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Innovative Methodologies and Approaches to Teaching with Artificial Intelligence in Ukrainian Higher Education

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Abstract: The aim of the research was to evaluate innovative methodology and approaches to teaching with AI in Ukrainian higher education and to outline the effective delivery practices. The research objectives were to explain AI-based teaching approaches and methods used in the Ukrainian institutions of higher education, to find the most effective teaching approaches and methods in the system of training of future specialists, and to develop the methodological recommendations for instructors involved in the training of future AI experts. Within the framework of the given research, a number of pedagogical articles and key documents devoted to the analysis of used artificial intelligence in teaching, and implementation of AI-based methodology were studied . Over 50 scientific that were published during the recent five years to understand the problem and to evaluate the improvements brought by AI were selected. A mixed methodology that combined descriptive, association, and intervention methods was applied. Descriptive methods included literature review, narrative, content analysis of educational and professional programs, as well as the phenomenological approach. Associational methods included predictive analysis aimed at forecasting of the probability of innovative methodology and approaches that impact the AI education. The intervention suggested using a survey and an assessment. The research included 42 instructors of Ukrainian institutions of higher education that were involved in the training of future AI experts. They represented graduating departments that were responsible for the development of educational and professional program, formulated the training objectives, and designed the conceptual framework for the creation of innovative educational environment with the use of AI. The research resulted in the development of methodical recommendations on using teaching methods and approaches in AI-powered higher education. The recommendations can be suggested by instructors at higher education institutions that are involved specifically in training future AI experts . Also, the recommendations are applicable for scientific and pedagogical stuff working on digitalisation of educational process.

Keywords: approach, artificial intelligence (AI), innovative educational technologies, institution of higher education, teaching methods.

Introduction

Rapid progress in artificial intelligence (AI) in recent decades potentially marks new frontiers to conduct scientific research throughout different fields. The efficient use of AI has become a priority agenda of different international organisations such as The United Nations Educational, Scientific and Cultural Organisation, European Commission or Organisation for Economic Co-operation and Development and resulted in serious discussions of rules and recommendations on application of AI instruments as well as determination of key AI notions that are introduced in background documents and reports (European Commission, 2021; OECD, 2023; UNESCO, 2023).

AI, once merely defined as the capacity of computer systems to comprehend, acquire knowledge, and render judgments through the analysis of extensive data, has now seamlessly integrated into the fabric of modern existence. Today AI reshapes entire industries and makes the technological giants invest in the development of AI-powered tools (Bharadiya et al., 2023). Also, AI is highly involved in administration activities in the government offices (Straub et al., 2023). Now the neural network can be used to diagnose the diseases (Zhylka et al., 2022), to analyse international financial environment (Yan, 2023), to develop extensive automation of production (Kim et al., 2022a), and to provide smart product quality control (Sundaram & Zeid, 2023). In addition, AI has brought a revolutionary wave to the entertainment sector changing content creation and generating strategic ideas (Nader et al., 2022).

Moreover, AI is frequently used in war and presently the Armed Forces of Ukraine successfully use some AI-driven tools like Reface and Clearview AI that help identify personality of Russian soldiers, counteract to disinformation and propaganda, to discover the location of lost persons and servicemen killed, especially in harsh conditions or challenging terrains (Espindola, 2023; Valko & Osadchyi, 2022). AI technology plays a crucial role in various military applications such as conquering territories, disarming missiles, and creating interactive online maps of military operations (Nevliudov et al., 2021).

AI has become an extreme focus of educational institutions significantly affecting the educational process. In recent years, there has been observable progress in the introduction of interactive assistants and personalized training courses, with the overarching objective of adapting the educational landscape to cater to the specific needs and preferences of students. This advancement is fueled by the desire to streamline laborious technical processes while simultaneously expediting the processing of information (Kamalov et al., 2023; Seo et al., 2021).

Currently, Ukraine is undergoing the education reform to transform education system into innovative environment where learners can develop key competencies necessary for successful professional activities in the modern digital world. The digitalisation of education is the main goal of reform which particularly deals with the introduction of modern technologies (Ivanenko et al., 2023). Extensive opportunities of the use of AI in education are to change the educational process and make it more innovative, inclusive, efficient and effective through the introduction of new high-quality learning methods. And the real goal of AI in education concerns individualization of education, building students' personalised learning trajectories according to their strengths and weaknesses, and adaptation of didactic materials to interior and exterior conditions of educational process (Drach et al., 2023; Shust et al., 2023).

This requires in-depth study of innovative methodologies and approaches to teaching with AI in Ukrainian institution of higher education since the results may result in modernisation of professional training of future specialists and obtain the maximum benefit from AI-powered technologies within the educational process.

Research Problem

According to the Concept of development of AI in Ukraine, AI is an organised set of information technologies which can perform complex tasks with the use of the system of scientific research methods and information processing algorithms. It may create its own knowledge bases and use them, generate unique decision-making models, and determine ways to achieve the expected goals (Concept of development, 2020). The development of AI technologies is an important direction of higher education enhancement and its application in educational environment has great potential to improve students' performance and introduce personalisation of the educational process.

Therefore, the analysis of innovative methodologies and approaches to teaching with AI in Ukrainian institution of higher education is a significant task since the transformation of educational environment and its digitalisation require reshaping of teaching methodology and implementation of effective approaches and techniques that increase the quality of educational delivery and improve learning experiences.

Research Focus

Recently, AI-based technological advancements have significantly transformed the educational environment in the institutions of higher education. The use of innovative methodology and approaches

in higher education can cause a range of advantages, improvement of teaching delivery practices, enrich the students' learning experience for students, and contribute to their professional development. This means the problem of through investigation of innovative teaching approaches and methods oriented towards using AI tools is important for the improvement of educational process in the institutions of higher education and modernization of the existing methodology.

Research Aim and Research Questions

The aim of the research was to evaluate innovative methodology and approaches to teaching with AI in Ukrainian higher education and to outline the most effective delivery practices that can be applied in the institutions of higher education where AI-powered technologies are extensively applied.

