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Gamification on Chatbot-Based Learning Media: a Review and Challenges

[1]Indra Hidayatulloh, Sigit Pambudi, Herman Dwi Surjono, Totok Sukardiyono
[1]Department of Electronics and Informatics Education, Universitas Negeri Yogyakarta
[*]Email : indra.hidayatulloh@uny.ac.id

ABSTRACT

The mobile learning sector has exploded, implying that the e-Learning trend is shifting to mobile platforms. As a result, chatbots have become increasingly popular alternatives for online learning and examinations on mobile platforms. However, it did not provide enough motivation for the student. On the other hand, gamification in a typical e-Learning platform is a widely used technique for increasing students' learning motivation. Therefore, combining gamification with chatbot-based learning and examinations possibly offer benefits, including increase student learning motivation. This study explored the possibilities and future challenges of the development of gamification within chatbot-based learning media. We discussed four aspects: architecture's reliability, security and privacy issue, user's acceptance and motivation, and gamification feature challenges.

Keywords*:* gamification, chatbot, e-Learning, mobile learning, learning media

INTRODUCTION

Universities are attempting to stay competitive by using contemporary technologies, such as e-Learning in online learning and examinations [1]. On the other hand, many individuals depend on cellphones for everyday activities and carry them at all times, according to Dacebo's e-Learning platform [2]. Additionally, the mobile learning sector has expanded significantly, indicating that the trend toward e-Learning is shifting to mobile platforms. However, there are certain disadvantages and limits to e-Learning. Many e-Learning platforms, for example, are intended for solitary learning, causing students to feel isolated or detached from their community or social context [3]–[5]. Lack of contact with other students and instructors is a common source of these emotions. Furthermore, in most e-Learning systems, the user interface is solely designed to fulfill learning functions and is not responsive to student response or interaction. As a consequence, pupils may feel alienated and disconnected, lowering their desire to study.

Messenger apps and chatbots, on the other hand, have become more popular options for communicating with users as the mobile device industry has grown over the past several decades [6]. As a result, learning activities are often supported by chatbots in messaging apps. A chatbot is an artificial intelligence (AI) program that uses a conversational interface to conduct conversations or respond to user queries [6], [7]. Furthermore, chatbots as learning Intelligent Assistants have been shown to decrease feelings of loneliness and alienation among e-Learning users [8]. Thus, the chatbot will assist students in maintaining their learning motivation using the e-Learning platform.

A variety of variables may influence students' desire to learn to utilize e-Learning. Quality of material and instructor competency, internet difficulties and a lack of learning resources (equipment), and time management, including flexibility in monitoring learning progress, are only a few of the variables [9], [10]. Furthermore, motivation in e-Learning is influenced by the teaching-learning process and the technique of assessing and evaluating information [11]. Gamification on an e-Learning platform is a commonly utilized method for increasing students' learning motivation [12]. This method may enhance students' desire to study by including gaming features such as points, contests, and levels. Therefore, combining gamification with chatbot-based learning possibly offer benefits, including increase student learning motivation.

This study explores the possibilities and future challenges of the development of gamification within chatbot-based learning media. First, we explore the four aspects of this study: the architecture's reliability, security and privacy issue, user's acceptance and motivation, and gamification feature challenges. Next, we discuss the possible strategy to cope with the challenges.

METHODS

Multi-participant chat systems have been extensively utilized in a variety of areas, including law, military, business (as a replacement for customer service) [13], and education [14]. In addition, a chatbot is utilized as a context-aware computing-based recommender system for tourist routes [15]. Chatbots with more specialized subject expertise, such as the ALICE chatbot [17], react better for broad discussions.

