-Gutierrez, 2020). According to Mladenovic (2020), in medicine, AR technologies are used to train future surgeons with surgical simulators and to visualise medical data, which facilitates the work with three-dimensional organ models. It is also important to note the

interactivity that AR technologies add to learning (Atanasyan et al., 2020). They create an environment where students can actively interact with materials and concepts, making the learning fun and engaging.

The visualisation of complex concepts is another significant advantage. Modern technology allows learners interacting with abstract ideas, making them easier for the understanding and memorisation (Harb, 2019; Keane et al., 2022; Vaughan, 2021). Hands-on learning that allows for experimentation and interaction in real-world scenarios is a key benefit, especially in the fields of science and medicine. These technologies also allow for individualised learning, adapting it to the needs and pace of each learner (Wolf et al., 2020). In general, it has been proven in scientific studies that modern technologies stimulated greater interest and development of personal skills. In addition, the use of interactive elements in technology increases the motivation of learners, which contributes to active and effective learning.

Research Problem

Even though there are a number of studies on this issue, certain aspects related to changes in learning conditions and the emergence of fundamentally new requirements for the educational process remain unresolved. Thus, it is necessary to rethink the teaching methods used to form a new image of a personality. In view of these changes, it becomes an important task to find effective mechanisms and modern approaches for the creation of conditions that conduct to the harmonious development of the individual in the context of modern reality. Given the innovative development of education in the future pedagogical landscape, modern digital technologies play a key role. Researchers point out that these technologies will become the main element in the training of specialists, not just an additional component (Kolbina & Oleksenko, 2020; Santoveña-Casal & FernándezPérez, 2020). At the same time, the choice of the main tools for creating an innovative personal learning environment is an individual task that depends on the specific learning objectives. The more diverse and richer the personal learning environment is, the more opportunities it opens up for the learner. Thus, it is recommended to constantly review and develop the learning environment, taking into account new technologies and their aptitudes. The introduction of a modern pedagogical landscape provides students with the opportunity to better understand their learning goals and choose appropriate learning tools.

Research Focus

The main focus of the study was to characterise the key aspects of the future pedagogical landscape based on the use of augmented reality technologies. They involved the introduction of a technological educational approach that combined the real world with the virtual world by adding computer-generated objects, information, or effects to the real environment. The main idea of AR is to expand or improve the user's perception of reality through visual, acoustic, or other sensors. Therefore, the main focus of this study was to empirically test the impact of augmented reality on the development of education and certain teaching methods.

Research Aim and Research Questions

The purpose of the study was to characterise the future pedagogical landscape with augmented reality technologies through the prism of an empirical study based on a survey and questionnaire among teachers and lecturers conducted during the first semester of the 2023-2024 academic year.

The research questions are as follows

1. The definition of the basic conditions for AR technologies use.

2. The characteristic of the impact of AR on the use of certain teaching methods and determining the effectiveness of this technology in general.
3. The analysis of the strengths and weaknesses of AR in the system of the modern innovative pedagogical landscape.

Research Methodology

General Background

A mixed-methods research design was used in order to collect a complete data set combining quantitative and qualitative data. A sequential approach began with quantitative data collection, followed by in-depth qualitative data collection to provide a detailed understanding of the effectiveness of AR in modern educational settings.

Sample / Participants

The study involved 50 teachers of different levels of educational institutions. Data collection took place from 1 September to 1 November, covering the first semester of the 2023-2024 academic year. The participants of this research experiment had to actively use augmented technologies in their professional activities during the specified period. The sample provided a diversity in various parameters: age, years of teaching experience, teaching disciplines.

Sampling Method. The sampling method used in this research was the purposeful sampling. The advantages of purposive sampling included the ability to select participants who are most relevant to the research question, ensuring that the study focused on individuals with specific characteristics or experiences related to the research topic.

The purposive sampling involved selecting participants based on specific criteria relevant to the research question or objectives. In this case, the researchers targeted teachers who actively used augmented technologies in their professional activities.

