

An Online Web-based Adaptive Tutoring System for University Exit Exam on IT Literacy

Charoenchai Wongwatkit

School of Information Technology, Mae Fah Luang University, Thailand

wongwatkit.c@gmail.com

Abstract— With the significance of information technology literacy in the 21st century, the university requires all students to have specific knowledge of this topic before graduation by taking the exit exam. The university has encountered the problem with the meager rate of students who passed this exam. Since they learned this topic in the freshmen year, their understanding of this topic may be lost and limited consequently. Therefore, the students need a tutoring system that can help them to review the content effectively before taking the exam. In this study, an online web-based adaptive tutoring system has been developed by adopting the context of exit exam on information technology literacy. The developed system embedded an adaptive structure on questions, assessment and learning profile that can help students to better prepare and refresh their knowledge before taking the exit exam. The system has been tested for the system performance before use. To find the effectiveness of this system, the data analysis has been conducted. The results show that the students who learning and practicing on this system have higher achievements on the exam, while the university has a higher rate of students who passed this exam accordingly. The findings of this study shed light on the significance of preparing students to be ready before graduation by the competent, meaningful support of online learning system.

Keywords— Online Tutoring System, Information System, Adaptive Learning System, Information Technology Literacy, University Exit Exam

I. INTRODUCTION

In the past years, the advancement of information technology has played a crucial role in modern society and everyday activities and lifestyles. Information technology literacy has become one of the essential skills in 21st century education [1], [2], which includes how to use the Internet safely and ethically, how to work collaboratively and efficiently, how to assess the quality and reliability of information and sources, how to applying existing technologies to enhance quality of life, study, work and health, etc. In recent years, many employers strongly require this literacy from the job applicants and the existing workers [3].

This IT literacy skill has been continuously promoted in schools and universities through some courses. Some universities have an exit exam on this skill to assess and guarantee the sufficient knowledge and skills before graduation in preparing them ready for real-world lives. However, most students have encountered the difficulty in passing this exam owing to the low retention level of

knowledge, lack of updating modern techniques and tools, and no exercises to practice their skills.

In the past years, many studies have been working on developing the online learning systems on different applications [4]–[6]. It was repeatedly found that they could help enhance learning achievements successfully. Some researchers have attempted to improve such environments by equipping with interesting features to further promote learning motivation and attitude on the online learning environments. In educational technology, adaptive learning system has been proposed with the ability to adapt the learning activities based on the diagnosed learning experience, resulting in better learning performance, motivation and acceptance [5], [7], [8].

Based on this perspective, it is necessary to address the issues as mentioned above in better preparing the students' IT literacy for the exit exam. Therefore, this study aims to propose an online web-based tutoring system to help the students to review and exercise before taking the exam. In this study, the software development lifecycle has been employed to develop the system. An adaptive module has been designed to analyze the learning profile and adapt the tutoring activities. After successful implementation, the students who enrolled for the exam can use this system for personal preparation. Their before-and-after exam results were collected for analysis in this study.

The structure of this paper has been organized as follows. The background and significance of this study are presented in Introduction, followed by the review of related studies of online tutoring system and adaptive learning. The methodology in developing the system has been presented in details. In the end, the results of using the proposed system are revealed, while the conclusion and discussion of this study have been stated accordingly.

II. LITERATURE REVIEW

A. Online Tutoring System

Online tutoring system aims to foster the learners' better learning performance with the support of technology. This type of system has been used for many purposes, ranging from preparing students' readiness for examination or competition, for reviewing the knowledge learned, for extending and enhancing more skills. This can be used to support formal and informal learning settings. Tutoring system has been developed in various platforms, web-based system, mobile application, individual and collaborative learning [9]–[11].

Some tutoring systems have adopted the benefits of content management system or open source learning platforms [12]. This technology provides a number of ready-to-use functionalities with ease of use for both admin and the learners. However, these free systems are limited in some specific features. Therefore, it needs tailor-made tutoring systems with specific design and functionalities. This type can be designed to incorporate any changes or updates during the use and to support several roles of users.

