A Conceptual Framework for an Adaptive Tutorial System with Gamification to Enhance Digital Literacy

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Abstract—Digital literacy skills are essential for working in a digital society. Therefore, the university emphasizes teaching and finding ways to assess knowledge and prepare students before completing their studies. The university has an issue with the low percentage of students who pass this exam. Since they learned this material in their first year, their understanding of it may be limited and stale. Therefore, students require a tutoring system to help them effectively review the material before the exam. This paper presents the conceptual framework for developing an adaptive tutorial system to assist undergraduate students in preparing for the digital literacy exit exam. This system's unique feature is not only the exam for students to practice reviewing their knowledge but also the exam's adaptability to the student's abilities. In addition, this concept is reinforced through gamification by incorporating game elements to motivate, increase the difficulty of competition and make exam preparation enjoyable. The system design was evaluated by seven experts who determined that the components and procedures of the tutorial system were appropriate. This paper's findings are the components and steps of developing a tutorial system to alleviate the monotony of taking traditional exams through motivation based on exam challenges tailored to the examinee's skill level. In addition, this study suggests that considerations should be made when applying the gamification concept to the design of a system.

Keywords—tutorial system, adaptive tutorial, gamification, digital literacy, online testing

1 Introduction

It is widely accepted that digital literacy is the primary means of obtaining employment in the modern era [1]. As a result, universities must provide mechanisms for promoting and assessing students' digital literacy abilities to ensure that students possess the competencies required by employers in Industry 4.0. Digital literacy has been defined as a necessary skill for 21st-century citizens [2,3]. Most Thai universities require students to pass a digital literacy assessment before graduating with a bachelor's degree. Numerous studies have demonstrated various strategies for developing or preparing students for digital literacy skills before graduation [4]. Previous studies have reported the importance of developing an instructional model that promotes

digital literacy skills and fosters an environment conducive to developing digital literacy skills through various learning media and instructional methods [5]. However, these methods do not guarantee that a student will retain the necessary knowledge to pass the digital literacy skills exit exam prior to graduation.

The researcher presents a system for students to practise with a digital literacy tutorial system to foster this issue. According to Larsen [6], teachers utilize testing to enhance the retention of acquired knowledge and skills by retrieving information through various quizzes or questions. Therefore, a system of testing or training for learners to practice retaking the exam is an additional method for learners to review their knowledge and comprehension before taking the actual exam. Additionally, it boosts self-assurance and reduces exam anxiety.

The tutoring system is a recognized automated system that performs comparably to human tutoring for exam preparation. Furthermore, the tutorial system is always available and can be utilized at any time based on the students' needs. This student autonomy serves two purposes: first, it fosters a sense of responsibility, and second, it increases motivation [7]. In learning or practice situations, it may be challenging to keep all students from becoming bored if they possess varying levels of background knowledge. In addition, questions that are too difficult for the student may discourage them or reduce their motivation for continuous testing [8]. An adaptive tutorial system for each learner's knowledge or skill level is an intriguing concept.

The problem encountered with existing tutoring systems was the lack of emotional motivation and discouragement in continuing to practice [9]. These are crucial components of the learning process because most students crave a sense of progress; they want to feel like they are acquiring and mastering new information and skills. Furthermore, González et al. [10] discovered that if students are not motivated, they will have little desire to participate in activities. As a result, adapting tutoring systems to game features such as immersion, motivation, and emotion is a tremendous challenge [11].

Numerous studies have revealed that the concept of gamification is widely used in contexts that promote engagement and learning behaviors [9,12]. The term ‘gamification’ refers to incorporating game elements into non-gaming contexts and applications. Gamification is frequently used to increase student engagement and performance in educational settings [13-14]. Moreover, gamification helps students maintain their motivation and interest [10]. This is consistent with Sanchez et al. [15], who discovered that the game element increased test-taking motivation. Students are motivated to take quizzes because game elements, such as rules and objectives and leaderboards, generate challenges and attract attention.