In the education context, many e-Learning chatbots have been developed, including by [16], [17], and [18]. According to a study, chatbots are intelligent helpers in learning, such as answering queries about course content or repeating lecture material [19]. Ranoliya utilized chatbots to answer questions in lectures during the study [18]. Chatbots may also be used to learn the Java programming language [19]. In this research, the social conversation is used to improve user happiness in Question-Answer systems. Chatbot access with no time restriction may be utilized for various purposes, including self-taught foreign language study [20]. Chatbots have also been proven to improve student engagement and switch on the learning process [21].

A. Architecture

A study by [22] proposed EconBot as an economic learning platform. The design of EconBot is shown in Figure 1.

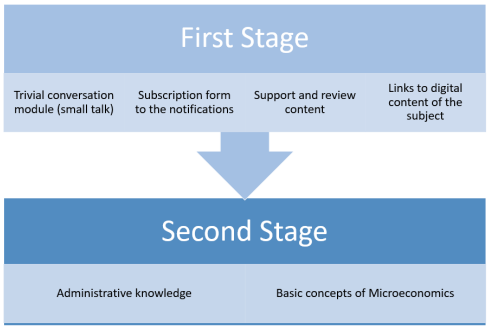

Figure 1. Stage of EconBot Design

This suggested Chatbot-based e-learning architecture does not yet take into account the student's comments while learning and customizing depending on their conversation history. Another intriguing idea in conversational-based learning was proposed by Gavin & Glavin [23]. Their proposed framework considering a more personalized learning experience with the help of AI in conversation-based learning, as shown in Figure 2.

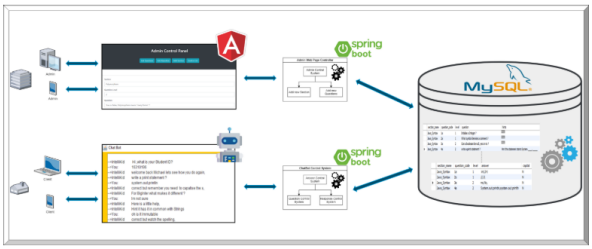

Figure 2. Framework by Gavin Glavin [23].

Sperli [24] also proposed a microservice architecture for the cultural heritage learning chatbot, as shown in Figure 3.

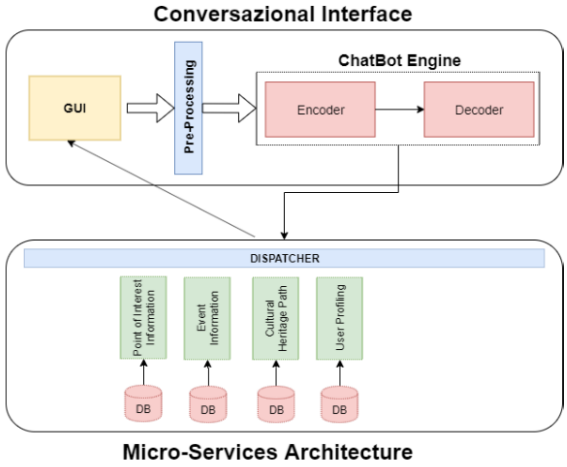

Figure 3. Architecture fo Heritage System by Sperli [24].

Many researchers proposed design and architecture for the chatbot of the learning system. However, there is still limited study that creates a general architecture of the chatbot for the general learning system. Tamayo [22] proposed the content design, while Sperli [24] and Gavin & Glavin [23] proposed a more technical side of the chatbot system.

B. Acceptance of Chatbot as Learning Media

The use of chatbots as tools for effective learning is not something new. Its characteristic of allowing the user to do multitasking while learning as well as make the way of educational scenarios become easier[19]. The acceptance of the chatbot itself is still debatable due to the lack of motivation of use because of "boring conversation" or the limitation of the "fast-response" agent [25], [26].

As for increasing the agent's response, a Deep Learning method has been widely used [27]–[29]. However, the study about increasing user motivation and engagement while using a chatbot as a learning medium is still limited.

