Approaching the ASSURE Model and Proposing a Teaching Process for Mathematics Using AI Chatbots Combined with Gamification in a Self-Regulated Learning Framework

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ABSTRACT: The ASSURE model is a method for designing and implementing lessons developed to optimize the teaching and learning process, particularly in integrating educational technologies. This model assists teachers in creating highly flexible lessons, enabling students to acquire knowledge more effectively through the use of technology and modern teaching methods. AI Chatbots facilitate the automation of responses and support personalized learning for students, while gamification provides an engaging learning environment that helps students develop critical thinking and problem-solving skills in mathematics through the incorporation of game elements. Research findings indicate that the combination of AI Chatbots and gamification in teaching can enhance students' learning of mathematics, while also increasing engagement and motivation. This paper approaches the ASSURE model and proposes a teaching process utilizing AI Chatbots combined with gamification in a self-regulated learning framework, aiming to guide teachers in organizing mathematics instruction in a scientific and effective manner.

KEYWORDS: ASSURE model, artificial intelligence, AI Chatbot, Gamification, Self-regulated learning, Teaching maths in primary school

1. INTRODUCTION

The ASSURE model, created by Heinich and colleagues, is a systematic design process tailored for teachers to use in traditional classrooms, aimed at designing and developing the most suitable learning environment for students. It is the most convenient model for integrating theories of educational technology and research into practice. This instructional design framework assists teachers in analyzing learners' needs, setting objectives, selecting appropriate methods and materials, evaluating performance, and making revisions. The model emphasizes the use of media and technology in designing educational activities and enhancing the learning process.

AI Chatbot is an automated software tool that simulates conversational interactions between users and computers, utilizing natural language. When the AI Chatbot technology is activated, end users can 'converse' with a pre-programmed chatbot rather than with a human individual. AI Chatbots facilitate personalized learning for students, allowing learners to develop knowledge, skills, and foundational abilities at their own pace. In the context of personalized learning, learners set their own goals, plan, monitor, assess, and choose appropriate learning strategies, which is a fundamental principle of self-regulated learning. Furthermore, gamification elements such as badges, levels, leaderboards, challenges, and rewards significantly influence motivation and engagement, thereby enhancing learning participation, persistence, and outcomes, while fostering students' motivation and involvement. Designing instruction according to the ASSURE model is reasonable and convenient for effectively utilizing AI Chatbots combined with gamification to support self-regulated learning among students.

2. RESEARCH RESULTS

2.1 An overview of the effectiveness of the combination of AI Chatbots and gamification in teaching on students' self-regulated learning.

Khlaisang and colleagues presented an innovative learning system in the form of gamified self-regulated learning (GSRL) designed to address the low completion rates and high dropout rates of learners in MOOCs. This system functions as a personal

assistant for students seeking to enhance their learning experience by utilizing an AI chatbot integrated with a smartwatch to set goals (iSet, iSchedule, iFollow), track learning progress, and receive automated notifications (tasks, levels, and badges). By using this system, teachers can establish schedules, levels, and badges according to the learners' progress or when learners complete assignments through the web application. Learners can choose to follow the teacher's schedule or adjust it in a way that is more convenient for themselves. Students can monitor their learning progress throughout the course. The levels and badges achieved by students are displayed in the AI Chatbot.

Some authors have developed a gamified conversational agent (CA) using natural language that can deeply support learning processes, provide assistance, motivate learners, and engage them in their learning activities. Preliminary results indicate that learners generally prefer the conversational agent for self-regulated learning, with many appreciating the gamified experience that enhances their motivation to learn. The human-like characteristics of CA technology, in particular, are not constrained by the strict boundaries of traditional learning and therefore have the potential to support self-regulated learning activities in digital education. In summary, learning through AI Chatbot technology can offer greater autonomy and support for learners who are less dependent on traditional learning activities, thus enabling them to adhere more effectively to self-regulated learning processes.

Learners often face difficulties in organizing their own learning processes, becoming distracted or procrastinating, making it challenging to maintain motivation and engagement. Consequently, the authors have presented gamified AI chatbots as a potential solution to this challenge. AI chatbots can provide a more engaging learning experience, while gamification can offer motivating incentives to sustain learner participation. This study employs an experimental approach to differentiate how the combination of badges and progress bars can support and encourage learners to maintain engagement in their learning activities. The authors detail the impact of gamified AI chatbots and provide guidance for educators on how to design gamified AI chatbots in education.

