

Investigating How Generative AI Can Create Personalized Learning Materials Tailored to Individual Student Needs

Mohammad Hassan Yousif Binhammad¹, Azzam Othman¹, Laila Abuljadayel², Huda Al Mheiri³, Muna Alkaabi⁴, Mohammad Almarri⁵

¹Department of Computer Science, British University Dubai, Dubai, United Arab Emirates

²Department of Cybersecurity, Dar Al-Hekma University, Jeddah, Saudi Arabia

³Department of Engineering Science, Dubai, United Arab Emirates

⁴College of Business, Abu Dhabi University, Dubai, United Arab Emirates

⁵Department of Computer Information Science, Dubai, UAE

Email: m.hassan.y1994@gmail.com

How to cite this paper: Binhammad, M. H. Y., Othman, A., Abuljadayel, L., Al Mheiri, H., Alkaabi, M., & Almarri, M. (2024). Investigating How Generative AI Can Create Personalized Learning Materials Tailored to Individual Student Needs. *Creative Education*, 15, 1499-1523.

<https://doi.org/10.4236/ce.2024.157091>

Received: June 18, 2024

Accepted: July 26, 2024

Published: July 29, 2024

Copyright © 2024 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

This research focuses on the possibility of utilizing generative AI in developing learning content to suit each learner's requirements. The study will evaluate the outcomes of the use of AI-created content in enhancing students' interest, desire, and performance in contrast to conventional learning resources. A qualitative study involves interviewing educators and developers of AI to understand their experience and perception about the generative AI in education while the quantitative study involves the performance data of students to determine the effectiveness of the content generated by AI. The paper also explores the ethical and privacy issues that come with the integration of AI in learning and offers solutions to these issues. To compare the efficiency of the AI-generated learning material with the traditional one, the study designed a quantitative comparative study on the performance of the students in Object-Oriented Programming (OOP) course. The course was split into two equal independent assessments; the professors uploaded AI generated content such as the title of the lesson, the content that was taught, and the learning outcomes expected, for each class. LMS was integrated with the OpenAI API to write content that is in line with the learning objectives as defined earlier. Performance data of students as obtained from the two evaluations was used to determine the effect of using AI-generated contents on students' learning. The results indicate that despite the students' increased test scores and grades after applying AI-created study materials, some of them are not benefited from them. These are some of the effects that show that it is essential to consider aspects like students' interest, their prior know-

ledge, and the quality of the AI model while adopting generative AI in education.

Keywords

Generative AI, Personalized Learning, Education Technology, Machine Learning Student Engagement, Adaptive Learning, Artificial Intelligence, Educational Innovation

1. Introduction

The education sector is no behind as the intelligentsia of AI enthusiasts march in their fortress of innovation. Generative AI, a sort of AI, is what is called the generated personalized learning content, which movable is according to the student's needs and level. Demonstration on that analyzing data of students, for instance, learning style, performance reviews and the engagement level, generative AI will be empowered to personalize learning materials in accordance with the individual student's strengths and learning habits. The offering of adaptive AI for individualized learning keeps one remarkable benefit that pupils will be able to manage and comprehend the content provided with appropriate difficulty according to the performance of learners (Brown & Yarowsky, 2000). The same as another example, the system may be able to generate easily changing reports with more difficult questions as students show ability and proficiency in a certain area, so they will be able to get the right level of support and challenge. Generative AI is not only capable of re-shaping the traditional way of learning by means of customized lesson plans, but it also perfectly fits the students who differ by their personal preferences, talents, and learning styles. The situation of having students themselves act more involved and enthusiastic about the material, is quite possible, because that could be the way someone will get interested and engaged with the subjects that meet their interests and plans (Chen & Guestrin, 2016).

However negative impact of generative AI for education may be or some moral issues it could lead to. On the other hand, there is also an option of bad and inaccurate inherited content, hence it should be relevant, accompany with accurate information and also tailored to the curriculum. Additionally, these systems can endanger student data privacy and security that the personalized learning materials are generated based on the student-level data. The customized learning content, enabled by generative AI, has the ability to revolutionize education as it suits each student's individual need. Though, conquering challenges like contents quality, data protections and ethical use of AI is also important because of getting the powerful AI education (Devlin et al., 2018).

1.1. Background

Individualized learning is an educational model presuming teaching, pace, and

learning atmosphere is geared towards individual students. It recognizes the existence of different types of learning styles and preferences which are accommodated by proven relevant, effective and appealing strategies. Technology and research-based studies have contributed to the noticeable increase in the use of individualized learning methods. Generative AI, a powerful AI tool capable of customized learning materials creation, has come up as an AI tool with the power to create new content from patterns and datasets. The aim of this method is to leave the complacent traditional one-size-fits-all fashion in favor of the more student-centered approach (Goodfellow et al., 2016).

The Generative AI technology can be a game changer in modern personalized learning by offering customized learning materials for each student according to individual specificities. Generative AI technology can compare and analyze student data (learning preferences, performance metrics, and engagement levels) and thus, create personalized materials that adapt to each student in the shortest period of time and in accordance with their current knowledge level. Consequently, the quiz system and the assessments are personalized in a way so that they become more difficult as students become more proficient in the subject matter. Not only that, generative AI may also develop individualized learning paths, integrating the content with learner's interests, objectives, and learning styles. An individualized approach to education may lead to increased student engagement and motivation, since students are more likely to be enthusiastic and active participants when the educational material aligns with their interests and goals.

In the last two decades, the utilization of digital tools in education had highly increased and a few factors that had contributed to this were the tools that became available and changing student expectations. The learning management system (LMS) is the main digital tool in this technological transition, which is used by the main part of higher and secondary education institutions around the world. LMS assists in self-paced learning, which inculcates cooperation by the means of forums and discussion, and sharing the lessons and materials. The systems are not only server data gathering functions, but they also allow educators to track student engagement and identify struggling students in due time. Some technology-driven discoveries like augmented reality and AI-powered teaching assistants have also come into the grasp of students. The use of information technologies in education has been said to have advantages from an administrative and academic viewpoint most especially in higher institution scenarios. Accordingly, the adoption of digital tools in the education sector has given positive implications both to administrators and teachers (Kingma & Ba, 2014).

1.2. Research Aim

The purpose of the study is to examine how generative AI could be employed to generate educational resources that are customized to meet the needs of personalized learning for students in education (LeCun et al., 2015).

1.3. Research Objectives

- To conduct a literature review on the use of generative AI in education for personalized learning.
- To analyze case studies of educational institutions or organizations using generative AI for personalized learning.
- To explore the potential benefits and challenges of using generative AI for personalized learning in education.
- To develop a framework for implementing generative AI in education for personalized learning.
- To validate the framework through expert feedback and pilot studies in educational settings.
- To provide recommendations for educators and policymakers on implementing generative AI for personalized learning in education.

2. Literature Review

Artificial intelligence with the ability to generate (generative AI) is being pursued with a lot of vigor nowadays, and there is a possibility that its integration to educational settings could lead to the development of personalized learning. This paper investigates the latest approaches in the field of generative AI for the design of self-paced learning materials that meet the needs of each and every student. The review takes in account the applications, benefits, challenges and ethical issues of generative AI in education and highlights the foremost findings and existing knowledge gaps (Mikolov et al., 2013).