Based on the studies mentioned above, this research proposes a conceptual framework for the adaptive tutorial system with the gamification concept. This tutoring system is intended to assist students in preparing for an exit exam by assessing their digital literacy knowledge. The challenge is determined by the exam's difficulty level, which matches the learner's level of digital literacy. We aim that the conceptual framework we propose will be developed into tools that will assist learners in increasing their digital literacy skills, having fun, and remaining engaged as they continuous-

ly use this adaptive tutorial system. However, none of these studies focus on the design of a gamified adaptive tutoring system in Thailand.

Consequently, this study sought to address the following research questions. What components and steps are involved in developing an adaptive tutoring system with gamification? The findings are crucial for advancing the development of a system to review the content of university exit exams to assist students before graduation.

The structure of this paper has been organized as follows. In the Introduction, the context and significance of this study are presented, followed by a review of related studies on adaptive tutorial systems and an analysis of the game elements incorporated into the gamification of this system. The methodology has been presented concisely in each prototype development phase. In the results and discussion section, describe the outcomes of the conceptual framework design, the system's components, workflows, and the results of expert validation. Then concludes the paper.

2 Literature review

Numerous studies have been conducted on adaptive tutorials and intelligent tutoring systems used in training to track learners' progress. In addition, gamification is applied to e-learning systems to increase motivation. However, gamification and adaptive tutorial systems are rarely mentioned. Therefore, this section provides empirical studies' backgrounds of the tutorial system relevant to our work. Specifically, we discuss the use of adaptive techniques to improve intelligence and respond to individual learning of the tutorial system. We also discuss the background of gamification-related work and game elements implemented to provide readers with the context for our work.

2.1 Adaptive tutorial system

The tutoring system was developed on various platforms, including a web-based and mobile application, as well as for individual and collaborative learning [16-17]. A tutorial system's purpose is to encourage students to improve their academic performance by using technology to assist them in preparing for exams or competitions by reviewing previously acquired knowledge, expanding their understanding, and honing additional skills [18-20]. Several recent studies have developed an intelligent tutoring system to facilitate collaborative learning [21-22]. Das and Pal's [8] intelligent tutorial system emphasized adaptive learning by delivering a set of instructional materials based on the level of student comprehension.

These studies have also applied game-based tutoring systems to increase the learner's enjoyment of the learning process [23-24]. Similarly, Li et al. [25] developed GamiCAD, a gamified software tutorial system focused on providing motivational feedback and encouraging the completion of repetitive tasks through score improvement. According to the findings, the intervention positively impacted the student's academic performance and motivation. It also encourages a positive attitude about using the learning system for examinations.

We examined the methods for enhancing the effectiveness of the tutorial system. Adaptivity techniques modify a student's learning experience according to individual characteristics such as subject knowledge, emotion, and learning styles [26]. In addition, it may be necessary to modify both content and navigation options to determine the type of immediate feedback and long-term guidance the student will receive based on his past actions [7]. Several studies suggest that adaptive techniques can tailor the learning process to each student's unique characteristics, mainly when applied to the testing system [8, 27]. The advantage of an adaptive testing system is that the test adapts to the learner's skill level, unlike conventional tests, which require all learners to take the same set of tests. As a result, students will be able to take the exam at a level of difficulty appropriate to their level of proficiency and will find the exam more challenging.

2.2 Gamification

Gamification is a term that refers to the application of game-design elements and game principles in non-game contexts [28], intending to increase active participation, enjoyment, and participants' flow. In other words, gamification pursues valuable fun by incorporating game-like elements into non-fun tasks [29]. Gamification has been a well-established trend in educational research for an extended period. The most compelling reasons to promote gamification in education are its vital elements, which include immediate feedback, a sense of accomplishment, a sense of challenge, and a sense of defeat [30]. According to the literature, gamification can incentivize expected behaviors in education and ensure that these behaviors assist students in meeting their learning objectives [31,32]. Biro [33] noted that gamification shares several characteristics with behaviorist learning theory, including the superiority of positive reinforcement, immediate feedback, and progressive challenges. At the same time, Sua & Cheng [34] stated that educational gamification shapes learners' behavior through game-like rule systems and player experiences. Moreover, gamification puts gaming metaphors to the test to influence behavior, boost motivation and boost engagement [35-36], in line with Lister [37], who argues that gamification is one of the most effective and valuable tools for attracting and maintaining students' attention in class.