To better support self-regulated learning, conversational agents have become increasingly relevant. These agents can serve as tutors or study partners for learners. Although conversational agents have the potential to enhance self-regulated learning processes, challenges remain that require implications for making these interactions more engaging and supportive. This study discusses the value of gamified conversational learning AI chatbots that utilize game elements to engage learners, aiming to guide researchers and educators in designing conversational agents that can effectively motivate learners while also providing self-regulated learning opportunities. Therefore, we propose a systematically developed framework for gamifying educational conversational agents and contribute to the theory by integrating various theories of gamification, digital learning, and conversational agents, while also providing educators with implications on what to consider when gamifying conversational agents.

Zandvakili and colleagues developed SmartPal, a generative AI Chatbot integrated with gamification to enhance learning support. SmartPal leverages psychological game theories to provide personalized contextual recognition services. This allows it not only to deliver answers but also to offer proactive interactive prompts such as reminders and feedback. The integration of gamification enhances the interactive aspect, motivating learners to engage with the course content and technology in an appealing manner. Additionally, SmartPal provides instructors with valuable insights into learners' progress and engagement, facilitating early identification and intervention for learning obstacles.

2.2 The combination of AI chatbot and gamification in teaching

The use of generative AI chatbots, such as ChatGPT, can serve as a platform for learners to self-regulate under conditions where they are taught about appropriate usage contexts, such as when, where, and how they should use the AI chatbot system for learning. Furthermore, chatbots have the potential to impact academic performance or learning outcomes. Therefore, educators should integrate AI chatbots into the classroom and implement them appropriately to promote learning, rather than restricting learning to ensure students adhere to ethical behavior boundaries. Additionally, gamification elements facilitate learners' self-regulated learning by altering the learning environment, providing effective feedback, and training metacognitive skills. The primary benefit of gamification is that it offers immediate and effective feedback that stimulates learners' self-regulated learning capabilities.

AI Chatbots have become an increasingly popular alternative for online learning and mobile platform assessments. However, they do not provide sufficient motivation for students. On the other hand, gamification is a widely used technique to enhance students' learning motivation. Therefore, the integration of gamification with AI chatbot-based learning can yield benefits, including increased student motivation for learning.

Students can use AI chatbots to receive information about rankings, progress, and rewards that they and other students have earned. Additionally, supplementary information provided by the chatbot will help enhance motivation and competitiveness among students. However, even engaging and expressive chatbots for learning media may not be sufficient to keep students actively involved. Chatbots should focus more on delivering content that may not be available through interpersonal learning, such as reiterating specific course materials. On the other hand, repetition, which is often employed in gamification, can be beneficial to "encourage" students to revisit certain content in an engaging manner.

Typically, students face difficulties in organizing their own learning processes due to distractions or procrastination. Maintaining learners' motivation and engagement can be a significant challenge. Therefore, gamified chatbots present a potential solution. On one hand, chatbots can offer a more engaging learning experience. On the other hand, gamification can provide motivating incentives to sustain learners' participation and motivation.

2.3. ASSURE Model

ASSURE is an acronym made up of the uppercase letters of the steps in the model (Figure 1): A (Analyze learners), S (State standard and objectives), S (Select strategies, technology, media and materials), U (Utilize technology, media and materials), R (Require learner participation), E (Evaluate and revise).
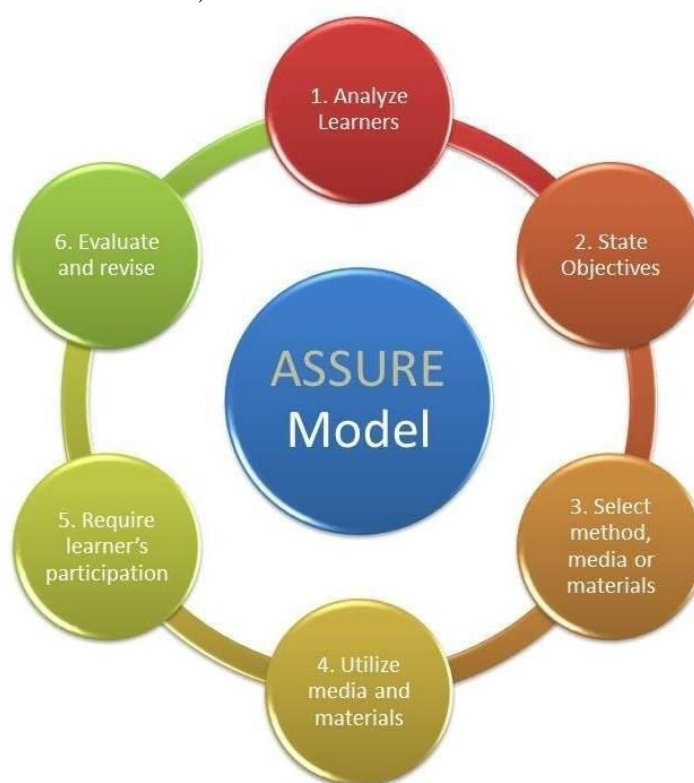