2.1. Evolution of Generative AI Models

Generative AI models have a long history, starting with basic statistical algorithms and culminating with complex deep learning models that are based on an increase in the amount of computing power, the availability of data, and the development of algorithms. At first stages, n-gram-based models failed to render complicated linguistic peculiarities and coherent output. Recurrent neural networks and LSTM networks that capture long-range dependencies in text as well as generate contextually relevant output were the ground-breakers in the generative AI field that enabled neural network-based approaches. Yet, such models are still encountered with the difficulties of boring and monotonous language. The Transformer architecture, firstly introduced in 2017, laid the foundation for the self-attention mechanism to play a role in the reweighting of the importance of different words in a sentence, and consequently, generated more contextually relevant texts. Therefore, the capability of models like GPT-2, GPT-3, as well as Llama-2 possessed by Meta, kept on improving significantly. The further development of generative AI units is a necessity that is driven by large-scale datasets, the growth of computing power, and algorithm improvements (Radford et al., 2018).

2.2. Applications of Generative AI in Education

The role of AI applications within the framework of the education sector is diverse, and one of the areas is the development of individual learning materials with the help of the generative AI. Essentially, it enables the generation of formative assessments and quizzes in real-time, which change based on students' performance. This ensures that the tasks presented to the students are challenging enough but not too difficult (Ruder, 2018). Syntrophically with the published study that illustrates numerous opportunities of the adaptive assessments in enhancing student learning outcomes, the current research investigates the application of generative AI in designing personalized assessments. This study builds upon the previous literature by exploring how the integration of generative AI with LMS affects the learners' engagement and motivation (Silver et al., 2016).

2.3. Automatic Question Generation

Automatic question generation (AQG) is a recently come up application of generative AI, that enables educators to build customized tests and quizzes for students who have different needs. Through natural language processing and machine learning approaches, AQG systems work with you to provide questions that are contextually pertinent and belong across various subjects and levels of difficulty. It facilitates a greater level of student engagement as well as learning achievements by providing formative and important assessments. In addition, it makes life easier because the process of creating assessments is automated and its quality is not compromised. AQG extends personalized learning by asking questions that cater to the unique needs of each learner. Nevertheless, issues of easily producing low-quality and single-minded questions as well as biases in AI systems still exist (Socher et al., 2013).

2.4. Automated Correction of Free-Format Answers

The effective spelling change feature is one of the powerful usages of generative AI in education as it enables educators to make individualized corrections when response to free formation answers is required. This technology has the capability to handle written language and it uses of natural language processing and machine learning algorithms to analyze and present student responses, identifying whether the sentences that they have created are correct, complete and coherent. It has the power to provide items like immediate feedback, figure out subjects of weakness, and lessen the time when evaluating students' works. Automated recognition systems can parse out common errors and wrong notions, and thus likewise they might direct students to the helpers who specialize on the very areas that need help. While these AI systems bring a number of benefits including increased efficiency, they may also pose issues of system accuracy and reliability, considering ethical issues like student privacy and data security. However, automated correction has the height of helping to transform student

and marking assessment whereby speed and efficiency are the most common keywords (Vaswani et al., 2017).

2.5. Content Generation for Teaching Materials

Natural language processing generative AI is a good educational tool that can be easily used by a teacher to create bright and individual lessons. It is applied to assessing educational content and generating various teaching materials (for example, lesson plans and the learning goal in this way, students can be included in the process of teaching and learning which will make them interested and likely to grasp what has been taught; In addition, it became the basis for the diversity and learning materials that also reflected the diversity and experience of cultural background and focused on the use of this study also considers the issues related to the reliability and the absence of biases in the content created by AI, the aspect which has been investigated rather marginally in the existing literature (Xie et al., 2017).

2.6. Use of Generative AI in Technical Fields

Generative AI has brought about dramatic changes in emerging fields like programming that empower students to produce and perceive learning materials in a completely different way. This channel can be used to create various exercises, provide explanations of code and create interactive simulations in order to remind the learning process (Zoph et al., 2018). This aids students in mastering programming concepts and developing coding abilities. Thus, they will be able to easily implement the ideas and figure coding problems by themselves. In the areas like engineering and physics; generative AI could take the simulation of ideas to let the person conceptualize complex concepts in their areas that will facilitate the understanding of theoretical principles better. Not in all, it has increased the education level in technical activities into a more sense of grasp (Branco et al., 2017).

2.7. Challenges in Using Generative AI in Education

Generative AI in education is likely to interact with the system and change the model. Thus, it has advantages and disadvantages. The quality and correctness of generated content may be misinterpreted with untruth, leading to disinformation. Additionally, AI models trained on massive data sets must be bias-free to be credible in instructional materials. Data privacy and security challenges arise when generative artificial intelligence algorithms ask students for their data to generate personalised learning material. Data privacy and security in AI-based educational systems have been highlighted, but the current research provides a more comprehensive review of the ethical problems of generative AI in education. This study also emphasises the necessity for ongoing research and development to overcome these difficulties and ensure ethical AI use in education (He et al., 2016).

3. Conceptual Framework and Ethical Consideration

3.1. Generative AI Models

Generative AI models of which GPT-3 is an example are leaders in the education sphere by boosting customization of learning resources. These models, powered by deep learning methods, can sufficiently handle this task with human-looking outputs depending on the prompt they get (Kim, 2014). These models, regarded as educational, can be used to construct various types of personalized instructional materials that are designed to meet the needs of the individual student. As an example, they can create diagnostic questions or paraphrase the source material and even make simulations while enhancing learning experiences (Brown & Yarowsky, 2000).

3.2. Educational Context

A learning space involved factors that differentiate the impact of generative AI application in education. It includes the subject, grade level, and learning objectives. One way might be, say, mathematics, where generative AI can be employed to make individualized problem sets based on the learner's skill level (Chen & Guestrin, 2016). In language arts, it may serve as a vehicle for producing writing activities grouped together by the students' interests and skills. Additionally, the educational context refers to the role of instructors in providing the instructions for someone using computer-generated materials and feedback to students (Devlin et al., 2018).

3.3. Personalization Techniques

The humanized learning process executable by AI allows personalization through different methods. This may involve using student assessment data to find out the areas where such students are strong and weak and adapting by personalizing their learning. Real-time feedback is also part of such a process. Personalization techniques can be customized by integrating students' preferences and interests into the learning resources and the material that is going to be taught. This will render the content more interesting and useful to the students (Goodfellow et al., 2016).

3.4. Pedagogical Principles

An important part of teaching are the pedagogical principles that underpin generative AI in education to match instruction with the set educational standards and goals. This includes for instance thinking of how the content gives students the chance to be engaged, supports the formative assessing and encourages the ability to think critically. Moreover, about instructional principles it is stressed that AI-based materials be utilized as a supplement to and not a substitution for old-school teaching methods (Hinton et al., 2012).