Recent studies have found that gamification generates motivational responses for measuring learning outcomes through integration into e-learning [35]. Marcos et al. [38] compared social networking websites and learning management systems (LMS) used in gamification strategies. Gamification increased student engagement, which resulted in improved student practice and productivity. Additionally, according to Kang and Kusuma [39], it is possible to increase students' motivation to learn by incorporating gamification elements into e-learning and matching specific gamification elements to the students' personalities, resulting in increased academic achievement. Malas and Hamtini [40] proposed a Gamified E-learning Design model (GED) to increase students' participation, performance, and motivation for learning by developing an e-learning platform.

In addition to the game mechanics to help learners feel engaged and have fun while learning, games can also help create a sense of security and resolve feelings of failure

that arise during learning. Failure to recognize this results in disengagement, frustration, and disinterest on the part of the learner [39]. This confirms the findings of Lee and Hammer [41], suggesting that games have the potential to stimulate and improve certain moods such as curiosity, optimism, pride, or safety through positive practices resulting from game failure, which allows for risk-free learning through repetition. Additionally, game mechanics can cater to the unique needs of individual learners [42].

However, although these papers present innovative uses of gamification in conjunction with intelligent tutoring systems [23, 25, 43], no study has yet been adopted for the exam preparation of senior students before graduation. Moreover, our system was designed with the actual context of the users and the problem of the Thai university's exit exam in mind.

This paper combines adaptive learning capabilities and motivation through game mechanics by focusing on each learner's knowledge level. The system will examine the results of the previous answers and immediately presents an exam corresponding to each student's skill level and adjust the difficulty level with score and time conditions so that it is challenging for the learner. The goal is to modify learners' behavior by stimulating their intrinsic and extrinsic motivations through game mechanics. Learners are expected to be motivated by the possibility of acquiring rewards and benefits based on their performance, can have personalized gamified learning pathways, and can satisfy their actual attitudes by interacting with other students in a system environment.

We have studied the literature that characterizes game elements in various ways. Hunicke et al. [53] proposed the MDA framework, which originated from digital games and described the game elements as belonging to one of the following categories: Mechanics, Dynamics and Aesthetics. However, this framework has been adapted to the generic gamification framework, which disregards the specifications of educational domains [54]. Based on a review of the relevant research, it has been determined that those aspects of the game can be divided into two categories. The first category includes concrete items like badges and leaderboards, while the second contains abstract concepts such as time constraints and game styles. Nonetheless, the game elements cited in our studies were synthesized from relevant research and defined the appropriate criteria for application to adaptive tutorial systems aimed at improving digital literacy skills [24,37,44-52].

The game elements used to design our system are known as game interface design patterns, which are a fundamental characteristic of applying game concepts to interactive problem-solving solutions or a model of their practical skill [47]. As shown in Table 1, when we incorporated game elements into this system, we had to consider how easy it would be for students unfamiliar with modern technology to use and strike a balance between usability and fun. Leaderboards and points are researchers' most popular gamification elements, followed by badges, feedback, and levels. However, the researcher considered functionality when choosing game elements for this system. This idea is consistent with the research conducted by Ahmad et al. [31], which suggests that each of these game elements serves a unique function, so selection should be based on their functions. As shown in Table 2, this study aims to use

game elements to motivate and engage students in continuous use of the tutorial system to develop digital literacy skills through the repetition of enjoyable quizzes.