In the past years, there have been many attempts to develop online tutoring systems in various formats and applications. Several studies developed an intelligent tutoring system to support collaborative learning [10], [13], while some developed game-based tutoring systems to further promote enjoyment while learning [14], [15]. Online tutoring systems have been designed for many subjects, e.g. computer [12], [16], [17], mathematics [11], language [18]. The findings of these developments have shown positive results for students' learning performance and motivation. Moreover, it promotes higher level of their learning attitude towards online learning system.

Based on the benefits of online tutoring system, it sheds light of this study to design the system that supports students to review and exercise before taking the exam.

B. Adaptive Learning

Adaptive learning is a way to provide adaptive learning activities and experiences to individual students by considering their learning background, profile or experience [19]. Facilitated by the interactive learning environment, this approach could better help promote students' learning achievement, learning motivation and attitude, necessary skills in 21st education, collaborative learning and distance learning [6]. In recent years, adaptive learning has been applied in different types of interactive learning environments, e.g., web-based learning system, mobile game-based learning application, ubiquitous and context-aware learning environments, and mixed for more personalized, engaging, enjoyment, and acceptance [20], [21].

In the meantime, adaptive learning has been applied and presented in a wide range. Many studies propose its mechanism in certain environments, which give more details of how it operates, what are the inputs and outputs of that mechanism. Some studies attempt to present the development with an embedded mechanism to present what application and context are used in running the system, while some applied the formative assessment technique in enabling their mechanism more powerful by emphasizing the on-going learning process [22], [23]. Furthermore, some studies have developed the adaptive learning mechanism to diagnose/identify the existing learning situations of the students in order to provide more meaningful and personalized learning experiences [24].

Adaptive learning has been widely applied in many interactive learning systems across fields of study, e.g., language, natural science, health science, mathematics, history, and computer [22], [25], [26]. They considered multiple sources of personalization, e.g., learning style, cognitive style, learning progress, and learning achievement, for different

investigations, e.g., feedback evaluation, conceptual knowledge learning, conceptual change [27]. The findings of these systems have aligned in the agreement that they could provide benefits to students on learning attitude, problem-solving skills, and scientific reasoning [28], [29].

Therefore, this study considered adaptive learning as a practical approach in enabling the proposed tutoring system more beneficial by considering in-progress learning profile to diagnose and identify suitable learning materials and activities.

III. METHODOLOGY

This study developed an online web-based adaptive tutoring system, after this called ITOLS, by following the software development lifecycle. The context of this study was based on the exit exam on IT literacy of Mae Fah Luang University, Thailand.

A. Analysis

Before designing the system, the initial analysis has been done by considering the context of exit exam on IT literacy. This exam is held six times per academic year for the students who completed all the required courses, mostly in the senior year. The university requires all students to pass this exam before graduation in order to ensure their sufficient body of knowledge and understanding on IT literacy before entering the real world.

The exam covered the content learned in the freshman year on Introduction to IT course, and some of the emerging technologies. Since the course had been finished three years ago, most students could not retain sufficient understanding and knowledge of this subject; moreover, they have not reviewed and refreshed their knowledge owing to the lack of effective tutoring system. Therefore, it led to the low rate of students who could pass this exam. Regarding this perspective, an online tutoring system was necessary. This system was not expected only to help enhance the exit exam results, but also to encourage meaningful learning.

B. System Design

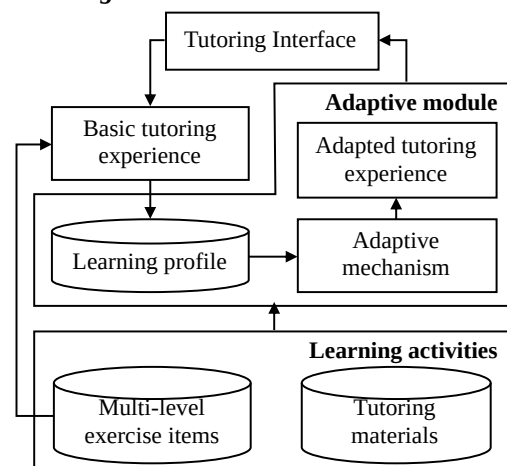


Figure 1. A system structure of the proposed adaptive tutoring system

In order to develop a tutoring system, a system structure has been firstly designed, as presented in Figure 1. The system