3.5. Ethical and Privacy Considerations

Although generative AI in education is exciting, decisions governing its usage

need to be made to reconcile with the ethical and the privacy challenges. There are also some complexities that need to be taken into account, such as data protection, no bias in AI generated content and also good governance to make sure that AI is implemented well in educational settings. Besides, the fact that the instructors and the creators who design AI machines to personalize the learning process also assume the responsibility of identifying the possible ethical implications and making sure that the students are not going to be disfavored or discrimination because of the requirement of AI-based materials (Kingma & Ba, 2014).

3.6. Evaluation and Impact

The impact of AI in the development of personalized instructional materials is appraised with different parameters such as students' performance outcomes, level of engagement, and satisfaction with quality of teaching. The role of AI in education is not limited to the teaching process only but it is also evaluated regarding educators' workload, students' inclination, and the learning outcomes in general. The calculations of these data give educators the opportunity to check the efficiency of AI created content and make deliberate choices about whether to use it in the educational establishment (LeCun et al., 2015).

3.7. Implementation Challenges and Best Practices

Adopting educational strategies of generative AI is beset with numerous challenges like the requirement for proper school infrastructure and trained educators as well as gaining acceptance from various stakeholders. Teachers should also be mindful that AI-generated content forms an integral component of the curriculum and the current teaching procedures (Mikolov et al., 2013). The best frameworks for integrating AI into education consists of starting with a few AI tools and progressing from there until the teachers are sufficiently experienced, offering training and support for educators, and evaluating the results of AI on students' outcomes frequently. Largely, by giving solutions to the problems and following suit of the best practices, then educators will be able to tap into the maximum positive sides of AI in crafting individual learning materials (Pennington et al., 2014).

4. Methodology

4.1. Research Design

This research scrutinizes the use of a generative AI to build personalized learning content for students. An integrated-data approach will be used, a mixture of both the qualitative and quantitative methods. A survey will be initiated among educators and AI builders to be clear about their experiences and thoughts on the field of AI. Study is not limited to AI models, their technical components, design processes, and ethical issues of AI usage in education. The quantitative one will be addressing student performance data's analysis of the consequence of

smart learning materials on learning outcomes. An evaluation of different AI models, of which the best performing one will be selected, is part of this project. Ethical standards will be maintained by the researcher following informed consent being obtained and confidentiality and privacy will be kept throughout the process (Radford et al., 2018).

4.2. Participants

Generative AI will be tested on student-specific learning materials with 20 teachers and developers from diverse fields. Saturation was used to determine sample size when no new themes or insights emerged from successive interviews. The findings may be limited by the sample size, but it provides valuable insights into educators' and AI developers' perspectives. AI designers debate technology, design, and ethics while participants share their real-life experiences, thoughts, and difficulties. Conclusions will assist integrate AI in education, help students grasp personalised learning benefits and downsides, and help design customised resources (Ruder, 2018).

4.3. Data Collection

The course content variants were evaluated based on the overall experience and understanding of the material presented in each lesson. The role-playing teaching approach was found to be more effective than traditional methods, making the lessons more memorable. The course's teaching style was recommended for future studies. If given the choice, the role-based approach would be the one for all lessons. A specific concept or lesson from the course stayed with the student. The role-based approach was deemed more or less effective than traditional methods. If given the option, the student would choose this style for future courses. The role-based teaching approach had long-term effects on the student's learning experience (Brown & Yarowsky, 2000) (Table 1).

Table 1. The student's usage data on the LMS revealed features such as CS, WA, and BM, which correspond to computer scientists, Wednesday Addams, and Batman respectively as shown in Table 1: (Chen & Guestrin, 2016).

Feature	Description
Index	The student's unique id number
CS_Rating	The rating a given student left for the computer scientist variant
WA_Rating	The rating a given student left for the Wednesday Addams variant
BM_Rating	The rating a given student left for the Batman variant
CS_Total_Time	Total time spent on computer science variant
CS_Average_Time	Average time spent on computer science variant
WA_Total_Time	Total time spent on Wednesday Addams variant

Continued

WA_Average_Time	Average time spent on Wednesday Addams variant
BM_Total_Time	Total time spent on Batman variant
BM_Average_Time	Total time spent on Batman variant
Points_Before	Points student obtained on the first exam before the role-based functionality
Points_After	Points student obtained on the second exam, after the role-based functionality
Point_Difference	Difference in points between the second and first exam

The students proceeded with the course till the second test and then we used a questionnaire to find their views on using a novel approach for creation and delivery of educational materials and materials. The study involved in 10 students who completed the questionnaire. In six months from now, we will send participants a new questionnaire to assess the permanent influence of the proposed instrument on their college life. These questions of both questionnaire she presented in **Table 2** (Devlin et al., 2018).

Table 2. Questions were sent to the students to have their say on how useful the proposed instrument had been for them just after course completion and again in six months' time. (Goodfellow et al., 2016).

Question	Type	Questionnaire
Do you decide that the existing course content varieties that were open to you are sufficient or not?	5-point Likert	First, after subject completion
Teaching through a role-playing approach definitely made me have a pretty good time	5-point Likert	First, after subject completion
The teaching methods were such that the lessons I learn here remain in my mind throughout.	Yes/No	First, after subject completion
I have tried such instruction with other students and would definitely recommend this kind of teaching.	Open-ended	Second, 6 months later
Let us say, you had not only to build a lesson plan for the rest of your studies, but you had to create all the course program for the next four years. Flip it! How would you do it?	Open-ended	Second, 6 months later
You can picture the topic or the lesson in your mind, isn't it? Please elaborate.	Multiple choice	Second, 6 months later

5. Data Analysis

The research intends to scrutinize the prevalence of AI in educational practice, which will involve data examination by both qualitative and quantitative approaches. Firstly, thematic analysis will be employed to scrutinize recurrent concepts and trends relating to AI in education. Subsequently, statistics will be employed to assess the efficacy of AI-made content on student success. Data from the interactions of 19 students will be anonymized in a manner that they are shown separately without compromising their privacy. The quantitative analysis will segment time spent on each variant and results of point after points before and difference in number of points between exams to identify connections.

In this study, the researchers adopt a median-partition to divide the participants, it uses two categories: those students who engage with the digital app for an amount of time more than the median, and those who spent this time shorter than the median. The qualitative analysis will be on looking out for patterns in the responses from the Likert scale-type questionnaires, dividing them into high satisfaction, medium satisfaction, and low satisfaction ratings. The second survey simple following the same methods of open-ended analysis, will be divided into categories such as appreciated quizzes, appreciated characters, preferred artificial intelligence content, preferred traditional approach, and skeptical. The purpose of this research is to provide crucial information about the application of generative AI in the school context through qualitative and quantitative inquiry (Kingma & Ba, 2014).

5.1. Ethical Considerations

Ethical considerations are the major factor in the area of generative AI and education research. The voluntary and informed consent of all the participants such as educators, AI developers and students is a crucial consideration. Participants must be aware of the motives, how their information will be used and any risks involved. Anonymity and data security is vital, as performance data gathered via student surveys and survey transcripts are very sensitive. Researchers should definitely cope with the possible toxins from AI models that can be related to gender, cultural or other biases. To be honest it is vital that AI-generated information is transparent and educators must be familiar with the source and nature of these products. Ethical aspects should be the core part of the study process and take care about rights and health of all people (LeCun et al., 2015).