Table 1. Shows the synthesis of game elements

Game elements	[24]	[37]	[44]	[45]	[46]	[47]	[48]	[49]	[50]	[51]	[52]
Leaderboards		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Points		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Badge		✓	✓		✓	✓	✓	✓		✓	✓
Feedback	✓		✓		✓		✓			✓	✓
Levels			✓		✓		✓	✓			✓
Progress bar					✓	✓	✓			✓	✓
Competition	✓			✓	✓						✓
Reward	✓			✓	✓						
Time								✓			✓
Achievement	✓			✓							
Avatar			✓				✓				
Challenges			✓		✓						
Status				✓				✓			

Table 2. Provides definitions of these elements

Elements	Description
Points	Numerical unit indicating progress based on progression. Students will receive a point when the mission is accomplished.
Level	A journey from one level to another.
Badge	A symbol indicates a specific achievement or accomplishing a specific task or skill.
Leaderboard	Displaying student performance compared to other students based on the number of points and badges earned.
Time	Assigning missions with time restrictions to create obstacles and allot time restrictions appropriately.
Progress bar	The level of knowledge required to indicate development progress.
Rewards	Students will receive points that can be redeemed for physical prizes at the conclusion of the lesson.
Feedback	Learners will receive recommendations for improving their knowledge skills upon completion of the test.

Note. The game elements applied to this system are the most common: points, level, badge, leader board, time, progress bars, rewards, and feedback. These elements perform different functions to motivate and engage students in the tutoring system. Each support motivates students to succeed, and a sense of competence and independence in controlling students' learning is required [55]. In addition to receiving immediate positive feedback, this system provides learners with a sense of fluidity by adjusting the difficulty level according to their skills and abilities, which is a crucial feature.

3 Methodology

Prior to the beginning of the research, full ethical clearance was obtained from the Human Research Ethics committee of Walailak University (approval number WUEC-21-313-01). The purpose of the study was explained to the participants, who were informed that their participation was purely voluntary.

3.1 Sample

The sample group consisted of seven carefully selected experts based on the following criteria: the expert must hold a doctoral degree in information systems development, game design, or a related field. These professionals have at least five years of experience working in a university or for a reputable Thai company.

3.2 Instrument

The validation instrument was a closed and open-ended questionnaire. The questionnaire is divided into three sections. Section A includes the respondent's demographic information, including gender, age, and work experience in related fields. Section B assesses the system's performance in system components, workflows, and development with game elements guidelines based on modifications from the previous study [11,56,57]. A total of 15 items were constructed; each was rated according to the 5-point Likert scale, from 1 – Very Not Important to 5 – Very Important. The open-ended questions in Section C solicit expert opinions and recommendations regarding developing practical and effective systems.

Three experts verified the reliability of the questionnaire by validating the instruments' content validity using the index of item objectives (IOC). Their respective correctness indices range from 0.66 to 1.00, indicating that all items can be utilized. It was determined that the suitability of IOC was 0.83.

3.3 Data analysis

The evaluation of expert opinions regarding the system's design is presented using descriptive statistics and the mean ($\bar{x}$) and standard deviation (S.D.). Qualitative data are used to describe experts' various perspectives on system development by presenting them in content analysis.

3.4 Procedures

A literature review on the adaptive tutorial system and gamification revealed numerous studies on adaptive tutorials and intelligent tutoring systems used to track learners' progress in training [43]. Gamification is used to increase motivation in e-learning systems [9, 10, 13].

Analyze the elements and steps necessary for development, combining adaptive learning capabilities and motivation through gamification by focusing on the knowledge level of each learner. The objective is to modify the test-taking behavior of students by stimulating their intrinsic and extrinsic motivations via game mechanics.

Propose our system to seven experts who have meticulously formulated selection criteria to evaluate and assess the conceptual model's suitability. The data were analyzed and compiled following the recommendations.

4 Results and discussion

This study's findings were used to answer the following research question: What components and steps are involved in developing an adaptive tutoring system with gamification?

4.1 Conceptual framework design

Our research proposed the conceptual framework for developing a tutorial system that selects exams based on the learner's knowledge level. For instance, the proposed exam level will provide practice for a weak learner until the correct understanding is achieved, followed by a more challenging exam based on the learner's knowledge level. In contrast, more successful students are presented with more difficult examinations [58].

The system components are illustrated in Figure 1 as follows:

Measuring students' performance. When students enter their answers into the system, this section determines whether the answer is correct or incorrect. The system then selects and displays questions from the test item bank that correspond to each student's current level of knowledge.