Figure 1: ASSURE Model

Step 1: Analyze learners

The first step in this process is to specifically identify who the learners are and analyze their characteristics. Understanding the target audience is crucial for selecting the best media to meet the established goals. The audience can be analyzed based on general characteristics such as educational level, age, gender, mental, emotional, physical issues, or socioeconomic status, among others. It is important to analyze specific input competencies to determine prior knowledge, skills, and attitudes regarding the topic. Additionally, it is necessary to analyze learners' learning styles through modalities such as visual, auditory, verbal, or logical approaches. Identifying the characteristics of the learners will guide educators in choosing specific strategies and resources to support the learning process.

In summary, learner analysis includes:

a. Analyzing the general characteristics of the learner population, such as age, educational ability, gender, interests, etc.

b. Analyzing foundational competencies.

c. Analyzing learning styles, such as auditory, visual,...

Step 2. State standard and objectives

The next step after analyzing learner characteristics is to specify the learning standards and objectives. Objectives represent the learning outcomes, indicating what students will gain from the lesson. These objective statements should be constructed using action verbs that clearly define the expected learning outcomes. Objectives typically include four basic components:

Behavior to be demonstrated: The specific actions or skills that learners are expected to exhibit.

Conditions under which the behavior will be observed: The context or circumstances in which the learners will perform the behavior.

Degree of proficiency: The level of mastery that students are expected to achieve with the learned skills.

Standards: Identifying the curriculum standards and technological standards that will guide the learning process.

Step 3. Select strategies, technology, media and materials

After identifying the target learners and having a clear understanding of the objectives regarding what students will acquire from the lesson, the next step is to select appropriate methods and strategies for the given learning task, choose available technology and instructional materials, and, if necessary, modify existing materials or design new ones to assist in completing this task. The teacher plays a supportive role in the learning process, helping learners discover answers to their own questions. Following this, the best technology, media, and supporting materials for the chosen teaching strategy should be selected.

In summary, at this stage, the following actions need to be taken:

a. Select strategies

b. Choose technology and instructional resources

c. Select, modify, or design materialsenvironment.

Step 4. Utilize technology, media and materials

In this step, it is essential to determine how to utilize the media, materials, and technology to implement the proposed methods and strategies. It is important to review the materials before using them. If electronic devices are to be used, it is necessary to practice using the equipment beforehand to ensure everything functions properly and that there are no technical issues. A backup plan must be prepared in case any problems arise with the devices. Another crucial aspect is that teachers need to practice the lesson (role-playing as a student) before implementation to anticipate and identify any out-of-scenario situations. Next, prepare the classroom, equipment, and necessary facilities. Additionally, learners must be prepared for the learning experience using technological devices; teachers should provide detailed guidance to students on the steps and methods for learning on electronic devices.

In summary, at this stage, teachers need to carry out the following tasks:

a. Review technology and instructional resources

b. Prepare technology and instructional resources

c. Prepare the learning environment

d. Prepare learners

e. Provide the learning experience

Step 5. Require learner participation

It is important to note that students learn best when they actively engage in the learning experience. Regardless of the teaching strategy employed, ensure that there are opportunities for questions and answers, discussions, group work, hands-on activities, and other methods that encourage students to actively participate in learning the content. For elementary students, who have shorter attention spans, it is crucial to keep the duration of activities manageable. Additionally, it is essential to observe and provide support to students as needed. Facilitate students in constructing their own knowledge rather than attempting to deliver information in a one-sided manner. Furthermore, feedback is also very important and should be provided before conducting any form of assessment.

a. Practice

b. Feedback

Step 6. Evaluate and revise

The final stage is the most important phase, yet it is often overlooked. After instruction, teachers need to evaluate the entire teaching process. Educators must reflect on the lesson, the established objectives, the implemented strategies, the instructional materials, and the assessments to determine whether these elements of the lesson were effective or if any changes are needed. If there is a discrepancy between what was intended and what actually occurred during the lesson, appropriate modifications should be made before reusing the lesson in the future.

a. Assessing the impact on student learning

Pre-assessment

Post-assessment

b. Evaluating and modifying strategies, technology, and instructional resources

Were the teaching strategies effective?