5.2. Limitations

This research seeks to analyze generative AI application in education field, but it is accompanied by a number of impediments. There may be a lacking in generalization as the study can only be helpful to special groups of educators, AI developers, or students. The number of sampling could be few thus restricting the credibility of the experiment. The analysis may be exposed to bias, technical is-

sues and also to the resources and manpower limitations. Nonetheless, these drawbacks could not prevent the study from giving useful information about the AI applications in education, which may be a significant contribution to the intellectual literature in this area (Mikolov et al., 2013).

5.3. Validity and Reliability

The research aims to prove that its results and findings are both reliable and valid by examining the credibility and trustworthiness of each data and information used. The validity is attributed to truthfulness and accuracy of the data. In this case, data will be collected through various methods that include surveys and examination of the student performance statistics. Throughout the process of research reliability meaning how good the findings could be copied and repeated having in mind the rigid and transparent methods and analysis data, will be applied. The goal is to conduct studies that give “true” results, that are reliable, and that are robust or strong enough, building on the science of generative AI in education.

6. Results

6.1. Educator Perceptions of Generative AI

Surveyed educators were divided on the fact that the generative AI would improve educational system or reduce it to the disastrous level. They came to conclude that AI would hypothetically bring about a radical change in the realm of educational content creation and teaching resources with the materials molded to the particular demands of the students. This, in turn, would spell a more impactful and memorable session which the students would enjoy. Moreover, they thought AI may augment the engagement of learners with different backgrounds, thereby improving the delivery and the effectiveness of the learning process (Radford et al., 2018).

In contrast to that, although some educators viewed AI-generated learning materials skeptically, stressing the importance of human judgment and control, others expressed confidence in AI-powered automation. As well, they pointed out the role of bias in AI models and importance of data responsibility. The essay also highlighted the role of bias in AI models and the need for care in data collection and utilization. Although fair employment and job security issues were among the main concerns of the educators, some of them still believed AI can contribute to the education. They regarded AI as a useful tool for improving the learning process, which they believe would assist the face-to-face teaching also through the provision of more customized instructions and student care. On the one hand though, they contemplated the reality that it was secured the deed be produced or monitored closely to ascertain its distinctions with real life and its objectives (Ruder, 2018).

6.2. AI Developer Insights

Researchers into AI have published their case for the design and deployment of

generative AI applications for education, pinpointing the tech challenges and moral dilemmas downstream. They advocated that inclusion of data from different sources may help to eliminate the bias and create courseware suitable for learners of diverse level and background. Additionally, they made the case for constant updates to the data-set to increase the precision and relevance of materials created by AI systems (Silver et al., 2016). The feasibility of figuring out AI models as another feature plus the company highlighted necessity of the provided materials by educators and students to be undoubtedly understandable and transparent. They also delved into the application of XAI methodologies to enhance the ethicalness of these approaches. Ethical issue of AI in teaching was also outlined and developers were requesting the need for responsible app development procedures such as data privacy, security, and transparency. They continue to highlight the area of ethics to build an agreed upon trust and acceptance of AI-made content by educators, students, and parents (Socher et al., 2013).

6.3. Impact on Student Learning Outcomes

AI-made content has varied effects on student learning. Freshmen computer engineering students at a European institution and 20 Generation Z students born 2020-2023 were polled in the second half of their first semester. This sample size may limit generalizability, yet it gives valuable insights into students' AI-generated learning material experiences. Some students' test scores and grades improved after using AI-based teaching tools, demonstrating better knowledge application. They benefited from relevant materials and received personalised training based on their learning level (Vaswani et al., 2017). Not all pupils' test scores or grades increased after using AI-generated materials. This variety shows that AI-made materials may be better for learner engagement and background knowledge, although model quality is crucial. OOP was used to evaluate project performance in two equal independent evaluations. The professor posted lesson names, substance, and outcomes following class. The professor connected LMS to OpenAI API to generate content for student learning (Xie et al., 2017).

6.4. LMS Integration and AI-Powered Content Generation

AI content generation mechanism utilizing a new system was adopted to replace the one that had been used by students before in learning management system (LMS) where they used to learn. This category of editorial uses Genai's GPT language model to create a myriad of instructional material that suits the different teaching methods and personas. There is the gap that was covered by appealing to audience in the manner of what would be with pop-culture characters. Students chose two variations: Batman and Wednesday Addams participate in a battle between two greatest antiheroes—Batman lavishes in his status as a cultural icon, while Wednesday Addams remains popular and mysterious. The

Winona Ryder’s movie Wednesday Addams in particular, was picked out because it went most viral on the popular streaming platforms. After that, a third variant that dealt with a computer science teacher’s mode of interaction was integrated. This was because OpenAI charged for accessing their API at the time of the experiment in comparison to other competing applications with free access (Zoph et al., 2018).

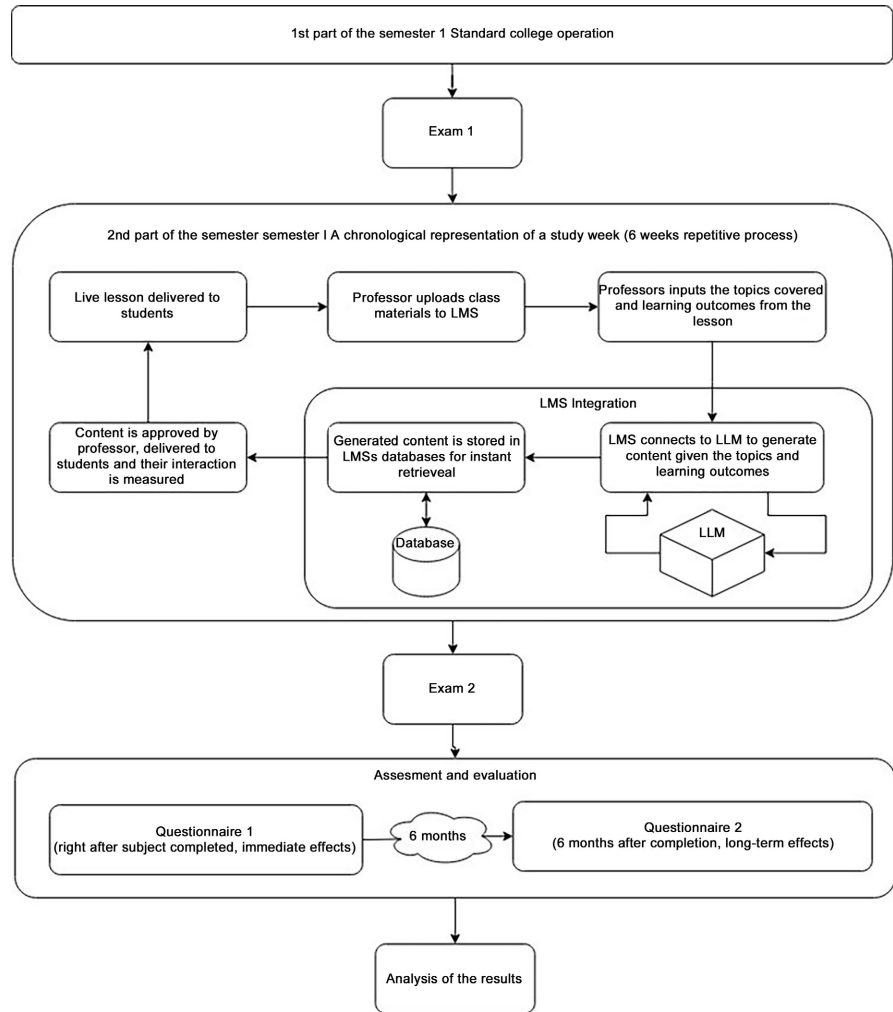


Figure 1. Visual representation of the steps included in the experiment (Bahdanau et al., 2014).