To achieve the aim of the research, the following research questions were formulated:

1) What AI-based teaching approaches, teaching methods, assessment techniques are used in Ukrainian institutions of higher education?
2) What teaching methodology and approaches are considered to be the most effective ones in the system of training of future specialists with the use of AI-driven tools?
3) What are methodological recommendations for instructors involved in training of future AI experts?

Research Methodology

General Background

During the research a mixed methodology that combined descriptive, association, and intervention methods was applied. Descriptive methods included literature review, narrative, content analysis of educational and professional programs, and phenomenological approach. Associational methods included a predictive analysis aimed at forecasting of the probability of innovative methodology and approaches that impact AI education. And intervention suggested using a survey and an assessment to collect the data from respondents and further to analyse it making relevant conclusions.

Sample / Participants / Group

The research included 42 instructors of Ukrainian institutions of higher education that were involved in the process of training of future AI experts. They represented graduating departments that are responsible for the development of educational and professional programs of training of future specialists, formulated the training objectives, and designed the conceptual framework for creation of innovative educational environment with the use of AI-powered tools. The institutions of higher education included: National University "Lviv Politekhnika", National Technical University "Kharkiv Polytechnical University", State University of Telecommunications, Igor Sikorsky Kyiv Polytechnic Institute, National Aviation University.

Instrument and Procedures

The research of evaluation of innovative methodologies and approaches to teaching with AI in Ukrainian institutions of higher education was conducted in three stages. The first stage (January-March, 2023) was related to the collections of qualitative data and thorough literature review to understand the concepts of the problem and organise the pattern of the research.

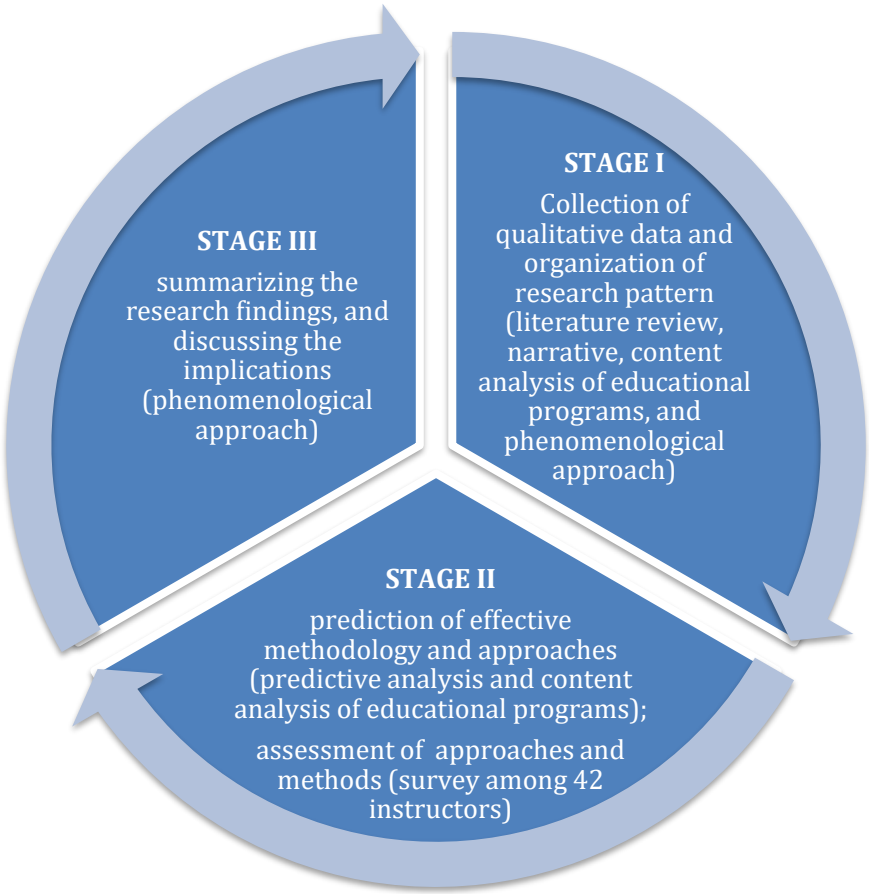
During the second stage (April-June, 2023) the most effective methodology and approaches to teaching with AI in the basis of predictive analysis and content analysis of educational and professional programs were predicted. Also, a survey among instructors of institutions of higher education to assess the approaches and methods used within the educational process was conducted. The questionnaire form used in the survey is shown in Appendix. It is worth mentioning that the analysis of the results was based on five categories: high efficiency, effective, sufficiently effective, moderately effective, and low efficiency.

The third stage (July-October, 2023) included summarising the research findings, and discussing the implications. The focus was on the elaboration of methodological recommendations for instructors of Ukrainian institutions of higher education to enhance the efficiency of training of future AI experts. The phenomenological approach inspired to generating of new knowledge and innovative teaching practices oriented towards creation of digital educational environment.

Figure 1 shows the stages of the research used to evaluate innovative methodologies and approaches to teaching with AI in Ukrainian institutions of higher education.

Figure 1

Research Stages



Source: authors' own development.

Data Analysis

The content analysis of educational and professional programs for training future bachelors in intelligence systems involved examining the content of text, audio, and video materials. Also, it represented qualitative data which we conducted a detailed analysis of educational materials, instructional videos, classroom discussions, and students' assessments. The qualitative data were analysed according to the following steps: selecting the sample of the content to be analysed; development of key concepts of AI-based methodology relevant to our research; actual analysis through applicable research methods and identification of innovative trends in higher education related to teaching with AI; interpretation of the results and discussing the potential limitations.

Quantitative data were selected when the instructors were interviewed through online questionnaire forms and face-to-face conversations to evaluate innovative teaching methodology and approaches, they apply within the educational process. Closed-ended questions provided us with quantitative information of efficiency of innovative approaches and methods used for teaching with AI. The data received during the survey are applicable for further designing of methodological recommendations to improve AI-based teaching practices and enhance professional training of future AI experts at the institutions of higher education.

Research Results

AI in education refers to using AI-driven technologies or instruments in the educational environment to facilitate data processing, decision-making, teaching delivery, or learning (Nalbant, 2021). In recent years, AI has seen remarkable advancements and is now capable of fulfilling various tasks within educational environments. Recognising its possibilities AI tools have been widely adopted and used with institutions of higher education to enhance the efficiency of educational process.