Criteria for inclusion and exclusion.

- a. *Inclusion criteria:* (1) teachers with at least one academic year of experience in using digital technologies; (2) teachers and educators currently teaching at different levels of education; (3) teachers who have a clear understanding of the specifics of AR.
- b. *Exclusion criteria:* (1) teachers who have not implemented digital technologies in their teaching methods; (2) teachers with less than one year of experience in using blended or distance learning.

Data Collection and Instruments

The data for the study was collected in stages, and different tools were used at each stage.

Collecting Quantitative Data. At this stage, a survey among teachers was used. The survey was sent by e-mail to those participants who previously agreed to participate. This survey was uploaded to Google Forms. The main questions in this survey focused on the integration of augmented reality, its perceived impact on teaching methods, and the overall effectiveness of this technology in the innovative pedagogical landscape. Therefore, the core inquired in this survey delved deeply into the seamless integration of augmented reality, aiming to understand its impact on various facets of

teaching methods. The focus extended to examining not only how augmented reality is perceived by educators but also its broader implications for instructional strategies and the transformative potential it holds within the innovative pedagogical landscape. In addition to assessing the perceived impact, the survey also sought to gauge the effectiveness of augmented reality in enhancing the educational experience. By exploring the multifaceted aspects of its integration, the research aimed to contribute comprehensive insights into how this technology is shaping the contemporary educational environment (see Table 1).

Table 1

Sample Survey

Section of the questionnaire	Question
Part 1 The use of technology.	1. Do you use augmented reality in your teaching? 2. What are the conditions for using these technologies? 3. How often do you implement augmented reality in your teaching? Rarely From time to time Often Always 4. What types of augmented reality technologies do you use?
Part 2 Evaluation of the impact and effectiveness	5. On a scale of 1 to 5, how would you rate the impact of augmented reality on your teaching methods? 1 (No impact) 2 3 4 5 (Significant impact) 6. Please describe the specific ways in which augmented reality influences your teaching methods. 7. Rate the effectiveness of augmented reality technologies from 1 to 5 1 (Not effective at all) 2 3 4 5 (Very effective)
Part 3 The gaps and challenges identification	What difficulties did you face when integrating augmented reality into your teaching?
Part 4 General results	How does augmented reality contribute to the overall learning experience of your students?

Source: Author's development.

Validity. The validity of this research hinged on the careful selection of participants and the alignment of research questions with the goals of the study. The inclusion of teachers actively using augmented technologies ensures the relevance of the findings to the targeted subject matter. Additionally, efforts to capture diversity in age, teaching experience, and disciplines enhance the

external validity, allowing for potential generalisations to a broader population of educators. The survey instruments and methodologies employed in data collection contribute to the internal validity, ensuring that the study effectively measures what it intends to explore in the realm of augmented reality in education.

Reliability. The reliability in this research was upheld through consistent and standardised data collection procedures. The utilised survey instruments were pre-tested or piloted to ensure clarity and reliability in responses. The defined timeframe for data collection (from September to November, covering the first semester) adds a temporal reliability element, ensuring that responses are reflective of a specific period. Moreover, the use of quantitative measures, such as Likert scales, enhanced the reliability of the gathered data by providing a structured and consistent format for participant responses.

Result Output. The result output of this research is presented in a tabular format, as evidenced by Tables. These tables detail the participants' ratings on the impact and effectiveness of augmented reality technologies. The distribution of ratings across categories allowed for a clear visualisation of the teachers' perceptions. The use of numerical values, such as the counts of participants in each rating category, added a quantitative dimension to the output. Such structured presentation facilitated straightforward interpretation and comparison of findings, providing a foundation for meaningful discussions and conclusions in the subsequent sections of the research report.

Collecting Qualitative Data. During this period, in-depth interviews were conducted with 14 participants to gather qualitative insights. These participants agreed to be interviewed further. The interviews explored personal experiences, faced challenges, and observed benefits associated with the use of augmented reality in education.