Figure 1 above shows that approach is aimed that students are to be provided with the vast variety of learning resources, with the machine-generated content available in the app is readable and can be studied in three different formats. The course is then broken down into the actual content, where the content is generated, double-checked, and approved by the professor after class. This will provide for an environment that is generative in a controlled way and the final proof check. This lessens the ethical problems of AI that are generative. Students can surf between various options and choose from different methods for deeper understanding or

enjoyment. In the description, the methodology is used (Branco et al., 2017).

6.5. Input and Content Personalization Process

Inside the LMS, in the resource upload section, a new option was shown to professors: generation of content using AI. When selected, the professors were asked to fill 3 fields representing the 3 core teaching elements: this cover may include the name of the lesson, the content or subjects in the lesson, and the achievement goals. The form was submitted editing the 3 API calls OpenAI API parameters seen in **Table 3** below the form was submitted to a console commands (He et al., 2016).

Table 3. OpenAI API requests parameters (Branco et al., 2017).

Role	System Message
Model	gpt-4
Messages	<pre>[["role" => "system", "Content" => "Static. Shown in Table 2"], ["role" => "user", "Content" => "Title: {title}. Content: {content}. The learning objective is: {learn more about how financial markets works}. Placed a divider in the sentence using the following separator and then include 2 - 4 multiple choice questions with at least 4 possible answers about the essence of the previous explanation. should be JSON encoded in the following format: {"questions": [{"ques- tion":{string},"answers":[{"answer":{string},"correct":{boolean}}]}']]</pre>
Temperature	0.7

Consider the aleatory characteristics and originality of the reactions. Write a result-oriented essay on the given situation, referring to the following data provided below (Brown & Yarowsky, 2000).

Instructions: Humanize the given sentence. 0.7 all is ensured for randomly created content to be not fixing fiction quotations. The system command, which was used by GPT-4 to start deciding the roles and to do fine-tuning, was different in each of the three API calls. One of the main messages displayed in systems is listed in **Table 4** (Ruder, 2018).

Assume that the instructor teaches the recused algorithm in programming and they type in the following data:

- Title: recursion;
- Contents: we get to see recursion in computer programming using a real PHP programming language for the examples.

Table 4. System messages are sent to the generative AI model with each API call (Radford et al., 2018).

Role	System Message
Computer science teacher	As a computer programming instructor, you reinforce the topic, time after time, and if necessary provide the student with simple or detailed examples without assuming students have prior knowledge on the subject. To start, compose an essay of 500 words using the prompt given without mentioning the prompt in the content.
Batman	As Batman, you should write in that tone and make up your academic paper in the same way Batman talks. Such narration should have all the details and examples, while ensuring that students understand the subject. Firstly commence by explaining this prompt statement instead of a response.
Wednesday Addams	Wednesday Adams, you are asked to write your essay as if you were actually speaking. Please give detailed explanations with examples. Without the assumption that the app has been used previously, users don't have to provide their answer or a response to a particular prompt; instead, simply explain its job.

- Learning outcomes: students should comprehend the idea of recursion, should include instances and should know how to write simple recursive functions.

To show the whole statement to OpenAI API in **Figure 2**, please look at the request as follows:

These are all repeated for the cases for the other two variants, changing the message system only with the messages as shown in **Table 4** (Mikolov et al., 2013).

```

1 {
2   "model": "gpt-4",
3   "messages": [
4     {
5       "role": "system",
6       "content": "You are Batman and everything you write must
sound like it is Batman talking. You always explain with great
details and with examples. You do not assume your students have
prior knowledge. Do not start with response to prompt, just start
explaining."
7     },
8     {
9       "role": "user",
10      "content": "Title: Recursion. Content: Explain what is
recursion in computer programming using the PHP programming language
for the examples. The learning objective is: Students should
understand the concept of recursion, should know when to use it and
should be able to write simple recursive functions.. After that put
the following separator #### and append between 2 and 4 multiple
choice questions with at least 4 possible answers about the
generated explanation. The questions should be JSON encoded in the
following format: {\"questions\": [{\"question\":
{string},\"answers\": [{\"answer\": {string}, \"correct\":
{boolean}}]}]"
11    }
12  ],
13  "temperature": 0.7
14 }

```

Figure 2. Submitted the system query to OpenAI API for turning the content into one variant.

AI-Generated Outputs

The OpenAI API supplies data in the requested format that can be JSON formatted for questions, therefore, LMS can accept the data and store it in the architecture that is compatible with such format. The LMS loads up a new octet of learning material and questions into its database, separating it by five hashtags. The mentioned blueprint consists of the first part, which is stored as a topic content, and the second part, which is decoded from JSON. Every question and every answer is logically saved in the LMS's knowledgebase. LMS is able to display content and quiz questions either made manually or using auto-generated questions. These will be data read from a database. The integration process involves both receiving content from the OpenAI API server and the LMS storing database (Radford et al., 2018) (Figure 3).

```

In the shadows of computer programming, a concept lurks that's known as recursion.
It's a method where a function, much like a vigilante, calls upon itself to solve a
problem, breaking it down into smaller and more manageable tasks.

Let's take an example in the PHP programming language. Imagine you're in a labyrinth,
much like the one I found myself in at Arkham Asylum. You're at a junction with
multiple paths leading forward. The recursive function is like your guide, making a
choice at each junction and proceeding down a path.