Currently, personalised learning has emerged as one of the most commonly adopted applications of AI in the field of education (Berondo, 2023) and it is more effective in improving students' learning outcomes compared to traditional teaching strategies. In personalised learning students show significant improvements in their performance and increase motivation to learning. According to Patkar and Kumbhar (2021) personalized learning helps keep learners engaged, makes educational environment more interactive, ensures objective assessment and provides better time management.

Intelligent tutoring systems are actually computer-based learning systems that apply AI-powered tools and organise adaptive instruction both in the classroom and online. These systems model students' mood, emotional condition, cognition techniques. Also, they are able to analyse students' prior learning experience, competencies, and preferences. This helps monitor students' progress, provide immediate feedback, and design appropriate materials to practice considering their learning styles (Lin et al., 2023; Wang et al., 2023).

AI significantly contributes to assessment of students learning outcomes and makes it fully automated, objective and high-quality (Martínez-Comesaña et al., 2023). Automated assessment focuses on continuous monitoring of students' outcomes and evaluates their performance with quantitative and qualitative data (Hooda et al., 2022). AI-powered assessment uses different techniques including learning analytics, educational data mining, intelligent sensors, and machine learning (Caspari-Sadeghi, 2023).

Other innovative educational technologies brought by AI include Virtual Reality learning (Liubchak et al., 2022; Marougkas et al., 2023), data management (González-Calatayud et al., 2021;

Khosravi et al., 2023), learning management systems (Fırat, 2023), smart content creation (Kamalov et al., 2023), curriculum design (Aliabadi et al., 2023; Yang et al., 2023a), and gamification (Yang et al., 2023b).

Table 1 shows the analysis of innovative educational technologies brought by AI in institutions of higher education.

Table 1

AI Innovative Educational Technologies in Higher Education

Innovative educational technologies	Definition	Authors
Personalised teaching	adjusting task complexity based on learners' cognitive abilities and learning experience; provide conditions when students can interact with each other and receive personalised feedback based on their performance.	Berondo (2023) Kamalov et al. (2023) Patkar and Kumbhar (2021)
Intelligent tutoring systems	providing students with one-on-one teaching, emulating the experience of learning from a human tutor	Kamalov et al. (2023) Lin et al. (2023) Wang et al. (2023)
Assessment automation	based on meaningful learning activities (a game or collaborative work) where all learning is analysed	Caspari-Sadeghi (2023) Hooda et al. (2022) Martínez-Comesaña et al. (2023) González-Calatayud et al. (2021)
Virtual Reality learning	computer-generated learning environment with setting and objects that appear to be real; digital simulation of real-life scenarios for training purposes.	Liubchak et al. (2022) Marougkas et al. (2023)
Data management	data extraction and mapping through data processing software to improve data quality and analysis	González-Calatayud et al. (2021) Khosravi et al. (2023)
Learning management systems	software tool used to create, deliver, and report on training courses and programs	Fırat (2023)
Smart content creation	development of cognitively demanding tasks that make students engage deeply with training course and acquire the educational material	Kamalov et al. (2023)
Curriculum development	Development of the courses considering students' learning styles as well as future professional context; Presentation structurally and logically learning material	Aliabadi et al., (2023) Yang et al. (2023a)

Gamification	Transformation of the traditional classroom environment and conventional activities into a game	Yang et al. (2023b)

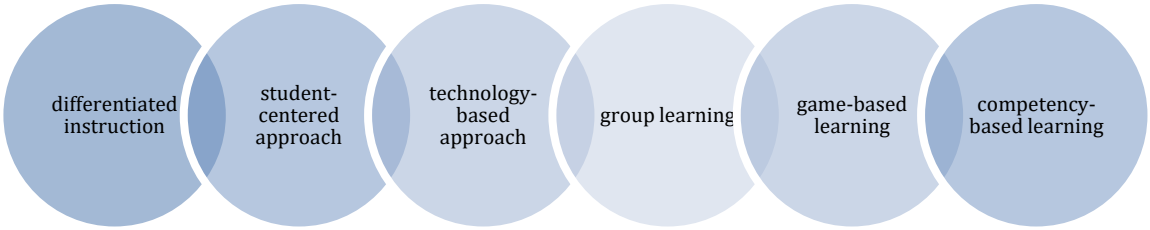
Source: authors' own development.

To implement the above mentioned innovative educational technologies, efficient approaches and methods must be selected within the educational process. The teaching approach is explained as a set of principles, or ideas about the nature of teaching which is delivered in the classroom (Mladenovici et al., 2022). At the same time, teaching method is a well-organised, systematic, and thoroughly planned procedure aimed at facilitating and enhancing students' learning activities (Hasanova et al., 2021).

Analysing the research devoted to AI-based methodology in higher education, it was found that six teaching approaches are effectively applied. They include: differentiated instruction (Büyüksoy et al., 2020; Eikeland & Ohna, 2022), student-centered approach (Kerimbayev et al., 2023; Liao et al., 2021), technology-based approach (Kozlova & Pikhart, 2021; Zawacki-Richter et al., 2019), group learning (Kim et al., 2022b; Seo at al., 2021; Tan et al., 2022), game-based learning (Priyaadharshini et al., 2020; Videnovik et al., 2023), and competency-based approach (Margienė et al., 2022; Oroszi, 2020). Figure 2 shows the teaching approached in higher education with AI.

Figure 2

Teaching Approached in Higher Education with AI



Source: authors' own development.

The differentiated instruction deals with considering learners' individual learning styles and level of knowledge when designing a lesson plan (Büyüksoy et al., 2020). The differentiated instruction can be organised through the smart education, building digital educational environment, using diverse teaching tools and providing more accurate and comprehensive assessment. Eikeland and Ohna (2022) state that differentiated instruction is introduced on three levels: differentiating the content, differentiating the process, differentiating the product, and differentiating the environment. The findings (Büyüksoy et al., 2020; Yuen et al., 2023) show that the approach suggests offering various learning options to students, providing multiple learning materials, using personalised learning and smart assessment, and applying different teaching methods like cooperative exercises, think-pair-share, brainstorming, progressive tasks, student-led activities, learning station, tiered assignments, interest-based learning, and flexible grouping.