Observation phase. Teachers were observed during actual teaching sessions using technology. The observed changes in teaching methods and student engagement were documented.

Data Analysis

In order to carry out the quantitative data analysis, statistical methods were used to analyse the main survey responses. Patterns and correlations in the quantitative data set were also examined to draw quantitative conclusions.

In order to analyse the qualitative data, a thematic analysis of the interview notes was used. Subsequently, the comparison method was also used to compare the results with the opinions of contemporary scholars. The conclusions of the study were based on the method of generalisation.

Results

The process of introducing augmented reality into educational institutions is a recent one. Initial hesitations arose from issues such as the prohibitive costs associated with hardware and content creation. However, as technology has evolved and become more affordable, there has been a gradual shift that has favoured the integration of AR into educational practice. Increased accessibility of technology has played a key role in overcoming barriers and increasing the availability of these tools for educational purposes (But & Panchenko, 2016). This change has been dramatic, allowing educators to use the immersive and interactive features of augmented and virtual reality to enhance the learning experience for students (Cobo & Rivas, 2023; Lazinski et al., 2021). Recognised as one of the most influential technologies, augmented reality has now become a prominent trend in the study of foreign languages, biology, chemistry, physics, history, and mathematics. This is underlined by the diverse

sample of respondents who have implemented AR technologies in their educational practice (see Table 2).

Table 2

What Areas Have AR Technologies Been Implemented in

Scope	% of participants
Social sciences and humanities (language, history, geography)	32% of respondents
Technical and natural sciences (physics, chemistry, biology and medicine)	38% of respondents
Formal sciences (logic and mathematics)	30% of respondents
Overall.	50 respondents

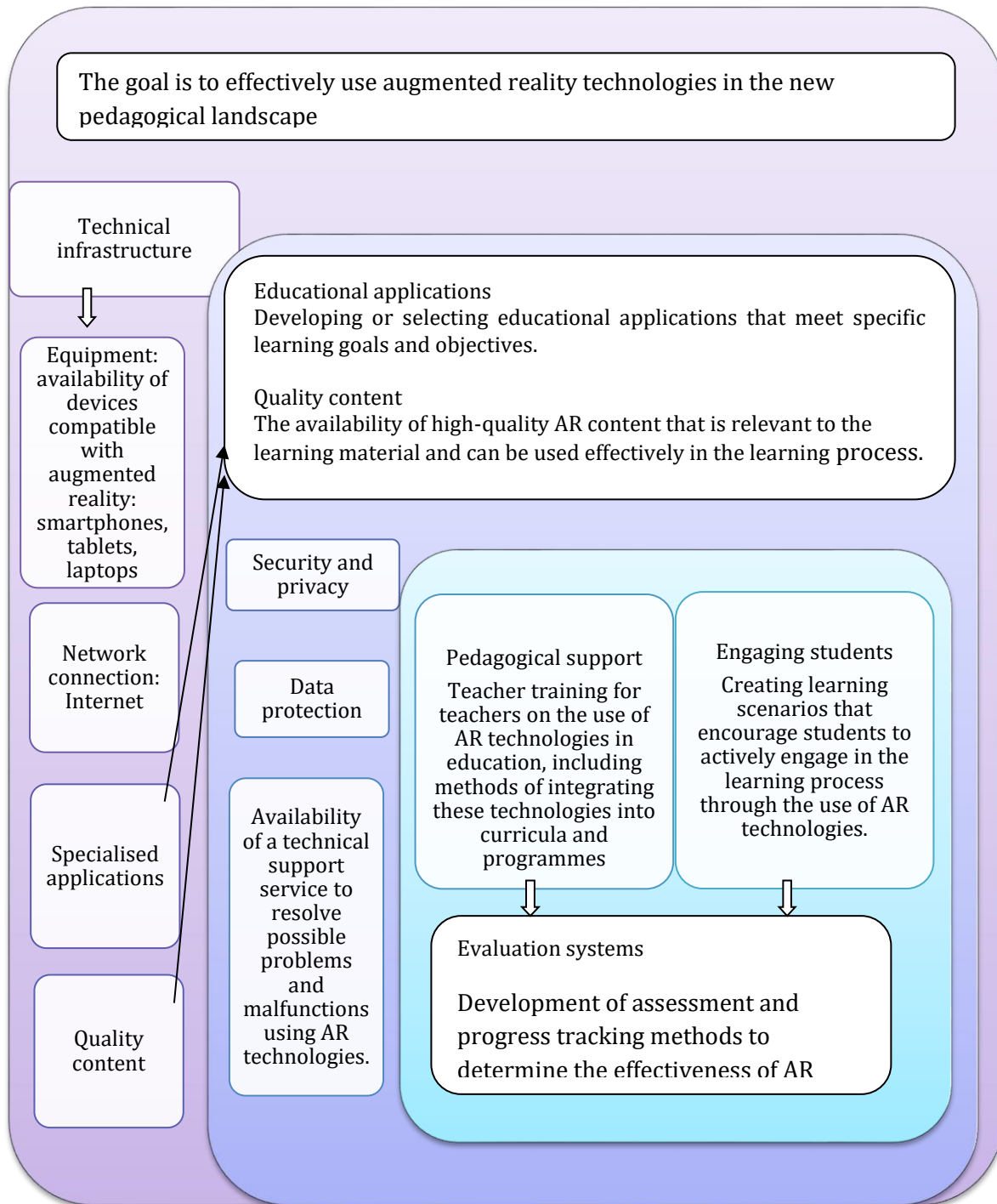
Source: Author's development.