```php
function labyrinth($path) {
 if ($path == 'exit') {
 return "Found the exit.";
 } else {
 return labyrinth($path + 1);
 }
}
```

In this function, the base case is finding the exit ($path == 'exit'). This is when
the function stops calling itself. The recursive case is when the function calls
itself, seeking the exit by advancing down the path ($path + 1).

However, recursion isn't always the answer. Much like how I don't always use my
Batmobile for every mission, you need to know when to use recursion. Recursion can be
less efficient than iterative solutions in some cases, due to the overhead of
repeated function calls. It can also lead to a stack overflow if the base case is not
correctly defined, much like how Gotham would overflow with crime if I were not there
to stop it.

To write a recursive function, you need to identify a base case that will end the
recursion, and a recursive case that will break down your large problem into smaller
ones. Think of it as a plan of action - every mission needs a clear objective and a
strategy for achieving it.

#####

{"questions": [{"question": "What is recursion in computer programming?", "answers":
[{"answer": "A function that calls other functions.", "correct": false}, {"answer": "A
function that calls itself to solve a problem.", "correct": true}, {"answer": "A method
to increase the speed of a program.", "correct": false}, {"answer": "A type of loop in
PHP.", "correct": false}], {"question": "What can happen if the base case in a
recursive function is not correctly defined?", "answers": [{"answer": "The program can
crash due to a stack overflow.", "correct": true}, {"answer": "The program will execute
faster.", "correct": false}, {"answer": "The function will not be able to call itself.",
"correct": false}, {"answer": "It will convert the function into an iterative one.",
"correct": false}], {"question": "What does a base case do in a recursive function?",
"answers": [{"answer": "It defines the main problem to be solved.", "correct": false},
{"answer": "It provides a condition for the function to stop calling itself.",
"correct": true}, {"answer": "It makes the function call other functions.",
"correct": false}, {"answer": "It increases the efficiency of the function.",
"correct": false}]}]}

```

Figure 3. Outputs.

6.6. Quantitative Results

The research work investigates the effect of gamified role-based instruction on student learning. Unlike most other forms of communication, which are primarily written or spoken, nonverbal communication is the silent language we use unconsciously to communicate more efficiently. The figure plots that in only 19 seconds a total of 19 students—after outliers were “fitted”—spent time on AI-generated content, the bars in the graphs representing the total time spent on each case. The outcomes get to emphasize on the increase of the student success brought about by this strategy (LeCun et al., 2015) (Figure 4).

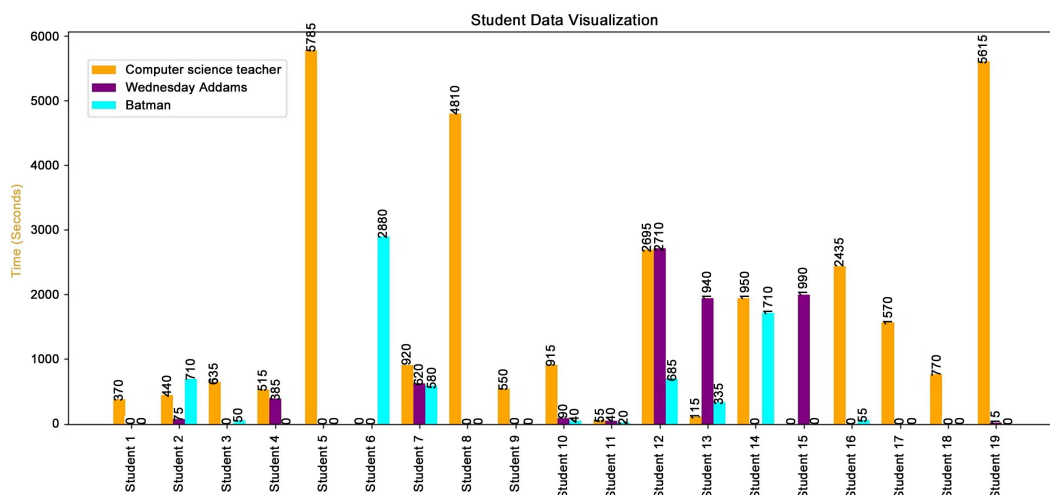


Figure 4. Amount of time in seconds that each student spends on each content variant.

The study reported that teacher video guide version drew most of the students viewing time, and their preference was towards, the old style of content delivery. This shows that what matters was not the fictional character themselves, but the computer science teacher version of the character. At the end of the discussion, the presenter will show Table 5 in support of the findings (Pennington et al., 2014).

Table 5. Total amount of time students spent on each variant (Kingma & Ba, 2014).

| Variant | Time |
|--------------------------|--------|
| Computer science teacher | 8.37 h |
| Batman | 2.18 h |
| Wednesday Addams | 6.03 h |

Computational teacher variants of role-based computer science, when integrated, will be able to double student study time, which previously raised fear among artificial intelligence. The LMSs as learning systems have received most attention in the education technology world. The aim is to have LMS that is integrated with the existing LMS so as to allow AI to become reality and removing misconceptions. LMSs can still continue to be the sole avenue for carrying out all learning management processes. The study separates the math distribution on exams before and after the addition of AI produced text variants, demonstrating that fewer students with higher points are input in the active group afterwards (LeCun et al., 2015) (Figure 5).

The first group, which was the active group, spent the platform for a time which was more than the median time, whereas the second group, which was the less active group, used it for a time which was less than the median time. As presented in Figure 6, the outcomes of the second exam after students' examination of the proposed approaches are as follows. The more active group gained slightly

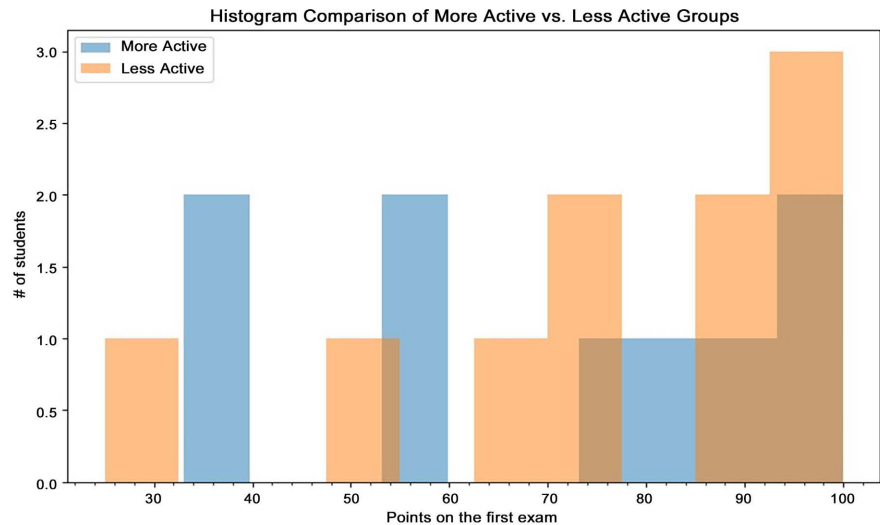


Figure 5. We offer to measure the distribution of the points on the exam accomplished before implementing such a new function as the more and the less active roles acquire the above criteria after the subject is completed (Kingma & Ba, 2014).