The student-centered approach is related to teaching methods that place the needs and interests of students at the center of the educational process. It is oriented towards students' collaboration and engagement, develops educational autonomy among students (Kerimbayev et al., 2023). Educational environment where students-centered approach is applied provides students with rational support and contributes to overcoming challenges in the classroom like poor communication, misunderstanding, biased interpretation, or low motivation. According to Liao et al. (2021), the student-centered approach helps solve skill-oriented complex tasks, enhance students' learning interest, and improve their innovative readiness. When using AI, the following methods are effective real cases, project-based learning, collaborative learning, interactive exercises, dialogue, group discussion, games and simulations (Ochoa & Wise, 2021; Zhang et al., 2023).

The technology-based approach means teaching delivery through information and communication technologies (ICT) that help students understand educational material better (Zawacki-Richter et al., 2019). ICT are known for their ability to accelerate the transfer of information, increase students' interest to learning activities, and make educational processes automated (Kozlova & Pikhart, 2021). In most cases technology-based exercises suggest using different devices in the classroom and during online like mobile phones, laptops, desktop computers.

The group learning is related to building positive connections between students to motivate them to work together and interact (Tan et al., 2022). Group learning includes working in both small groups and large teams where all the roles are distributed. AI technologies make group learning more interesting and maximize its efficiency since it provides group assistance, create real-life tasks, form adaptive groups, give immediate feedback (Seo at al., 2021). We found that group learning enhances critical thinking, improves communicative and decision-making skills, promotes deeper understanding of the topic through increasing their attention and maintaining their focus on the tasks (Kim et al., 2022b).

The game-based learning is one of the most innovative teaching approaches as it is aimed at increasing students' interest in education by playing games (Priyaadharshini et al., 2020). Additionally, the game-based learning can be defined as the integration of educational content into a game format, fostering active participation and interaction among students in order to acquire new knowledge or cultivate professional skills (Videnovik et al., 2023). The findings show that AI-powered instruments allow to make the game-based learning environment more personalised, flexible, inclusive, and interactive (Wagan et al., 2023). At the same time, games used in the classroom increase the level of professional skills, and improve critical thinking, help generate new ideas, solve real-time problems, and make strategies and structured action plans for future.

The competency-based approach, an innovative advance in higher education, organises academic content according to students' and ensures students use past experiences, skills, and knowledge to complete a course (Oroszi, 2020). In addition, the competency-based approach focuses on the students' learning outcomes considering their professional interest and needs (Sistermans, 2020). AI assisted to create competency-based environment (Margienė et al., 2022) and requires to use certain methods including case study, project-based learning, peer learning, preparation of presentations, role-plays, storytelling, simulations, work with video, micro-teaching, conceptual learning tasks.

Ukrainian researchers are advocating for a groundbreaking transformation of higher education through the implementation of various AI-driven tools. These tools aim to revolutionise classroom management, enhance student-teacher collaboration, and empower professional training (Fiialka et al., 2023), behavior analytics, tutoring, and university admission campaign (Fedushko et al., 2022). But the

analysis of methodology and approaches to teaching with AI in Ukrainian institutions of higher education requires demands deep analysis to select the most effective techniques and elaborate methodological recommendations for instructors.

A detailed content analysis of educational and professional programs for training of future bachelors was conducted (field of knowledge 12 Information technologies) on specialty 122 Computer sciences used in five Ukrainian institutions of higher education: National University "Lviv Politekhnika", National Technical University "Kharkiv Polytechnical University", State University of Telecommunications, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", and National Aviation University.

The results show that the programs are aimed at training future AI specialists and focus upon education in computer sciences and information technologies; ability to analyse, forecast, model, and make decisions with the use of AI-based methods (National University "Lviv Politekhnika", 2023); modern concepts and calculation methods, algorithm and programs of AI, data consolidation, management of IT projects (National Technical University, 2023); orientation towards research in the sphere of information technologies and training of specialists able to solve professional tasks using AI-based tools (State University of Telecommunications, 2021); extensive use of modern methods and technologies of computational intelligence, machine learning, deep learning and Big Data Mining and solving applied tasks of AI (National Technical University of Ukraine, 2021); training of specialists of modern information technologies in different spheres of human activities that are able to create and use systems of data processing and analysis, AI systems and aerial unmanned vehicles (National Aviation University, 2023). Table 2 presents the general analysis of educational and professional programs.

Table 2

General Analysis of Educational and Professional Programs

Institution of higher education	Title of educational and professional program	Objectives of educational and professional program	Focus of educational and professional program
National University "Lviv Politekhnika"	Computer sciences (artificial intelligence systems)	To provide students with knowledge, skills, and abilities that are necessary to making decisions in complex systems with the use of AI-based methods and modern information technologies, fundamental and applied methods of data processing and analysis for solving problems	General education in computer sciences and information technologies; ability to analysis, forecasting, modelling and decision making in complex systems with the use of AI-based methods, deep learning and machine learning
National Technical University "Kharkiv Polytechnical University"	Computer sciences. Artificial intelligence and project management	To train specialists to conduct the research in computer sciences; to use mathematical methods and algorithm principles in modelling, projects, and development of information technologies; to implement intelligence systems of data processing and analysis	Modern concepts and methods of calculations, algorithm and programs of AI, data consolidation, management of IT projects and project teams

State University of Telecommunications	Artificial intelligence	To form and develop general and professional competencies among graduates able to perform theoretical and experimental research in computer sciences; to use mathematical methods and algorithms in modelling and projects; to implement intelligence systems of data processing and analysis	Educational program has an applied character and oriented towards research in the sphere of information technologies and training of specialists able to solve professional tasks using AI-based tools
Igor Sikorsky Kyiv Polytechnic Institute	Systems and Methods of Artificial Intelligence	To train students to solve tasks in development of software, databases, AI systems, administration of systems and networks, web-development; to perform intercultural professional interaction oriented towards integration of university education in European educational environment through internationalisation of educational process under conditions of sustainable innovative development of society; to teach future experts to solve complex tasks; to form adaptability of students to labour market transformations	Program is based upon extensive use of modern methods and technologies of computational intelligence, neuron networks, machine learning, deep learning and genetic algorithms of evolutionary programming, Big Data Mining and solving applied tasks of AI
National Aviation University	Data analytics and artificial intelligence	To train specialists of international level in computer sciences that possess modern information technologies of data analysis and AI in the sphere of machine learning, deep learning, and neuron networks and able to conduct research activity in different applied fields including aerial unmanned vehicles	Training of specialists of modern information technologies in different spheres of human activities able to create and use systems of data processing and analysis, AI systems and aerial unmanned vehicles

Source: authors' own development.