can be presented in three main modules. In learning activities module, it contains the database of multi-level exercise items (easy, medium and difficult) and multimedia-based tutoring materials. Once students entered the online web-based learning interface, they firstly receive basic tutoring experience retrieved from the mentioned module. In the adaptive module, their learning status was stored in the learning profile database and analyzed by the adaptive mechanism whether they passed the required threshold level. If passed, they are considered to learn the next unit; otherwise, the mechanism will adapt the tutoring experience with a different level of exercise items and tutoring materials. At this point, the system provides a more meaningful learning experience that is suitable for their learning performance. Consequently, the students are expected to gain sufficient knowledge of each learning unit and passed all learning activities.

C. System Development

In this study, the proposed online adaptive tutoring system has been developed with Moodle 3.4 on the local web server. Several settings and configurations have been performed. Starting from setting up the course, enrolling students, importing the materials, setting the exercises, and configuring all the conditions and requirements.

As presented in Figure 2, a login page for students who enrolled in the exam. They can simply log in with their associated Google accounts provided by the university. Figure 3 shows the layout of the tutoring system and several learning units in hierarchy structure. Figure 4 shows the exercise page with sample exercise items. The students can also navigate to any of the items on the right-hand side to review or change their answers.

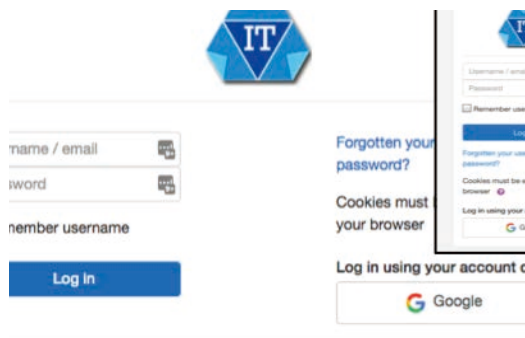
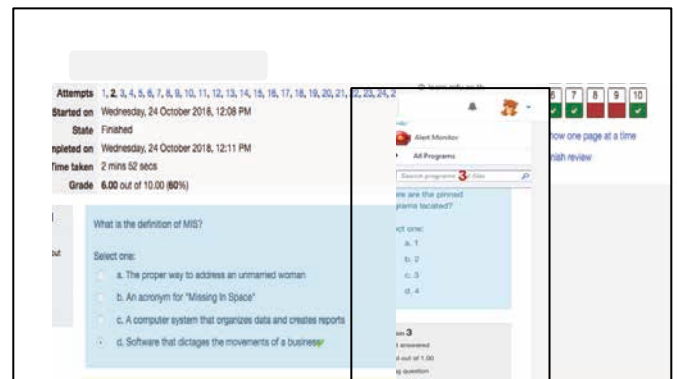


Figure 2. A login page of the tutoring system with University Google account



Figure 3. An overall structure of learning units



D. System Implementation

In this phase, the system has been implemented on the production server. The specification of the server includes Windows Server 2016 Standard, Intel Xeon CPU E5-2640 v4 @ 2.10Ghz (2 processors) and 4.00GB of RAM. The web server installed is XAMPP for Windows 7.0.26 which includes PHP 7.0.26, Apache 2.4.29, Maria DB 10.1.29 and phpMyAdmin 4.7.4.

Once deployed on the server, the system has passed several tests. As shown in Figure 5, the system obtains good performance of loading time of 4 seconds on 3G network, while Figure 6 shows that the proposed system was in a good position compared to other top-performing sites in the same industry. The testing also suggests a few fixes to reduce loading time by compressing images and resources with GZIP and eliminating render-blocking JavaScript and CSS in above-the-fold content (<https://testmysite.thinkwithgoogle.com>). Figure 7 also reveals the good results of the system on page speed, fully loaded time, page size and number of requests (<https://gtmetrix.com/analyze.html>).