Can these strategies be improved?

Did the technology used and the instructional resources support students in achieving the learning objectives?

Did they facilitate meaningful engagement from the students?

2.4. Proposed Teaching Process for Mathematics Using AI Chatbots Combined with Gamification in a Self-Regulated Learning Framework

Step 1: Analyze learners

The first step to be taken is to specifically identify the target students regarding the following factors:

The target group consists of 5th-grade students aged 10-11, an important transitional age before children enter puberty and prepare for higher-level learning. At this age, students experience significant development in logical thinking, learning abilities, and social skills.

Students have foundational knowledge in numbers and operations, fractions, basic geometry, measurement, and some elements of statistics and probability after completing the 4th-grade mathematics curriculum.

Students possess certain mathematical competencies, such as mathematical thinking and reasoning skills; mathematical modeling abilities; problem-solving skills; mathematical communication skills; and the ability to use tools and resources for learning mathematics, although each student may be at different levels.

Learning styles: Each student has a different learning style, so the AI Chatbot can be configured to support various learning styles, such as visual, textual, or video-based learning.

Technology skills: Students have sufficient skills to use desktop computers and laptops to interact with the Chatbot, including typing in Vietnamese, using a mouse, and accessing websites.

Step 2. State standard and objectives

In this step, it is essential to clearly define the learning objectives that students need to achieve after the lesson. Based on the content and requirements of the 5th-grade mathematics curriculum, as well as the specific content of each lesson, specific objectives should be established for each lesson. Depending on the lesson, specific objectives may be identified regarding: specific competencies, general competencies, and the qualities to be attained.

Step 3. Select strategies, technology, media and materials

Choosing Appropriate Teaching Methods and Technology, Integrating Learning Media and Support Materials. In this context, students learn with an AI Chatbot combined with gamification integrated into a website.

Selecting the AI Chatbot

The author develops the AI Chatbot based on the ChatGPT platform. ChatGPT is an artificial intelligence model developed by OpenAI, designed to converse and interact with users through text. ChatGPT utilizes knowledge from various data sources such as books, articles, websites, and other information sources to provide information, answer questions, and assist in problem-solving. ChatGPT is recognized for its significant impact on learning objectives, learning activities, and assessment activities, as it can lead to changes in these areas.

The ChatGPT model employs Transformers, a specialized deep neural network architecture designed to process and generate text sequences. This model belongs to a category of large language models (LLMs) based on the Generative Pre-trained Transformer (GPT) architecture.

The main components of the ChatGPT model (GPT-4) include:

Transformer Architecture:

The Transformer is a neural network architecture characterized by the Self-Attention mechanism, which allows the model to process all words in a sentence simultaneously rather than sequentially, as done by previous models (like LSTM or GRU). Self-Attention enables the model to "attend" to words in a sentence flexibly, assessing the importance of each word in relation to others. This helps the model understand the meaning and relationships between words, even when they are far apart in the sentence.

GPT (Generative Pre-trained Transformer):

GPT is a specialized form of the Transformer, utilizing the Transformer architecture but with a unique training approach. GPT is trained in two phases:

Pre-training: The model is trained on a large amount of text data from the internet to learn how to predict the next word in a sentence. This process helps the model understand the grammar of sentences and the relationships between words.

Fine-tuning: After obtaining a pre-trained model, it is fine-tuned on specific datasets or with human intervention to improve its ability to answer questions, handle dialogues, or provide reasonable responses in various situations.

Attention Mechanism:

Transformer models use Multi-Head Attention to compute attention between different parts of the input sequence. This allows the model to understand the relationships between different segments of the sentence.

Position Encoding:

Position encoding is also used to simulate the positions of words in a sentence, as the Transformer does not utilize sequential structures like RNN or LSTM.