RESULT AND DISCUSSION

A. GAMIFICATION AND E-LEARNING

Gamification is the application of a game's design, in whole or in part, to real-world issues [30]. Gamification has been extensively used in learning, particularly MOOCs (Massive Open Online Courses). Gamification, for example, is the use of points, badges, leaderboards, rewards, and punishments systems [31]. This approach has been proven as a good strategy to increase the interaction within distance learning systems at 10% on average as well as reduce its dropout rate [32].

Nick Pelling, a game designer, invented the term "gamification" in 2002 to describe the application of game design principles in non-game settings to enhance enjoyment, target behavior, and engagement, as stated by Nicholson[33], Kim[34], and Yildiz[35]. Because of its ability to attract people's attention, involve them in certain activities, and even affect their behavior, gamification is a powerful instrument [34].

Furthermore, a general review for gamification in the education area was done by [36]. Metwally et al. in [36] stated six popular areas on the gamification in education: (1) concept and theoretical knowledge, (2) design, (3) development, (4) impact, (5) personalization, and (6) higher education. One of the challenges of gamification in higher education is the less rewarding system[36]. By rewarding students for their efforts, gamification may help them learn more interactively. However, despite the widespread gamification in CMS e-Learning, it remains distinct from students' social lives. Students can only receive incentive information by visiting e-Learning regularly.

On the other hand, students may utilize chatbots to receive information about top users on the leaderboard, progress, and prizes earned by other students. Additionally, the extra information provided by the chatbot will increase pupils' competitive drive.

B. CHALLENGES ON GAMIFICATION WITHIN CHATBOT

Building Chatbot with Gamification may have to face many challenges as the reliability of the architecture, user acceptance, privacy concern, and mobility challenges. In this section, those challenges will be discussed.

1. Architecture's Reliability

Architecture is a foundation of a chatbot system. However, the choice of architecture is also quite tricky and is dependent on the kind of system to be developed, such as a Question Answer-based chatbot.

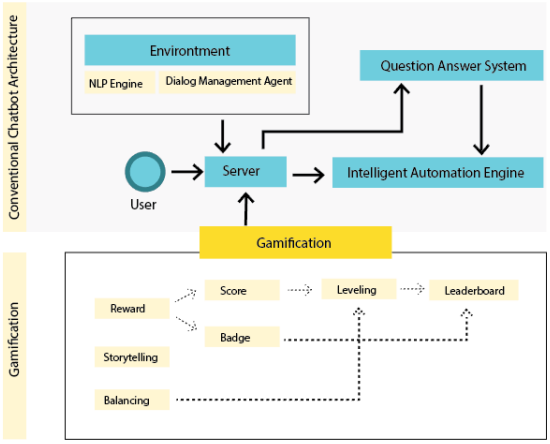

Figure 4. Chatbot with Gamification Architecture

The user of this kind of chatbot may leave the chat in the midst of a conversation and then return. Chatbots may not keep track of previous conversations, which will inevitably impair the chatbot's usefulness.

The addition of gamification to the Question-Answer format, as seen in Figure 4, poses a new architectural design problem. For example, the server should use a balancing method to balance the reward-punishment system, such as assigning a reasonable score and converting the score to a level. If we need to run the conversational procedure on a separate server, how to maintain its reliability? What is conventional approach has been made previously?

Telegram is one of the instant messaging software that provides chatbots within its services. In the Telegram bot, to create a quiz, we can use the Poll feature. This feature can give a poll creation service that contains one question for each poll which can be displayed alternately

or concurrently. For every question, the administrator can set several answers. Furthermore, there are two types of the poll in Telegram bot; Quiz and Regular.

The quiz poll only has one correct answer from several answer choices. Every time students finish answering the test, the answer key is displayed and followed by the next question. This type of quiz is undoubtedly not suitable for quiz models that can be re-taken.

In contrast to quiz poll type, there may be questions with multiple answers in the Regular poll type and questions with one correct answer. The answer key may be set or not for questions with just one valid answer. If this option is enabled, the answer key will display as soon as each user has completed responding. If it is not set, no answer key will be shown, and the following question will be displayed if there is one. As a result, there is no need to specify an answer key while sending multiple-response questions to the user's Telegram.