Besides, the content analysis of educational and professional programs demonstrates that the most spread teaching approaches include student-centered, problem-based, competency-based, differentiated learning, and technology-based approach. The regulative documents indicate that collaborative learning, project-based activities, case study, practical tasks, simulations, and modelling are the teaching methods applied for training of future AI experts. At the same time all the institutions use lectures, practical lessons, seminars, laboratory work, independent work, and consultations to organize the educational process. In addition, assessment techniques refer to written tasks, oral presentations, laboratory reports, testing, defense of bachelor's projects. Table 3 shows the analysis of teaching delivery practices and assessment techniques outlined in the educational and professional programs for training of future bachelors of AI systems.

Table 3

Analysis of Teaching Delivery Practices and Assessment Techniques on the Basis of Educational and Professional Programs

Institution of higher education	Teaching approaches	Teaching methods	Assessment techniques	Types of lessons	Teaching aids and equipment
National University "Lviv Politekhnika"	Competency-based Student-centered Interactive ICT-based	Research-based methods Collaborative learning Use of textbooks Project-based learning	Written tasks Oral presentation Laboratory reports Exams Defense of bachelor's projects	Lectures Practical lessons Seminars Laboratory work Independent work Consultations	Modern computer aids Special software Online learning platforms
National Technical University "Kharkiv Polytechnical University"	Student-centered Problem-based Self-regulated learning Task-based learning Differentiated	Online learning Group activities Project-based learning Practical exercises Demonstrations Case study Simulations	Computer-based testing Written tasks Oral presentation Laboratory reports Individual tasks Exams Defense of bachelor's projects	Lectures Multimedia lectures Interactive lectures Seminars Practical lessons Laboratory work Independent work Consultations	Microsoft office 365 ICT Cloud technologies Mobile phones Laptops Special software Systems for project management
State University of Telecommu-nications	Blended learning Student-centered Problem-based Competency-based Differentiated Technology-based	Practical tasks Visualization Case study Modelling Project-based learning Situational tasks Presentations	Computer-based testing Written tasks Oral presentation Laboratory reports Exams Defense of bachelor's projects	Lectures Online lectures Practical lessons Laboratory work Individual lessons Consultations Apprentice-ship	Mathematic models Modern ICT Cloud technologies Mobile phones Systems of databases management
Igor Sikorsky Kyiv Polytechnic Institute	Blended learning Student-centered Problem-based Competency-based learning Differentiated learning	Small group work Simulations Practical tasks Modelling Case study e-learning	Testing Written tasks Oral presentation Laboratory reports Exams	Lectures Seminars practical Lessons Laboratory work Individual work	Cloud technologies Database management systems MOOCs ICT

	Self-regulated work Technology-based Integrated approach		Defense of bachelor's projects		
National Aviation University	Student-centered Problem-based Competency-based Differentiated learning Interactive approach Integrated	Problem-based tasks Situational tasks Practice-oriented activities Conferences Project-based learning	Testing Written tasks Oral presentation Laboratory reports Exams Defense of bachelor's projects	Lectures Interactive lectures Seminars Practical lessons Laboratory work Apprentice-ship in industrial enterprises	Computer Cloud technologies Database management systems Special software Electronic libraries Cognitive interfaces ICT Personal electronic office Multimedia complexes

Source: authors' own development.

The survey among 42 instructors of Ukrainian institutions of higher education that were involved in the training of future experts of AI experts showed the efficiency of implementation of innovative teaching approaches and methods. The list of methodology and approaches to teaching was prepared on the basis of literature review and content analysis of educational and professional programs. Thus, it was found that technology-based approach, competency-based approach, differentiated, and interactive learning are considered to be the most effective among instructors. At the same time, self-regulated learning and task-based approach are characterised by a low efficiency. Table 4 shows the analysis of innovative approaches to teaching with AI.

Table 4

Innovative Approaches to Teaching with AI

Teaching approaches	High efficiency	Effective	Sufficiently effective	Moderately	Low efficiency
Differentiated instruction	17,4 %	21,5 %	22,3 %	28,1 %	10,7 %
Student-centered approach	19,1 %	22,7 %	23,5 %	29,3 %	5,4 %
Technology-based approach	20,8 %	22,3 %	26,7 %	19,1 %	11,1 %
Interactive approach	21,0 %	24,8 %	29,6 %	11,2 %	13,4 %
Game-based learning	12,7 %	19,5 %	29,6 %	24,7 %	13,5 %
Competency-based approach	19,6 %	20,1 %	23,8 %	22,5 %	14,0 %
Problem-based approach	11,7 %	18,7 %	30,6 %	17,6 %	21,4 %

Distance learning	13,8 %	23,4 %	28, 6	30,4 %	3,8 %
Integrated approach	9,6 %	17,8 %	32,8 %	27,1 %	12,7 %
Blended learning	19,9 %	28,9 %	30,5 %	14,1 %	6,6 %
Self-regulated work	8,6 %	16,7 %	32,1 %	27,5 %	15,1 %
Task-based learning	11,4 %	19,6 %	21,5 %	23,4 %	24,1 %

Source: based on survey results.

Table 5 represents the analysis of innovative teaching methods with AI. The results demonstrate that instructors use a wide range of different innovative teaching methods to increase the students' learning outcomes, enhance their motivation, and make the educational environment optimal and balanced.