Tokenization and Embeddings:

The GPT model converts words and sentences into tokens (the basic units of text) and then transforms these tokens into numerical vectors through a process called embedding. These vectors are processed through the Transformer layers to understand their meanings.

Generative Modeling:

ChatGPT (GPT) is a generative model capable of producing new text based on the given input context. Upon receiving a question or command, the model predicts the next content based on the provided context.

Create Prompt for AI Chatbot

In the context of AI and machine learning, a prompt is a piece of text or input information provided to an AI model to activate and guide it in generating a response or performing a specific task. A prompt can include questions, commands, or any form of text that the user wishes to use to communicate with the AI.

The technique of prompt engineering is referred to as a method for guiding the behavior of large language models (LLMs) such as GPT-3. This technique involves designing specific prompts or instructions that the model will use to interact with users.

Choose a platform to build interactive exercises that use game elements

The author develops interactive exercises and quizzes using gamification elements on the Quizizz platform. Quizizz is a popular online learning platform that allows teachers to create and organize interactive exercises and quizzes incorporating game elements such as badges, progress bars, and feedback, aimed at helping students review and assess their knowledge. This platform not only supports learning activities but also makes learning more engaging and interactive, enabling students to absorb knowledge more easily.

Quizizz allows teachers to access a diverse question bank or create their own sets of questions tailored to assessment objectives. Students in the same class can participate in answering questions on Quizizz at the same time as determined by the teacher or complete the quiz at a convenient time before the deadline set by the teacher. Quizizz provides immediate feedback on results and rankings for participants, thereby generating excitement among students.

Step 4. Utilize technology, media and materials

Teachers will integrate the AI chatbot into the website, allowing students to access the site to interact and learn through the chatbot.

When students engage with the AI chatbot, it can provide lesson content, concise theories on topics such as arithmetic, geometry, measurement, probability, and statistics, suggest learning pathways, and offer immediate, personalized feedback based on the topic. Additionally, it can provide interactive exercises that incorporate gamification elements, making the learning activities more enjoyable and engaging, as well as offering guidance and problem-solving strategies. For example, if the AI chatbot detects that a student requires additional assistance in understanding a concept, it can provide further explanations or supporting materials.

Step 5. Require learner participation

For students to truly absorb knowledge, they need to actively engage in the learning process. Students will learn under the guidance of the chatbot, answering questions posed by the chatbot for each task until they grasp the lesson content in a personalized manner. They will complete exercises and solve problems presented by the chatbot and participate in games provided by it. Additionally, the chatbot will assess their results and provide feedback on correct or incorrect answers. Students can send questions to the chatbot if they encounter difficulties during their learning.

Teachers can monitor students' progress through the chatbot and intervene when necessary to explain or assist students. Encouraging students to ask questions to the chatbot when they face challenges is important. Furthermore, teachers can organize live group discussions after class for students to share problem-solving strategies or approaches with each other.

During the time students engage in learning with the chatbot, teachers can assess their learning process through the chatbot by asking questions and providing feedback to promptly identify any difficulties or obstacles students encounter in their learning, such as solving exercises or addressing real-life situations, allowing for immediate support. Additionally, this approach encourages and enhances students' motivation to learn.

Step 6. Evaluate and revise

After completing the lesson, teachers need to evaluate the effectiveness of the learning process, the learning outcomes, and make adjustments if necessary. Teachers should measure students' understanding of mathematics through questions, quizzes, interactive exercises, feedback, or the participation process. The chatbot can track students' learning effectiveness through their responses and the completion rates of assignments. Based on the results, the chatbot can recommend appropriate exercises for students to reinforce their knowledge. Therefore, teachers can also assess learning outcomes through the chatbot.

After completing several lessons, teachers may organize a group discussion or assessment to evaluate students' understanding of the material. Based on feedback from students and data collected from the chatbot, as well as assessment results, teachers can adjust the lesson content, teaching methods, or improve the chatbot to better tailor future lessons, modify exercises, or change the chatbot's explanations to meet students' needs, or enhance the chatbot's interaction capabilities with students. If teachers notice that students are struggling with a particular topic or type of exercise, they can provide additional supporting materials or offer direct explanations during online classes.