Student's profile. This section contains two student profile elements: 1) student information related to the exam, including student responses for each question, the student's time on the exam, the number of incorrect answers, and usage statistics. 2) the relationship between student achievement and game elements such as points, rewards, and student level. This section identifies each learner's skill level. It also reflects each student's understanding of the topic being practiced.

Test item bank. This section collects digital literacy exams that will be used to formulate exams tailored to the individual learner's knowledge. The exams are grouped according to the test item's difficulty. The item's difficulty was determined by administering the exam to the test group. Then, take the examination to determine the difficulty level for each question and classify them according to their literacy.

Matching students' profiles and the test item. This section decides the selection of appropriate questions for the learner's level of knowledge based on the student profile. In addition, it is the part that considers questions from the Item test bank to compare and consider the difficulty suitable for the learners. The goal is to encourage and train students to develop more.

Game elements management. This section employs game mechanics to stimulate and encourage learners' responsive behavior. The student's profile is processed to update the game element based on the student's performance.

User interface. This section displays exams and game elements obtained from the system. In addition, it serves to collect learners' responses to each question. When the learners complete the exercises on time, the system will display their scores and rank the results on a scoreboard. In addition, students can practice and repeat the exercises as often as they desire.

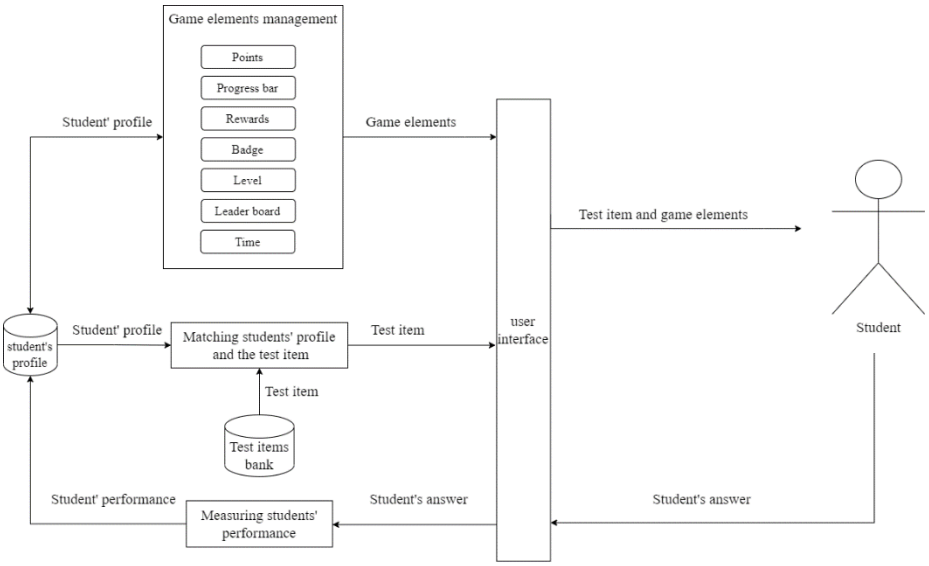

Fig. 1. The adaptive tutoring with gamification system

After analyzing the system's key components, the researcher identifies the main phases that will guide the design of the system's flow, consisting of the phases listed below.

Knowledge assessment step. When learners log into the system, the system will assess their level of knowledge. If students use the system for the first time, it will select questions randomly to assess their prior knowledge. The difficulty level of the questions is determined based on the learner's level of knowledge and Bloom's taxonomy. However, suppose the learner has previously completed the exercises. In that case, the system will randomly select questions based on the learner's stored point values and select questions based on the learner's skill level.