Table 5

Innovative Teaching Methods with AI

Teaching methods	High efficiency	Effective	Sufficiently effective	Moderately	Low efficiency
Research-based methods	3,4 %	12,7 %	23,4 %	27,1 %	33,4 %
Collaborative learning	18,9 %	22,1 %	25,6 %	14,5 %	18,9 %
Use of textbooks	4,1 %	11,8 %	30,2 %	26,5 %	27,4 %
Project-based activities	11,3 %	19,5 %	34,4 %	18,3 %	16,5 %
Online learning	9,5 %	20,6 %	27,0 %	23,9 %	19,0 %
Group activities	18,6 %	30,7 %	21,5 %	16,3 %	12,9 %
Practical exercises	19,3 %	29,5 %	24,3 %	17,1 %	9,8 %
Demonstrations	14,2 %	20,1 %	31,7 %	12,4 %	21,6 %
Case study	10,9 %	19,8 %	32,6 %	24,5 %	12,2 %
Visualisation	7,8 %	18,9 %	31,5 %	21,6 %	20,2 %
Modelling	9,1 %	13,4 %	21,8 %	34,9 %	20.8 %
Simulations	11,8 %	21,7 %	28,5 %	26,3 %	11,7 %
Presentations	5,4 %	12,8 %	38,7 %	23,4 %	19,7 %
Small group work	12,3 %	19,9 %	32,6 %	25,1 %	10,1 %
Situational tasks	15,6 %	22,8 %	29,6 %	23,4 %	8,6 %
Conferences	7,8 %	15,8 %	31,2 %	25,6 %	19,6 %
e-learning	11,5 %	23,1 %	24,3 %	26,2 %	14,9 %
Problem-based tasks	14,6 %	22,5 %	28.6 %	21,9 %	12,4 %
Think-pair-share	4,2 %	13,2 %	28,5 %	30,1 %	24,0 %
Brainstorming	7,8 %	15,5 %	30,7 %	29,2 %	24,6 %
Progressive tasks	9,1 %	16,1 %	24,9 %	31,2 %	18,7 %
Student-led activities	2,3 %	8,4 %	32,9 %	38,1 %	18,3 %
Learning station	5,6 %	12,3 %	29,5 %	31,2 %	21,4 %

Tiered assignments	4,1 %	18,9 %	24,6 %	28,7 %	23,7 %
Flexible grouping	12,4 %	25,6 %	23,7 %	21,4 %	16,9 %
Dialogue	9,8 %	21,4 %	34,8 %	18,7 %	15,3 %
Group discussion	11,1 %	20,5 %	40,2 %	13,2 %	15,0 %
Games and role-plays	17,3 %	28,9 %	30,4 %	15,6 %	7,8 %
Peer learning	3,1 %	11,8 %	35,6 %	28,7 %	20,8 %
Storytelling	6,4 %	15,9 %	28,6 %	38,6 %	10,5 %
Work with video	7,6 %	23,1 %	29,5 %	18,5 %	21,3 %
Micro-teaching	2,1 %	11,6 %	41,2 %	28,6 %	16,5 %
Conceptual learning tasks	4,9 %	15,4 %	24,3 %	31,7 %	23,7 %

Source: based on survey results.

The findings show that instructors consider the following teaching methods of high efficiency: practical exercises (19,3 %), group activities (18,6 %), games and role-plays (17,3 %), situational tasks (15,6 %), and problem-based tasks (14,6 %). At the same time, tiered assignments (4,1 %), use of textbooks (4,1 %), student-led activities (2,3 %), micro-teaching (2,1 %) are used minimally because of the necessity to design additional educational materials or lower students' engagement.

The findings have played a significant role in formulating systematic recommendations on effectively incorporating AI in teaching, including the utilization of innovative methods and approaches. Table 6 gives the methodical recommendations on usage of innovative methods and approaches to teaching with AI.

Table 6

Methodical Recommendations on Usage of Innovative Methods and Approaches to Teaching with AI

Recommendations	Measures
Approaches to teaching with AI	
Technology-based approach ensures the integration of teaching technology into the educational environment (Kozlova & Pikhart, 2021; Zawacki-Richter et al., 2019)	to conduct questionnaire about the students' preferences on technologies, particularly AI-driven tool; to consider two tiers of implementation of technology-based approach where the first one deals wit technology as a tool to solve the educational tasks and the second one – technology as a process itself; to develop different tasks that demand using technologies; to keep students engaged; to provide all learning resources in electronic format
Competency-based approach is related to outcome-based practice and oriented towards the increase of knowledge, skills, and values required for dealing with professional and everyday situations (Margienė et al., 2022; Oroszi, 2020; Sistermans, 2020)	to design the relevant curriculum that is related to formation of professional competency; to apply practical exercises and simulations; to focus upon professional development and complex outcomes; to introduce competency framework; to improve the educational process continually according to changes within the professional sphere
Differentiated learning is used to design teaching delivery practices and educational materials considering students' learning styles, interests,	to conduct educational data analysis; to develop flexible teaching methods like grouping or student-led activities;