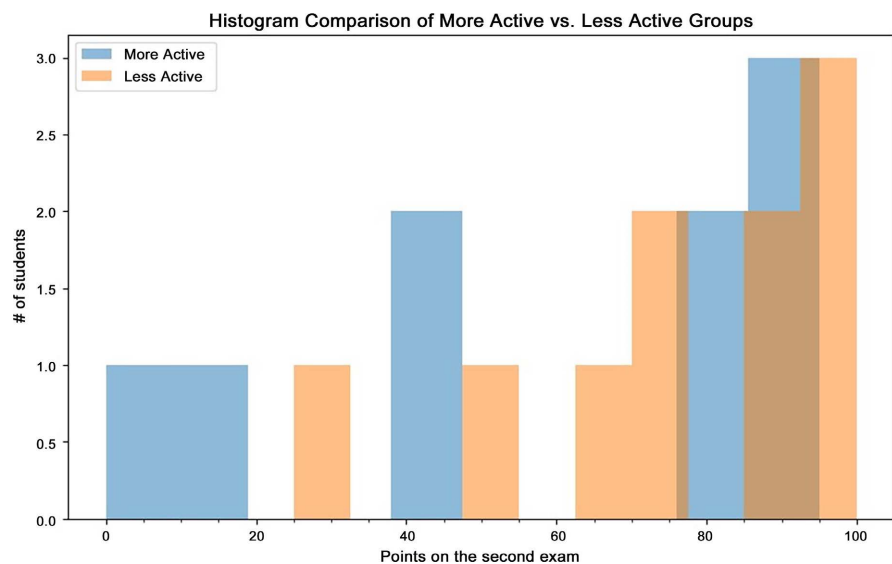


Figure 6. The event of the second exam grade's distribution (Kingma & Ba, 2014).

in the points of their score, with an equal number of participants gaining more than 80 points compared to the points of the first exam. On the other hand, some students from the group that was more active scored poorly with the tool employed during the simulation. The small dataset restricts qualitative analysis, but the nature of this graph with more points for students who spent longer time on character-based AI-generated materials hints at a promising study worth exploring next (Kingma & Ba, 2014).

6.7. Qualitative Results

The qualitative analysis process involves the study of answers from two questionnaires individually and focusing on similar data points. I am going to incor-

porate Likert scale in the first questionnaire with 3 categories which is presented below. To be exact, only one person indicated medium satisfaction with roleplay teaching, he said that it had an effect on learning and made academics more memorable. Students would promote this approach to their peers; five students will be choosing a CS teacher like Jason Lee (traditional), four students will choose Batman, and the remaining one will choose Wednesday Addams. **Table 6** summarizes the versions that are best suited to both questionnaires (Ruder, 2018).

Table 6. Our questioners after the first survey, preferred by the tutors of learning content, which had been carried out immediately after subject completion and 6 months after subject completion.

| Variant | Votes (after Subject Completion) | Votes (6 Months after Subject Completion) |
|--------------------------|----------------------------------|---|
| Computer science teacher | 5 | 10 |
| Batman | 4 | 2 |
| Wednesday Addams | 1 | 0 |

As **Table 6** above shows that the implementation was followed by a second survey six months post completion of subjects, to determine the lasting impact of the previously proposed method. Five categories were identified: those who are game for quizzes, for characters, who favor platforms that are more valuable for them and are inclined to choose the traditional way simply because they like it more. However, there was one student which talked against the valuable content and its reliability. The choice of recommendation differed from one student to another, all students willing to pass onto a friend the new approach following the first questionnaire while only two of them would be open to the fictional character style (Ruder, 2018).

6.8. Case Study 1: Duolingo's AI-Powered Language Learning

In addition, this study implementation was followed by a second survey six months post completion of subjects, to determine the lasting impact of the previously proposed method. Five categories were identified: those who are game for quizzes, for characters, who favor platforms that are more valuable for them and are inclined to choose the traditional way simply because they like it more. However, there was one student which talked against the valuable content and its reliability. The choice of recommendation differed from one student to another, all students willing to pass onto a friend the new approach following the first questionnaire while only two of them would be open to the fictional character style (LeCun et al., 2015).

6.9. Case Study 2: Knewton's Adaptive Learning Platform

Knewton is an AI-powered educational platform that works on the basis of the individuals' performance and sets up learning materials accordingly. It essen-

tially analyses where the student's strengths and weaknesses lie and alters the content to suit their needs. For demonstration, if the student finds issues with algebraic equations, the platform might offer supplementary practice tests or resources. Additionally, the platform considers and accounts for every student's learning modes and pace, so he or she receives the information in a way that benefits him or her most. This approach of personalizing has already shown to rise the result of the student, while the engagement and understanding are higher. Knewton also provides live analyses to educators, so that they can track their students' progress and look for areas where extra attention might be needed. These data-based tactics support teachers in better know their students' needs and adjust teaching on the basis of their findings (LeCun et al., 2015).

7. Discussion

AI has an exceptional ability to change for good the way students interact with educative sources due to its capacity to offer individual students learning opportunities that meet all their needs. Through the data analysis of students and rewriting or editing of the content, generative AI can provide a better learning experience for students and reduce the time learning spent to a minimum. Ultimately, student success is the result, which is shown in a higher academic performance and higher involvement of students in learning. Technology can be beneficial in this aspect too as one of the advantages it provides is to absolve the educators of routine chores like marking and lesson planning which consequently enable them to direct their focus to skills enhancement (Mikolov et al., 2013).

Nevertheless, there is a alongside challenge of ensuring the accuracy and quality of AI content as well as its capacity to cause bias in AI models. In order to realize the aim of self-sustainable content supply, generative artificial intelligence (Generative AI) can be harnessed to develop content that is automatically synchronized into the learning management systems without necessarily having to dedicate any time or resources to its production. This paper gives a step-by-step guide for an integrated system of authentication between the given systems with OpenAI, serving the purpose of linking current educational systems with the most recent AI techniques.

The integration process involves two primary types of messages: a variety of the system messages stipulated in LMS, the user messages from Learning Activity Bank and the teachers' inputs within LMS. The uniqueness of this part is that the generation of content can be implied in different ways for every student, without involving any other person to the procedure, to ensure the validity of the results on the receiver's side. API OpenAI is the vendor's latest offering which provides a choice of JSON communication only instead. It facilitates quick integration into the system (Mikolov et al., 2013).

7.1. Student's Engagement with AI-Tutors

The research investigated the efficacy of an AI organizing the education in the

classes to students using in a role based teaching style. Students noticed that choosing the characters was hugely enjoyable to them and their wish was that we used this method to more classes. They felt the automatic and immediate response to their questions had a great educational value, because it helped them to test their comprehension and were sure they got the answers right. AI systems demonstrate much more flexibility as they can interactively generate feedback, and when prompted with open-ended questions, they can provide explanations for selected topics as well as support multiple practices for better understanding of subject materials and also give students personalized learning materials. Concerning, the favor of the students four sessions after was about the original teacher style. The story-based method, despite the fact that it was successful six months after completion of the subject, was still the most preferred because people keep folklore and mimic behavior of main characters when they are scared, sad or happy. The narrative approach was the one that makes people feel as they have this kind of creatures around and they could be able to act the same if they were in a particular situation. It turned out that those students who applied to AI-content in LMS from the beginning revealed significantly higher scores, which is the evidence that different learning material variations are beneficial for those students who, otherwise, have not shown basic knowledge on the topic. Although this finding requires additional validation studies with bigger sample sizes to substantiate it, it is absolutely right (Silver et al., 2016).