The ability of AR to create engaging and contextualised material for language, geography, chemistry, biology, and other disciplines has attracted attention in academic and educational circles. To facilitate the implementation of AR in educational contexts, a large number of apps are available on platforms such as the AppStore and GooglePlay. These apps offer a variety of content and functionalities suitable for both classroom and individual learning experiences. The accessibility of AR apps highlights their versatility and potential to transform education by providing immersive and dynamic learning opportunities (Lai et al., 2022).

In the interview respondents noted that an important element of the success of AR applications was the use of an intuitive and generally simple interface that did not require much time to learn or get used to. In general, the effective use of augmented reality technologies in education is determined by various conditions that take into account technical, pedagogical, and organisational aspects. Technical conditions include the availability of equipment, network connectivity, and the use of special applications and high-quality content. Pedagogical conditions include pedagogical support, engaging students, supporting their motivation, and using up-to-date assessment systems. Organisational conditions include security and confidentiality, data protection of all participants (see Figure 1).

Figure 1

Diagram of the Pedagogical Landscape Based on the Use of Augmented Reality Technologies (Based on the Main Conditions of Implementation)



Source: Compiled based on the analysis by (Lai et al., 2022; Wong et al., 2022; Yan et al., 2020).

Thus, these conditions help create a favourable landscape for the successful use of AR technologies in modern education.

The systematic use of digital technologies plays an important role in the new pedagogical landscape. When asked how often they used augmented reality technologies in the classroom, teachers

answered that 40% used them continuously, 30% used them 2-3 times a week, 18% used them several times a month, and 12% used them very rarely.

At the same time, the choice of specific AR technologies may depend on the subject, the teacher's tasks, and the specifics of the learning material (Antonioli et al., 2014). Table 3 shows some examples of technologies used in teaching a particular subject.