3. CONCLUSION

Through a review of the literature on the use of AI chatbots combined with gamification in learning, it is evident that this approach facilitates personalized learning for students, enhances motivation and engagement, and particularly supports self-regulated learning. Recognizing the effectiveness of using AI chatbots integrated with gamification, this paper adopts the ASSURE model and proposes a teaching process to guide educators in effectively utilizing this technology in their instruction. This process is not only applicable to teaching mathematics but can also be adapted for use in other subjects across various educational levels and different learning environments, with appropriate adjustments made as necessary.

REFERENCES

1. Adedapo, A., & Opoola, B. T. (2021). Levels of integrating the assure model in lesson delivery of selected primary school teachers in Nigeria. Journal of Language Teaching and Research, 12(1), 177-182.
2. Benner, D., Schöbel, S., & Süess, C. (2022, December). Towards Gamified Conversational Agents for Self-Regulated Learning in Digital Education. In ICIS.

3. Benner, D., Schöbel, S., Süess, C., Baechle, V., & Janson, A. (2022). Level-up your learning–Introducing a framework for gamified educational conversational agents.

4. Cinglevue. (2017). Learning and educational applications of chatbot technologies, 8 11. Retrieved from Cinglevue: https://www.cinglevue.com/learning-educationalapplications-chatbot-technologies/.

5. Clark, I. Formative assessment: Assessment is for self-regulated learning. Educ. Psychol. Rev. 2012, 24, 205–249.

6. Deng, X.; Yu, Z. A Meta-Analysis and Systematic Review of the Effect of Chatbot Technology Use in Sustainable Education.Sustainability 2023,15, 2940.

7. Dennis, B., Schöbel, S., Janson, A., & Leimeister, J. M. (2024). Engaging Minds–How Gamified Chatbots can Support and Motivate Learners in Digital Education. In Hawaii International Conference on System Sciences (HICSS).

8. González-González, C. S., Muñoz-Cruz, V., Toledo-Delgado, P. A., & Nacimiento-García, E. (2023). Personalized gamification for learning: a reactive chatbot architecture proposal. Sensors, 23(1), 545.

9. Heinich, R., Molenda, M., Russel, J. D., & Smaldino, S. E. (2002). Instructional media and technology for learning. Pearson Education Ltd.

10. Khlaisang, J., & Koraneekij, P. (2024). Roles of Chatbots in Gamified Self-Regulated Learning System to Enhance Achievement Motivation of Learners in Massive Open Online Courses. Electronic Journal of e-Learning, 22(8), 106-120.

11. L. K. Fryer, K. Nakao, and A. Thompson, "Chatbot learning partners: Connecting learning experiences, interest and competence," Comput. Human Behav., vol. 93, no. December 2018, pp. 279–289, 2019, doi: 10.1016/j.chb.2018.12.023.

12. M. K. C. Yeh, A. Toshtzar, L. Guertin, and Y. Yan, "Using spaced repetition and gamification to enhance K-12 student science literacy with on-demand mobile short reads," Proc. - Front. Educ. Conf. FIE, vol. 2016 Novem, no. April 2018, 2016, doi: 10.1109/FIE.2016.7757361.

13. Megaw, A. (2006). Deconstructing the Heinch, Molenda, Russell and Smaldino Instructional Design Model. Retrieved onNovember 9, 2014, from https://ipislam.edu.my/ kplir/Bacaan/Assure/idm_angela.pdf.

14. Molnár,G. and Szüts, Z. 2018. The Role of Chatbots in Formal Education, IEEE16th International Symposium on Intelligent Systems and Informatics (SISY),Subotica, 197- 202. doi= 10.1109/SISY.2018.8524609

15. P. Smutny and P. Schreiberova, "Chatbots for learning: A review of educational chatbots for the Facebook Messenger," Comput. Educ., vol. 151, no. June 2019, p. 103862, 2020, doi: 10.1016/j.compedu.2020.103862.

16. Shah, M. AI-Driven Chatbot for Enhancing Learning for Students.

17. Zahran, F. A. (2023). The Impact of ASSURE Model-Based Program on EFL In-Service Preparatory Teachers Teaching Skills and Digital Literacy Skills. International Journal of Research in Education and Science, 9(4), 937-950.

18. Zandvakili, R., Liu, D., Li, A. T., Santhanam, R., & Schanke, S. (2024, June). Design and Evaluation of a Gamified Generative AI Chatbot for Canvas LMS Courses. In International Conference on Human-Computer Interaction (pp. 259-264). Cham: Springer Nature Switzerland.