abilities, educational needs (Büyüksoy et al., 2020; Eikeland & Ohna, 2022)	to adapt instruction according to students' learning styles and needs; to design flexible content; to use ongoing assessment
Interactive learning requires students' active participation (Fan & Li, 2023; Seo et al., 2021)	to make active learning a priority; to set clear educational objectives for students; to foster students' collaboration; to introduce the peer learning; to implement diverse methods; to gamify the learning; to apply scenario-based tasks with preliminary preparation; to encourage students to the peer assessment and self-assessment
Teaching methods with the use of AI	
Practical exercises allow students to develop new skills, improve learning experience, and change behaviour (Biwer et al., 2020; Yang, 2022)	to use demonstration; to discuss the task objectives and rules; to develop reality-based scenario; to study what students already know about the topic and determine what they need to learn; to focus upon professional development; to discuss the possible ways to solve the problem
Group activities relate to organised activity of group of students working on the same task (Eager & Brunton, 2023; Kamalov et al., 2023)	to introduce the idea of group work to students; to explain the activity; to divide students into heterogeneous groups; to encourage discussion through appropriate questions open-ended; to use teacher-led and student-led activities; to develop flexible methodology; to incorporate tasks based on professional activities
Games and role-plays bring high levels of engagement to students during the educational process and help create mirror-like professional environment in the classroom (Priyaadharshini et al., 2020; Videnovik et al., 2023)	to reinforce learning through game; to integrate game with lesson objectives; to deliver adjusted content and to control the content during the game; to involve all the students into the activity; to devote time to after-game analysis; to focus of digital games and AI-powered activities; to create learning stations; to assess the progress through the game
Situational tasks deal with tasks of professional activity (Boyko et al., 2021)	to aim at solution of practicable situations related to future professional activity; to focus upon building professional competencies; to develop personalized situations; to use mini-situations
Problem-based tasks means using student-centered activities when they learn about a subject by working in groups and solve open-ended problems (Wu et al., 2020)	to prepare the problem or real-life scenario; to orient students over the problem; to organize students' research in groups of individually; to encourage presenting the work; to monitor the project progress; to evaluate the experience; to focus upon improvement of students' oral presentation skills; to develop flexible knowledge

Source: authors' own development.

Providing students with access to AI education can help enhancing the efficiency of the educational process since AI-powered tool may maximise the teaching approaches and methods and simplify their usage. The advantages of introduction of AI in institutions of higher education include the following: the access to information through virtual assistant or electronic libraries (Piñeiro-Martín et al., 2023), improvement of e-learning experience (Tan et al., 2022), introduction of personalized learning as customized learning for each student's strengths, needs, and skills, and interests (Patkar & Kumbhar, 2021), inclusivity (Cachat-Rosset & Klarsfeld, 2023), accurate and objective assessment (Hooda et al., 2022), students' engagement into interactive activities (Ochoa & Wise, 2021), acceleration of simulation-based tasks (Zhang et al., 2023), and smart content design (Kamalov et al., 2023).

Therefore, AI possesses immense potential in addressing the challenges faced by higher education today. It innovates teaching and learning practices, and enhances the efficiency of educational process. AI-driven technologies allow make training of future specialists at the institutions of higher education high-quality and efficient as well as achieve the educational intentions.

Discussion

The research demonstrated that AI-driven technologies have a significant impact on teaching delivery practices in Ukrainian higher education institutions and contribute significantly to the modernisation of the educational environment to make the process of students' training more efficient, instructors must follow the methodical recommendations oriented towards maximisation of teaching approaches and teaching methods. Based on the results of multifaceted investigation it can be concluded that teaching approaches and methods that are used in the Ukrainian institutions of higher education with the use of AI tools are effective.

The application of innovative approaches to teaching AI were discussed in a number of pedagogical research. Su et al. (2022) released the cultivating approach (developing your own philosophy of education), the common approach (addressing the instructional design and examine the content knowledge, educational tools, activities, pedagogies, and learning outcomes), and the similar approach (developing and refining the AI curricula). Yau et al. (2023) defined the phenomenographic approach as a significant one in teaching with AI. This approach is usually used to investigate learning and teaching conception in education.

Some works (Kozlova & Pikhart, 2021; Zawacki-Richter et al., 2019) indicate the significance of technology-based approach describe that it deals with the integration of teaching technology into the educational environment. It was found that technology-based approach to teaching with AI in the institutions of higher education offers certain advantages that are able to enhance the efficiency of educational process and oriented towards increase of students' learning experience. The advantages include the following: flexibility of courses delivery that makes learning more accessible; personalisation and customisation of educational content to individual students' needs; interactivity and facilitation of collaboration between students and instructors; improvement of data analysis; cost efficiency; preparation of students to work in digital professional environment through formation of digital and ICT competency.

According to Margienė et al. (2022), Oroszi (2020), and Sistermans (2020), the competency-based approach means using outcome-based practice and it is aimed towards the increase of knowledge, skills, and values required for carrying out professional tasks adequately. The competence-based approach focuses on development and assessment of professional skills and competencies of future specialists. The use of the competence-based approach while teaching with AI has several advantages. They are related to the following: practical application of knowledge and engagement in real-life experience; focus of educational process upon formation of transferable skills including critical thinking,

communication, decision-making, conflict resolving, and teamwork. Also, competence-based approach contributes to the clarification of learning outcomes and building of individual learning trajectory. The survey findings demonstrate that the competence-based programs help students to adapt to changeable working environment and develop lifelong learning skills.

The differentiated approach is responsible for designing teaching delivery practices and educational materials considering students' learning styles, interests, abilities, educational needs (Büyüksoy et al., 2020; Eikeland & Ohna, 2022). Yuen et al. (2023) define it as a viable approach for accommodating the diverse learning needs of students in the same classroom. During the survey it was found that differentiated approach to teaching with AI includes a number of advantages that enhance the efficiency of educational process and maximize the potentials of AI-related tools in the classroom. The advantages concern, primarily, individualised learning because differentiated learning help instructors customize teaching delivery practices. Other advantages relate to build the educational environment on the basis of students' learning styles and skills; promotion of students' engagement and inclusivity. Besides, instructors are successful to foster efficient educational environment where AI-driven tools are introduced and further to assess students' learning outcomes more accurately.

Interactive approach is based on students' active participation (Fan & Li, 2023; Seo et al., 2021) and incorporates AI technologies (Ukenova & Bekmanova, 2023). It is suggested that the interactive approach enhances teaching with AI due to a number of advantages which refer to students' engagement instead of passive receiving of educational material; organisation of collaborative activities; customisation of learning based on students' individual needs and psychological characteristics; increasing motivation to learning and future professional activities. In addition, AI-based technologies contribute to enhancement of interactive learning through real-world applications and immediate feedback.