Table 3

Examples of AR Technologies Used in Specific Disciplines

Scope	Explanation
Mathematics	Didactic AR applications. Applications that use AR to display geometric shapes, solve maths problems, and interactively learn algebraic concepts. Geodetic AR applications. Apps that allow you to learn geometry and trigonometry in a real-world environment, for example, by measuring distances and angles using the device's camera.
History	AR tours. There are separate apps that allow you to create tours of historical places, events, and characters, adding context and visual elements to the real environment (Hart, 2020). Historical AR books. Apps that use AR to bring illustrations in textbooks or history books to life by telling additional stories and facts (Raghaw et al., 2018).
Chemistry	Applications that use AR to display three-dimensional models of molecules and chemical structures, contributing to a better understanding of chemical processes (Grunewald Nichele & do Nascimento, 2017; Irwansyah et al., 2020; Le & Nguyen, 2020). Chemical Laboratories Simulations of laboratory experiments where students can interact with chemical reactions and observe their results.
Languages	AR translators Applications that use AR to recognise text and provide real-time translation, helping to learn foreign languages (Kljun et al., 2020). Interactive Language Classes Applications that create interactive scenarios for language learning using augmented phrasebooks and real-life situations (Daling et al., 2020; Zhang et al., 2020).
Medicine, biology	Anatomical AR models. Virtual AR models of organs. Creating three-dimensional models of organs for a detailed study of their structure and interaction. Anatomy visualisation Use AR to design your own anatomical scenarios where students can explore different parts of the body. Medical Simulations Creating surgical scenarios where medical students can practice performing surgeries and doing practical exercises (Andersone, 2020; Campisi et al., 2020). Simulations of clinical scenarios to train healthcare professionals in real-life conditions using AR. Ecosystems

	Creating virtual ecosystems to study biological manipulation and understand ecological interactions between different species (Puspita et al., 2022).
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Source: Compiled by the authors.

In general, the choice of AR technologies in teaching can vary depending on the teacher's goals, the nature of the subject, and the specific needs of the students. Such technologies can help making the learning more engaging and effective, as when assessing the impact of AR on teaching methods, the majority of teachers rated it as a 4 - 24 people, and 19 people rated it as a 5. At the same time, 7 teachers rated it as a 3. Furthermore, it's noteworthy that the survey probed into the specific ways in which teachers implemented augmented reality in their classrooms. Some educators utilised AR for interactive simulations and virtual experiments, enhancing students' practical understanding of complex concepts. Others leveraged AR to create immersive learning experiences, fostering a more dynamic and participatory classroom environment. The diversity in the application of AR technologies underscores its versatility as a pedagogical tool and the adaptability of teachers in tailoring their approaches to meet the unique demands of their subjects and students. (see Table 4).

Table 4

Assessing the Impact of Augmented Reality Technologies

Assessment	Number of people
5 points	19 people
4 points	24 people
3 points	7 people
2 points	0 people
1 point	0 people

Source: compiled by the authors.

Thus, the average assessment of the impact of augmented reality on teaching methods based on data from 50 teachers is approximately 4.24 on a scale of 1 to 5.

When assessing the effectiveness of augmented technologies, the teachers provided valuable insights through a range of ratings: 1 - 0 people, 2 - 0 people, 3 - 8 people, 4 - 17 people, 5 - 25 people (see Table 5). This distribution of ratings indicates a notable positive trend, with a significant number of educators expressing a high level of satisfaction and effectiveness in integrating augmented technologies into their teaching practices.

Table 5

Evaluating the Effectiveness of Augmented Technologies

Assessment	Number of people
5 points	25 people
4 points	17 people
3 points	8 people
2 points	0 people
1 point	0 people

Source: Compiled by the authors.

Thus, the average assessment of the effectiveness of augmented reality technologies according to the data from evaluators is approximately 4.09 on a scale of 1 to 5. The prevalence of top-tier rating suggests that, for a considerable majority, augmented reality has not only met but exceeded expectations

in contributing to enhanced pedagogical outcomes. This underscores the promising potential of augmented technologies in fostering impactful and engaging educational experiences.

Despite its highly regarded effectiveness, the process of integrating augmented reality into teaching can cause a number of difficulties that should be taken into account. Firstly, technical problems may arise. It is worth considering the fact that it can be expensive and challenging to provide appropriate equipment for all students. In addition, the modern material and technical base of the educational institution must meet the basic technical requirements of AR. This, in turn, may entail additional costs for the institution.