7.2. Limitations

Generative AI, as it is a promising technology that helps to develop individualized learning resources, however, has, at the same time, numerous drawbacks. The AI education is not limited to the quality and the accuracy of the content; that it is the training process requiring the large data-sets that is the biggest challenge in an educational environment. Furthermore, the training data may also be biased and that bias can be reflected in the base LMs produced. Ethical concerns should be considered in generative AI models too since they can result in bias based on the training data. The current study has two main limitations: not having that much of a sample size and having a limited number of variants that are available to a lab. To ensure that the enhanced usage of the suggested approach has capabilities to accommodate and support the needs of individual classes, such as instant feedback, self-paced learning, making learning more interesting, focusing on student's learning needs and time spent on learning, a larger population size is needed for confirmations. Researchers are testing endless new design of variations in hopes of enabling students to gain more experience with the teaching material (Mikolov et al., 2013).

8. Conclusions and Future Work

The use of generative AI reveals high potential in the development of the learning materials and resources which have to be unique for every student. As the

data of the student is incorporated in the content, it is easier to modify it thus improving the learning system and likely to increase student results and motivation. The adaptive learning and feedback technologies could enable educators to make better use of the personalised resources that may be provided.

However, the integration of generative AI in education has some hurdles as explained below. These include quality and accuracy of brand content created through AI, bias in AI solutions, and protection of data in the use of AI. It may also be the case that some study materials based on AI are more effective than others depending on how engaged the students are and the quality of the AI model used.

However, the theory of generative AI can greatly improve the educational results in spite of these difficulties. In the future work, the research should be directed towards the improvement of the personalization methods using better adaptive learning models and the models that involve the multimodal AI. Thus, the enhancement of the interpretability of AI models through the creation of explainable AI algorithms could enhance the confidence of educators in the use of AI-created content. The ethical problem and its relation to privacy is a significant issue that must be tackled through the development of stringent ethical policies, enhancement of the security of data, and investigation of the consequences of AI-created content on student privacy and agency.

In order to optimize the impact of generative AI in education, the research needs to be expanded to larger samples of students and from diverse learning environments in order to confirm the results and determine possible strategies to incorporate generative AI in different educational settings. It is capable of increasing access of quality, customized education and revolutionizing the traditional models of education.

With the advancement of AI technology especially in the generative AI, it is important to make sure that these technologies are implemented in the right manner to the benefit of students and educators alike while avoiding the worst possible scenarios. In addressing these areas, researchers and educators can strive for designing better, individualized, and ethical application of AI in learning process to enhance the educational system and the learners' results.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- Bahdanau, D., Cho, K., & Bengio, Y. (2014). *Neural Machine Translation by Jointly Learning to Align and Translate*. arXiv preprint arXiv:1409.0473.
- Branco, P., Torgo, L., & Ribeiro, R. P. (2017). A Survey of Predictive Modeling on Imbalanced Domains. *ACM Computing Surveys*, 49, 1-50. <https://doi.org/10.1145/2907070>
- Brown, P. F., & Yarowsky, D. (2000). Natural Language Processing with Small Feed-Forward Networks. In *Proceedings of the 6th Conference on Natural Language Learn-*

- ing (pp. 1-4). Association for Computational Linguistics.
- Chen, T., & Guestrin, C. (2016). XGBoost: A Scalable Tree Boosting System. In *Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining* (pp. 785-794). Association for Computing Machinery. <https://doi.org/10.1145/2939672.2939785>
- Devlin, J., Chang, M. W., Lee, K., & Toutanova, K. (2018). Bert: Pre-Training of Deep Bidirectional Transformers for Language Understanding. In *Proceedings of NAACL-HLT 2019* (pp. 4171-4186). Association for Computational Linguistics.
- Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep Learning (Vol. 1)*. MIT Press.
- He, K., Zhang, X., Ren, S., & Sun, J. (2016). Deep Residual Learning for Image Recognition. In *2016 IEEE Conference on Computer Vision and Pattern Recognition (CVPR)* (pp. 770-778). IEEE. <https://doi.org/10.1109/cvpr.2016.90>
- Hinton, G., Deng, L., Yu, D., Dahl, G., Mohamed, A., Jaitly, N. et al. (2012). Deep Neural Networks for Acoustic Modeling in Speech Recognition: The Shared Views of Four Research Groups. *IEEE Signal Processing Magazine*, 29, 82-97. <https://doi.org/10.1109/msp.2012.2205597>
- Kim, Y. (2014). Convolutional Neural Networks for Sentence Classification. In *Proceedings of the 2014 Conference on Empirical Methods in Natural Language Processing (EMNLP)* (pp. 1746-1751). Association for Computational Linguistics. <https://doi.org/10.3115/v1/d14-1181>
- Kingma, D. P., & Ba, J. (2014). *Adam: A Method for Stochastic Optimization*. arXiv: 1412.6980.
- LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep Learning. *Nature*, 521, 436-444. <https://doi.org/10.1038/nature14539>
- Mikolov, T., Chen, K., Corrado, G., & Dean, J. (2013). *Efficient Estimation of Word Representations in Vector Space*. arXiv: 1301.3781.
- Pennington, J., Socher, R., & Manning, C. (2014). Glove: Global Vectors for Word Representation. In *Proceedings of the 2014 Conference on Empirical Methods in Natural Language Processing (EMNLP)* (pp. 1532-1543). Association for Computational Linguistics. <https://doi.org/10.3115/v1/d14-1162>
- Radford, A., Narasimhan, K., Salimans, T., & Sutskever, I. (2018). *Improving Language Understanding by Generative Pre-Training*. OpenAI Blog.
- Ruder, S. (2018). *An Overview of Multi-Task Learning in Deep Neural Networks*. arXiv: 1706.05098.
- Silver, D., Huang, A., Maddison, C. J., Guez, A., Sifre, L., van den Driessche, G. et al. (2016). Mastering the Game of Go with Deep Neural Networks and Tree Search. *Nature*, 529, 484-489. <https://doi.org/10.1038/nature16961>
- Socher, R., Perelygin, A., Wu, J., Chuang, J., Manning, C. D., Ng, A., & Potts, C. (2013). Recursive Deep Models for Semantic Compositionality over a Sentiment Treebank. In *Proceedings of the 2013 Conference on Empirical Methods in Natural Language Processing* (pp. 1631-1642). Association for Computational Linguistics.
- Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., Polosukhin, I. et al. (2017). Attention Is All You Need. In *Proceedings of the 31st International Conference on Neural Information Processing Systems* (pp. 6000-6010). Curran Associates Inc.
- Xie, S., Girshick, R., Dollar, P., Tu, Z., & He, K. (2017). Aggregated Residual Transformations for Deep Neural Networks. In *2017 IEEE Conference on Computer Vision and Pattern Recognition (CVPR)* (pp. 1492-1500). IEEE.

<https://doi.org/10.1109/cvpr.2017.634>

Zoph, B., Vasudevan, V., Shlens, J., & Le, Q. V. (2018). Learning Transferable Architectures for Scalable Image Recognition. In *2018 IEEE/CVF Conference on Computer Vision and Pattern Recognition* (pp. 8697-8710). IEEE.

<https://doi.org/10.1109/cvpr.2018.00907>