There's also an option for whether the poll should be anonymous or not. There will be no information on who selects a particular response for each question if it is anonymous. If it isn't anonymous, though, it will reveal the person's identity who selected a specific response. This poll feature is probably enough to add interactivity within chatbot learning media; however, some drawbacks, like privacy issues.

Moreover, the challenge is how to keep the server work in real-time while maintaining the interactive gamified chatbot. Chatbot itself, with natural language processing and deep learning inside, required a high computational process.

2. Security and Privacy Issue

Furthermore, privacy and security will be the next concern [37] as modern chatbots did not rely on the rule-based model only; instead, of collect personal conversation data. The irresistible data security and privacy issues may increase the risk of vulnerabilities and security threats in the future [38]. Regarding learning media chatbot with gamification, the privacy issue might also come from the leaderboard feature. For example, in the Telegram, while using the quiz feature bot with the bot was invited to the group chat, it blatantly shows another student's answer record. This exposure may lead to an uncomfortable feeling that may lead to hesitation to answer in the chatbot room. Furthermore, other sensitive data like student number, ID, contact also will lead to vulnerabilities [37]. The “unintentional” shared information between students may lead to security leaks.

Furthermore, the security threat is not only on the server side but also on the client side. Ye and Li [39] proposed four potential attacks modules: the client module, communication module, response generation module, and the database module. While the client, communication, and database modules focus more on technical security, the response generation module focuses more on human-related threats.

The response generation module is responsible for comprehending the input message and generating a suitable answer for the user [39]. Some of the response module attacks are adversarial attacks, language model attacks, and feedback engineering attacks. For example, the attacker types at conversation systems and creates an input phrase that may break the chatbot in an adversarial attack.

Another attack type, the language model attack, takes advantage of the Natural Language Processing(NLP) system that uses pre-trained language models. This vulnerability is hard to detect since it may look normal for some queries, but the chatbot will exhibit suspicious behavior such as harsh responses if provided specific triggers [39].

Last but not least, the feedback engineering attack. Attacks that take advantage of the response generating module's capacity to learn from user input are known as feedback engineering attacks.

3. User’s Acceptance and motivation

Acceptance of the user is one of the most critical matrices in human-computer interaction. When forming a relationship between a human and a chatbot, consider the process similar to developing an intrapersonal relationship [40]. Therefore a trust must be built first, followed by engagement and satisfaction [41]. Furthermore, it is also essential to maintain student motivation while learning with a chatbot with a gamification feature. One of the vital features to sustain motivation is providing sufficient empathy for student's emotions. Compassion for the feelings of pupils seems to boost their desire to learn [42].

A finding by Pérez-Marín [42] also revealed that the 'mood' of the chatbot might also decrease users' desire to leave the chatbot's room. Further research by Jin and Youn found out that the expressive chatbot may get different responses from people with social phobia and those who do not [43]. For people with social phobia, the use of anthropomorphism chatbots increases the acceptance of the user. On the other hand, it was the opposite for people who do not have social phobia. The more expressive chatbot, the more irritated the user will be.

However, even the attractive and expressive chatbot for learning media seems insufficient to keep pupils engaged [44]. The chatbot should focus more on providing content that might not be supplied by interpersonal learning, such as the repetition of particular course material. On the other hand, repetition is commonly used in gamification [45]. Thus, gamification can be beneficial to "force" pupils to replay some content attractively.