On the other hand, respondents noted that an important nuance was the inconsistency of the curriculum with modern technologies. In addition, creating new teaching materials that use AR can be challenging for teachers. It is also worth considering that the use of these technologies may require changes to teaching methods. Another important challenge is that the collection and processing of data using AR may raise questions about the privacy and security of students.

Discussion

In the course of this study, the main theoretical and practical principles of the formation of the new pedagogical landscape based on the use of modern educational technologies were formed. The study confirmed the positive feedback of teachers regarding the use of technology. The study of the augmented reality impact on the formation of a new pedagogical landscape has confirmed the effectiveness of AR technologies in improving the teaching methods. In this context, the statement coincides with the opinion of Almås et al. (2021) and Nazarenko (2015) regarding the difficulties that teachers may face when adapting to new technologies. It is also important considering technical support (Salinas, 2017; Soberanes-Martín, 2021), security aspects, and financial costs (Peddie, 2017), as well as privacy and data security issues (Mozelius et al., 2020).

The findings of the study are in line with Rudnik (2023) that AR programmes provide a virtual experience, but the financial costs required for their implementation should be taken into account, which can be significant (Ducasse, 2020; Truitt & Ku, 2018). In addition, learners may experience difficulties in transitioning from traditional teaching methods to AR (Truitt & Ku, 2018). In the innovative education system, Rudnik (2023) recommends using AR for visual experiences, such as the GreatPaintings VR and TheOmniGallery apps. They not only provide an immersive experience but also have educational value (Rudnik, 2023). AR's educational capabilities can be particularly useful for subjects such as fine arts, history, and English. Apps like Discovery AR allow for the integration of teaching methods and improve interactivity, creating a more holistic learning environment.

However, Long and Bouck (2022) consider that the difficulties that teachers may face in adapting to new innovative technologies are somewhat exaggerated. At the same time, research by Almås et al. (2021) and Nazarenko (2015) points to the importance of providing adequate support and training for teachers to enable them to effectively implement AR in the educational process and interact with students in this new context. The results do not contradict the opinion of these authors about the need to study and implement AR technologies in the educational process. Nevertheless, it is important paying attention to the individual needs of teachers and providing them with support in mastering these innovations.

In general, each of the above researchers emphasises the need to create an adaptive educational environment where teachers can improve their skills and implement AR with maximum efficiency. The adoption of these technologies requires not only technical readiness but also pedagogical support to make them an integral part of the educational process.

Also, most of these researchers point out that augmented reality technologies in education open up new opportunities for innovation and development (Nazarenko, 2015; Rudnik, 2023; Salinas, 2017; Soberanes-Martín, 2021), which generally coincides with the results of this study. However, for their effective implementation, it is important to provide support for teachers and students, as well as to take into account technical, organisational, and financial aspects. Therefore, AR technologies in education open up new opportunities for innovation and development, making learning more dynamic and effective: in this way, they contribute to the creation of a completely new pedagogical landscape that is interesting for students.

The insights garnered from educators actively engaged in integrating augmented reality (AR) technologies into their teaching practices offer valuable guidance for both individual educators and educational institutions seeking to enhance their educational methodologies. Educators can leverage the positive feedback regarding the effectiveness and impact of AR technologies to inform their professional development initiatives. Targeted training programs can be designed to equip teachers with the necessary skills and knowledge to proficiently integrate AR into their lesson plans. Additionally, the identification of specific disciplines or teaching scenarios where AR has been particularly effective can guide educators in tailoring their strategies to suit the unique needs of their subjects.

Furthermore, educational institutions can use these findings to inform broader policy decisions. Investments in AR infrastructure, software, and training programs can be strategically aligned with the disciplines and contexts where AR has demonstrated significant benefits. Establishing a supportive environment that encourages experimentation and innovation with AR technologies can foster a culture of continuous improvement in teaching methodologies. Moreover, the research findings can be communicated to curriculum designers, helping them incorporate AR applications into educational materials. This ensures that the curricula are not only aligned with technological advancements but also capitalize on the immersive and engaging qualities of AR to enhance student learning experiences.