Practice step. Questions will be tailored to the learner's knowledge level. The digital literacy test consists of three sections: information literacy, media literacy, and information literacy. These assessments are divided into three levels: remember, understand, and apply, corresponding to Bloom's learning levels. Therefore, if a student has previously received training or completed the exercises, questions will be randomly assigned to a more challenging level upon initial use. At the same time, stu-

dents who have never accessed or received a low score are presented with Level 1 questions, the basic level for practice until comprehension is achieved. However, the timer limits the difficulty of accomplishing the exercises. When the time expires, the system will display the students' scores. The procedure for modifying the examination is as follows:

(a) Questions on Level 1. The system will display Level 1 questions with a point value of two upon initial use. When students answer three consecutive questions correctly, the system will adjust the difficulty level to level 2. Nonetheless, if students answer incorrectly, the system will continue to randomize level 1 questions.
(b) Questions on Level 2**.** Each question in Level 2 is worth five points. When students answer three consecutive questions correctly, the system will switch to Level 3 questions. However, if the student answers incorrectly three times in a row, the system will decrease the difficulty by randomly posing level 2 questions. Moreover, if students provide three consecutive incorrect responses, the system will reduce the difficulty from level 2 to level 1.
(c) Questions on Level 3. Each question in Level 3 is worth ten points, the maximum possible score. To maintain Level 3, students must answer questions consecutively. However, the students were permitted to answer incorrectly three times. If students make consecutive errors, the system will lower the difficulty to levels 2 and 1. Calculating the score, as shown in Figure 2.

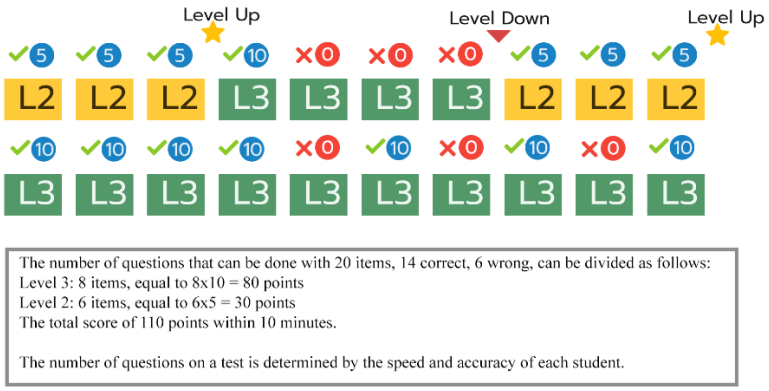

Fig. 2. Shows an example of calculating the score in case the learner has basic knowledge before

Evaluation step. The system calculates scores based on questions grouped by difficulty level. In other words, if a learner has the opportunity to take the exercises at level 3 and answer several questions correctly, they will score higher than the learner the students who take the exercises at other levels. The following is an example of scoring from 20 questions: The duration of a single exercise is ten minutes. Therefore, the number of questions the learner will practice will vary based on his or her knowledge and ability. For instance, a student with basic digital literacy knowledge

may complete more exercises than a student who has never studied them. As a result, there was a possibility of achieving a higher score than those who lacked this knowledge. It is also consistent with behaviorism theory, which holds that learning can be sustained if the learner repeats the exercises. Changing the player's level, as shown in Figure 3.

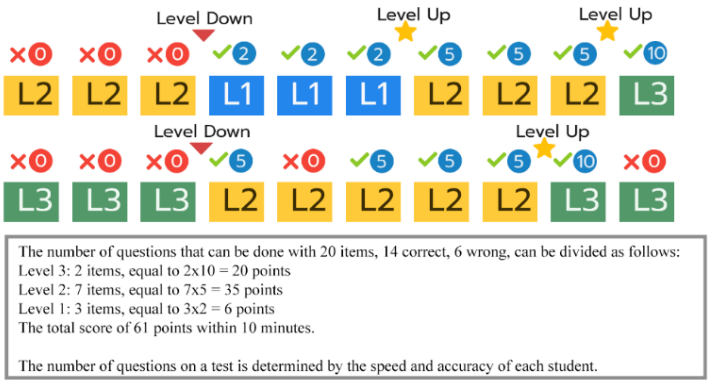

Fig. 3. Shows an example of exam levelling and scoring

Game mechanics' step. This step employs game mechanics to stimulate and encourage learners' responsive behaviour. When the learners complete the exercises on time, the system will display their scores and rank the results on a scoreboard. In addition, students can practise and repeat the exercises as often as they desire [27].