4. Gamification Feature Challenge

A technical challenge, which gamification feature included, must be decided before developing chatbot-based learning with gamification is game mechanics. The typical game mechanics included in the development of gamified learning are as follows: Scores, badges, leaderboards, levels, quests, countdowns, and specific rules and rewards [12], [21], [32]–[36]. However, not all of the game mechanics above will be smoothly applied to conversation-based learning. Therefore, this section will discuss the challenge of some standard features.

a. Scores

A score will be credited to the game when a user accomplished a task or mission [46]. In the standard e-Learning with gamification, a score is credited to the player that accomplished the task. It can be the quantities of the activity done by the player or the quality of their submitted work/ task. It will be more complicated when the learning media is a chatbot. How do we score student activity within the chatbot? How do we measure the quality of the student's answer?

The first challenge, how to score the activity of the student? In the conventional gamification on e-Learning, a score will be added every time students do activities such as reading material, posting in the forum, and submitting work. In the chatbot-based learning media, students can click on a particular option given by the bot and ask the bot to make a conversation. In an entirely text-based interaction, the student can ask anything many times. Therefore a re-scoring for the same question or interaction is inevitable.

The second challenge is how we measure the quality of the student's answer. With the growth of natural language processing, it seems not impossible to build a fast response bot that understands the student's question or answer, as research by Herwanto et al. that able to achieve an F1 score up to 97,6%[47][48]. However, the chatbot must empathize with student mistakes, i.e., typos or an almost correct answer. The bot must also decide the correct score for the nearly correct answer, which a human usually scores with empathy.

b. Badges

Players may be given badges after earning a specific amount of points. Badges are a kind of virtual accomplishment that the player may make [49].

c. Level

When a player reaches a point or a particular score, the player Level will be increased. The player may receive more rewards or even open a new task/ quest as the level increases. In chatbot-based learning media, the chatbot displays level information to the learner in the form of a floating icon or displays the level information when a trigger occurs.

d. Quest

Quest is a particular task in the game that contains a reward for the player. Some tasks or quests can be mandatory and used as a requisite before opening another task. In chatbot-based learning, a quest can be finishing some materials or answering some quiz.

e. Countdown

The countdown is a time constraint for a game. The player will have to accomplish a task within a certain amount of time. For example, in a poll or quiz, we can add a countdown. Interestingly, we can also set a timer for the student to answer within a specific time range.

f. Rule and Reward

The rule is a set of schemes, the principal on how the game works logically and its mathematical component. Therefore, the rule composition in the chatbot-based learning media must also consider the learning pedagogy.

g. Leaderboard

The leaderboard is an element of the game that provides social engagement to the players/ users by showing the players on a list, usually ordered in decreasing order with the most points at the top[49]. However, it may also discourage a new player if the list has a high score gap.

Research by Pérez-Marín [42] emphasized some challenges and future directions for developing chatbot media learning based on their exploratory study with students. Some of them are: the pupils see the agent as a friend with a personality, and pupils need jokes or other exciting activities within learning conversation as a break. As seen by Pérez-Marín's research, building an acceptable chatbot feature is also vital to maintain student engagement. Providing a break for the user will reduce the chance of a student getting bored during the learning session.

C. DISCUSSION

1. Architecture's Reliability

A reliable architecture is an important technical issue that must be addressed while developing any system. Despite the minimum literature that directly provides or proposed the architecture of chatbot-based learning media with gamification, mirroring its resemble in the gaming context might be insightful.

A visual novel is a common architecture for conversational-game-based learning. As a result, considering the design of a visual novel will aid in the development of an interactive chatbot for learning media.

Visual Novel Architecture

A famous creation of conversational-based games is a visual novel. The use of visual novels in learning contexts also has been developed by Camingue et al. [50] and Andrew et al. [51]. In the Camingue study, they proposed six taxonomies to be considered while designing a visual novel learning: 1) Teaching Through Choice, 2) Teaching Through Scripted Sequences, 3) Teaching Through Mini-games, 4) Teaching Through Exploration, and 5) Non-interactive Teaching.