Put simply, this research has important practical applications that go beyond just individual classrooms. It provides guidance for teachers and schools on how to make the most of augmented reality in education. By taking advantage of these findings, everyone involved in education can work together to create a learning environment that is more technologically advanced and successful.

Conclusions and Implications

The results showed that in this small dataset, teachers consider AR technologies to be effective in improving teaching methods. The mean score was close to 4.09 out of a maximum of 5, indicating a positive perception of these technologies in the classroom. The high average score may indicate that many teachers considered the introduction of AR technologies to be an important and effective element of their teaching approach. Given that the maximum score was 5, the results also confirmed the high level of satisfaction of teachers with the use of these technologies in their work.

Respondents noted that the success of using AR applications in education depended on an intuitive and simple interface that did not require significant time to learn. The effective use of AR technologies was determined by technical, pedagogical, and organisational aspects. The systematic use of digital technologies played a key role in the new pedagogical landscape. Teachers' answers to the question about the frequency of using augmented reality technologies indicated their widespread use: 40% used them continuously, 30% – 2-3 times a week, 18% – several times a month, and only 12% used them very rarely.

However, it has been established that the introduction of augmented reality into education, despite its high effectiveness, can lead to difficulties. There may be technical problems and high equipment costs. Curriculum inconsistencies with modern technologies, the complexity of creating materials, and the need for changes in teaching methods are other potential problems. In addition, data security challenges can be a problem when using augmented reality in education. Therefore, further large-scale use of augmented reality technologies in the system of innovative pedagogical landscape will require addressing these issues.

Suggestions for Future Research

This study has provided a limited overview of the key components involved in integrating augmented reality into educational settings. While the findings offer valuable insights, the scarcity of data necessitates further research in several areas.

1. Consideration of different educational contexts.

A possible direction is to narrow the scope of the study to cover one specific educational institution: either from primary school or to analyse a higher education institution. In this context, it is worth comparing the feedback from teachers in different educational environments to understand how augmented reality technologies are perceived in different contexts.

2. Study of effectiveness in teaching various subjects.

A separate area is the analysis of the impact of augmented reality technologies on the teaching of specific subjects, such as mathematics, history, languages, and computer science. It is in this system that it is necessary to determine whether there are subjects where the introduction of AR is particularly effective.

3. Analysis of the impact on students

The study could be extended to focus not only on the opinions of teachers but also on the impressions and learning outcomes of students. In this context, it is worth investigating how the introduction of AR affects students' motivation, learning, and overall satisfaction. We also believe that it is worth considering how different groups of students (by age, level of study, etc.) react to the use of augmented reality technologies. Determine whether there are differences in perception among different categories of students.

4. Checking the long-term impact

In addition, given the limited period of the experiment, a separate area of research could be the long-term impact of the use of augmented reality technologies in education. This study should determine whether teachers' and students' positive attitudes towards AR remain over a long period of use.

5. Study of socio-cultural influence

There is a significant need for additional exploration in the field of investigating the socio-cultural consequences of augmented reality (AR) in education. This entails examining how cultural and societal aspects influence the acceptance and efficacy of AR technologies in various geographical areas. It is worth noting that the integration of AR in education requires an understanding of different cultural contexts. Cultural adaptation involves adapting the AR teaching process to align with the values, norms, and language of specific communities, ensuring that it resonates positively within a variety of cultural settings. In addition, it is worth considering that AR has the potential to create inclusive learning

environments that respect cultural diversity. By incorporating content that reflects diverse perspectives, histories, and cultural practices, AR can contribute to more equitable representation in learning materials.

These areas can broaden the understanding of the impact of augmented reality technologies in education and contribute to further improvement of their use to improve the quality of learning and the educational process.

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