4.2 Expert validation results

Providing a conceptual framework is the most precise and exhaustive approach. The researcher administered a questionnaire to experts to obtain quantitative and qualitative responses to open-ended questions to revise the proposed framework until it was complete. The results which helped develop a conceptual framework for an adaptive tutorial system with the gamification to improve digital literacy, as evaluated and certified by seven experts, are as follows.

Table 3 shows that the experts agreed overall in terms of the tutorial system's components and procedures are appropriate (a total mean of 4.44). Most of the experts strongly agreed that the system design concept applies to the issue at hand (mean 4.86). This is followed by the components that can be used to improve exam preparation, and the addition of game elements encourages students to continue using the system (mean 4.71). This data showed that the experts concurred that the proposed system components were logically related at the lowest level (mean 4.00). There are some recommendations from experts regarding the design of adaptive tutorials with gamification, such as the number of exams that must be included in the test bank for greater randomization of the examination. In addition, the examination should be appropriately graded, neither too easy nor too complicated, so it is neither challenging

nor monotonous. The operation of the system is readily available and has a user-friendly interface.

Table 3. Expert validation results

Question	Mean	SD	Level of Agreement
1. The proposed system components are suitable for use in enhancing practice for exams.	4.71	0.49	Strongly Agree
2. The proposed system components are complete enough to be developed.	4.29	0.76	Agree
3. The proposed system components are logically related.	4.00	0.82	Agree
4. Game elements in the system can help motivate learners to practise exams.	4.43	0.53	Agree
5. The workflow are set correctly.	4.43	0.53	Agree
6. The steps are sequenced clearly and easy to understand.	4.57	0.53	Strongly Agree
7. The workflow is suitable and complete according to the function.	4.29	0.76	Agree
8. The workflow is related to each other according to the function.	4.29	0.49	Agree
9. The concept of system design is applicable to the issue at hand.	4.86	0.38	Strongly Agree
10. The concept of system design has the potential to develop.	4.43	0.53	Agree
11. The addition of game elements encourages students to continue using the system.	4.71	0.49	Strongly Agree
12. The presented conceptual framework assists students in developing digital literacy.	4.29	0.49	Agree
Overall	4.44	0.57	Agree

This study proposes a conceptual framework for designing an adaptive tutorial system to assist Thai university students in preparing for the digital literacy skills exit exam before graduation. Gamification is incorporated into the proposed system design concept to motivate and encourage students to practice more for exams.

However, only descriptive statistical methods were used for this study's data analysis. In future studies, we plan to employ more sophisticated statistical methods, including a comparison of the learning gains obtained when using this tool versus those obtained when using a traditional test, an evaluation of the tool's motivational impact, and a quantification of the enrollment pleasure associated with using this tutoring system.

5 Conclusion

This research aimed to determine the optimal components and procedures for developing an adaptive tutorial system to assist students in preparing for the digital literacy skills exit exam before graduating from university. This system was proposed based on a conceptual framework that provides a test item for practice based on the learner's proficiency level [23,25,43]. It also employs game mechanics to make the students who lack the motivation to practice taking exams more enjoyable and challenging [39,41-42]. The findings of this study can be summarised into six components

of the system design that have been validated by experts, consisting of 1) measuring students' performance, 2) student's profile, 3) test item bank, 4) matching students' profiles and the test item, 5) game elements management, and 6) user interface. Furthermore, we provide recommendations regarding six-game elements deemed appropriate for adaptive tutorial systems: points, levels, badges, leaderboards, time, progress bars, rewards, and feedback, which can be implemented in gamified tutorial systems or activities for education [31].

Despite the limitations of this study (small group of experts, basic statistical methods), it demonstrates that the results of our study could provide a robust framework for ensuring the development of practical systems. Therefore, a future study will focus on testing the usage of the adaptive tutorial system in preparing Thai university students for the actual exam, comparing students in the experimental group to those in the control group. This study's benefits include guidelines for developing tutorial systems for students and evaluating overall digital literacy achievement for policy planning to support them and in preparation for further literacy development for students at other levels for working in a digital society.

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