In the context of teaching methods, we analyzed a number of pedagogical works and came to the conclusion that their choice depends on the interior and exterior conditions of educational process (Grassini, 2023), learning objectives (Bai et al., 2020), and students' individual needs and characteristics (Patkar & Kumbhar, 2021). Accordingly, innovative methodology is related to implementation of a number of techniques oriented towards increasing efficiency of educational process and improve students' learning outcomes. They are the following: practical exercises (Biwer et al., 2020; Yang, 2022), group activities (Eager & Brunton, 2023; Kamalov et al., 2023), games and roleplays (Priyaadharshini et al., 2020; Videnovik et al., 2023), situational tasks (Boyko et al., 2021), problem-based tasks (Wu et al., 2020). We found that the use of these teaching methods helps instructors improve teaching with AI in the institutions of higher education since they are oriented towards: Enhancing student' engagement in the classroom; maximize adaptability and flexibility of technology and learning resources; incorporation of appropriate technology-enhanced instruments; increasing of students' motivation; improvement of collaborative learning and teamwork activities; formation of critical thinking skills; development of creativity.

Conclusions and Implications

AI is an organised set of information technologies which can perform complex tasks with the use of the system of scientific research methods and information processing algorithms. The emergence of AI technologies is a crucial focus in higher education, and its integration into the educational environment holds immense potential for enhancing student performance and introducing personalized learning experiences. AI in education refers to using AI-driven technologies or instruments in the educational environment to facilitate data processing, decision-making, teaching delivery, or

learning. AI contributes to personalised teaching, introduction of intelligent tutoring systems, assessment, Virtual Reality learning, data management, learning management systems, smart content creation, curriculum design, and gamification. We found that there six teaching approaches and they are applied effectively in AI-powered education. They include: differentiated instruction, student-centered approach, technology-based approach, group learning, game-based learning, and competency-based approach.

According to the content analysis, in Ukrainian institutions of higher education the most spread teaching approaches include student-centered, problem-based, competency-based, differentiated learning, and technology-based approach. The regulative documents indicate that collaborative learning, project-based activities, case study, practical tasks, simulations, and modelling are the teaching methods applied for training of future AI experts. At the same time all the institutions use lectures, practical lessons, seminars, laboratory work, independent work, and consultations to organise the educational process. In addition, assessment techniques refer to written tasks, oral presentations, laboratory reports, testing, defense of bachelor's projects. Table 3 shows the analysis of teaching delivery practices and assessment techniques outlined in the educational and professional programs for training of future bachelors of AI systems. The survey showed the efficiency of technology-based approach, competency-based approach, differentiated, and interactive learning are considered to be the most effective among instructors. Also, the findings show that instructors consider the following teaching methods of high efficiency: practical exercises, group activities, games and role-plays, situational tasks, and problem-based tasks.

Based on the results of multifaceted investigation the conclusion that innovative approaches to teaching with AI must include technology-based approach, competency-based approach, differentiated approach, and interactive learning can be drawn. Accordingly, the innovative methodology is related to an implementation of a number of techniques oriented towards increasing efficiency of educational process and improve students' learning outcomes. They are the following: practical exercises, group activities, games and role-plays, situational tasks, problem-based tasks.

The research resulted in development of methodical recommendations on using teaching methods and approaches in AI-powered higher education. the recommendations van be implied by instructors of institutions of higher education involved in training of future AI experts in particular. Also, the recommendations are applicable for scientific and pedagogical stuff working on digitalisation of educational process.

Suggestions for Future Research

The research revealed a number of advantages brought by AI-powered tools into the system of higher education like the access to information through virtual assistant or electronic libraries, the e-learning experience improvement, the introduction of personalised learning as customised learning for each student's strengths, needs, and skills, and interests, inclusivity, accurate and objective assessment, students' engagement into interactive activities, acceleration of simulation-based tasks, and smart content design. They are oriented towards the improvement of educational process and maximisation of its educational potentials.

However, AI education is also associated with several drawbacks that can potentially hinder and complicate the learning process. These disadvantages include data privacy and security, biased information, over-dependence on AI-driven technologies, lack of emotional intelligence, limited customisation. Further research should outline the strategies to eliminate these problems within the

educational environment and create all favourable conditions for students' training in the institutions of higher education.

A special attention should be paid towards the design of the model of training of future AI experts as they may contribute to different spheres of society development through AI systems, machine learning, deep learning and Big Data mining. Currently, a number of Ukrainian institutions of higher education are involved in training of future AI experts, but the analysis of educational and professional programs showed that the educational process requires comprehensive improvement of methodology and transformations in teaching approaches. Thus, further steps will be made towards elaboration of methodological system of professional training of future AI experts at the Ukrainian institutions of higher education.

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Appendix

Form used to analyzed innovative methodology and approaches to teaching with AI in the Ukrainian institutions of higher education

You are requested to fill in the following form to find out the approaches and methods used in the educational process using AI tools. Read the following items and assess them using grades from 1 to 5, where 5 means the method or approach is of high efficiency; 4 means the method of approach is effective; 3= sufficiently effective; 2= moderately effective; 1 = low efficiency.				
Approaches				
1. Differentiated instruction				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
2. Student-centered approach				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
3. Technology-based approach				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
4. Interactive approach				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
5. Game-based approach				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
6. Competency-based approach				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
7. Problem-based approach				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
8. Distance learning				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
9. Integrated approach				

a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
10. Blended learning				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
11. Self-regulated learning				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
12. Task-based learning				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
Methods				
13. Research-based methods				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
14. Collaborative learning				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
15. Use of textbooks				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
16. Project-based activities				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
17. Online learning				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
18. Group activities				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
19. Practical exercises				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
20. Demonstrations				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
21. Case study				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
22. Visualization				

a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
23. Modelling				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
24. Simulations				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
25. Presentations				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
26. Small group work				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
27. Situational tasks				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
28. Conferences				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
29. e-learning				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
30. Problem-based tasks				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
31. Think-pair-share				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
32. Brainstorming				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
33. Progressive tasks				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
34. Student-led activities				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
35. Learning station				

a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
36. Tiered assignments				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
37. Flexible grouping				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
38. Dialogue				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
39. Group discussion				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
40. Games and roleplays				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
41. Peer learning				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
42. Storytelling				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
43. Work with video				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
44. Microteaching				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency
45. Conceptual learning tasks				
a) 1= low efficiency	b) 2= moderately effective	c) 3= sufficiently effective	d) 4= effective	e) 5= high efficiency

Source: based on literature review