Teaching through choice in chatbot-based learning media can be an essential interaction for a particular learning context such as theoretical learning [51], [52]. Furthermore, teaching through the scripted sequence concept will create a more immersive interaction with the chatbot since the user must fill or type particular scenarios. One of the famous examples is Osiris [53]. Another research that revealed the strategy to build more interactive conversational games is research by Carstensdottir [54]. Furthermore, game-based learning like [55] also provides some insight into story involvement in education. Therefore, developing a chatbot with gamification for a learning system can be more attractive due to its story progression by a visual-novel-like approach.

2. Security and Privacy Issue

To cope with the security and privacy issues raised by the chatbot system, Hasal suggests three different approaches: the use of authentication and authorization, end-to-end encryption, and self-destruction message [38]. This approach may run smoothly on the technical aspect. However, it still does not solve the human-generated threat as exposed by [39].

Ye and Li already proposed several ways to prevent the response generated attack, such as: creating an algorithm to detect the malicious trigger, separate the response learning and training model server with layer abstraction[56]. Furthermore, Gondalia et al. proposed using Service Level Agreements (SLA) mechanism to mitigate the risk of chatbot services [57]. Another strategy to avoid SQL injection within user answer/ feedback in conversation with a chatbot is using SQL-IF and Naïve Bayes [58]. Using a combination of SQL-IF and Naive Bayes to detect the trigger or malicious code in the text inputted by the user will reduce the risk of response module attack.

3. User's Acceptance and Motivation

Since building communication within chatbot-human is similar to interpersonal

communication [40], it is essential first to develop trust between the two [41]. As a study by [42], it is beneficial to provide a personality to the agent; therefore, students feel more engaged. Moreover, it is also essential to give some break time within the learning session. The breaktime can either be a joke or fun activity. Empathy is also another potential aspect that should be taken into account. However, showing too much expression will also lead to drawbacks, especially for those with less social phobia. It may irritate the user or make the learning less meaningful. As for content, it is also advantageous if the material did not overlap with human-to-human activity like conversation learning and more into repetitive learning [44][45].

The acceptance model should be explored more in the future, not only for the technical aspect but also it social aspects like the communication between chatbots and humans. Currently, there is still limited study that focuses on how the language model in the chatbot is sufficiently acceptable, more natural, and safe and secure.

4. Gamification Feature Challenges

In the future, the researcher can apply fundamental game development technologies such as game mechanics and dynamics for the gamification of chatbot-based learning media. It will not take much processing to display score, leaderboard, and level as a floating menu or text-based information provided by the bot. The scoring procedure, particularly assessing the quality and amount of each action in the chatbot dialogue, may, nevertheless, be complicated. In order to create an expressive and empathetic bot, several Natural Language Understanding (NLU) Processes are required. Due to the bot's vulnerability to the response module attack must also be tested for its capacity to learn from user responses or feedback. Finally, include a game dynamic in the system. One example is demonstrating narrative development, which will pique students' interest in what will happen next and motivate them to complete the learning module.

Furthermore, the development of chatbot learning with gamification can also consider the blended learning technique, such as learning videos [59][60]. Likewise, to assist the student with a disability like visual disability, the researcher can consider an audio-based chatbot. The audio-based chatbot can be a complete voice assistant or earcon-based for a particular menu [61].

CONCLUSION

This study explored the possibilities and future challenges of the development of gamification within chatbot-based learning media. We discussed four aspects: Architecture's Reliability, Security and Privacy Issue, User's Acceptance and Motivation, and Gamification Feature Challenges. Reliable architecture must also consider the need for high computation to process the NLP while also maintain fast response and increased security to prevent attacks coming from internal or external. Furthermore, security risks may be mitigated by using SLA procedures and preventive measures, such as double-checking the language training model and identifying a malicious dialogue trigger inside the agent and user.

The acceptance model may also be investigated further to determine which bot is the most appealing and expressive to increase user engagement. The gamification feature element is the same way; the feature must be engaging and provide empathy and personality. A game element, such as a backstory, may also be incorporated to boost the user's incentive to complete the learning session.

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