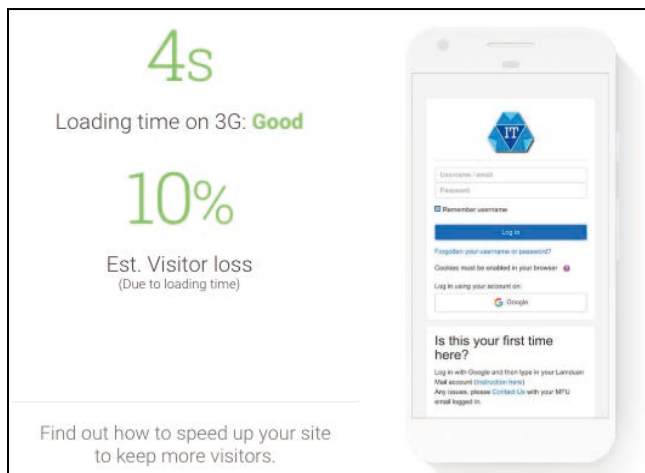


Figure 5. A testing result of system's speed test on 3G network

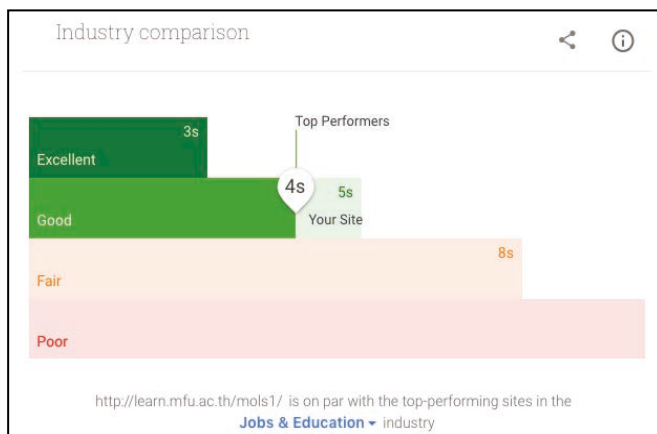


Figure 6. A testing result of system's loading time compared to top-performing sites

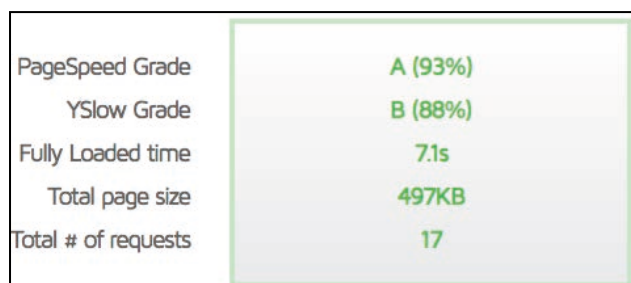


Figure 7. A testing result of system's performance scores and page details

IV. RESULTS

To examine the effectiveness of the proposed ITOLS, the EE-IT scores were used for analysis in this study. The participants recruited in this study consisted of 1478 and 1324 students before and after using ITOLS, respectively.

The students who enrolled for EE-IT used the system several weeks before the exam. They were from five major fields of study including Management, Aviation, Tourism and Business Administration (MNG), Health Sciences (H.SCI), Natural Sciences, Agro-Industry and Cosmetics (N.SCI), Liberal Arts and Sinology (L.ART), and Medicine, Nursing and Dentistry (MED).

A. Exam Scores

As shown in Table 1, it was found that the exam scores of students before using ITOLS ($M = 48.23$, $SD = 9.31$) were significantly lower than those scores after using ITOLS ($M = 67.07$, $SD = 11.25$). Moreover, when looking at their performance grouped by fields of study in Figure 8, it was clear that students from MNG, H.SCI, N.SCI, L.ART, and MED had increased the exam scores by 19.09, 20.30, 18.89, 17.82 and 18.10, respectively. This result showed that the proposed system could help students improved their exam performance.

TABLE 1. DIFFERENCE OF EXAM SCORES

Group	N	$M \pm SD$	t	p
Before	1478	48.23 ± 9.31	24.531	0.027*
After	1324	67.07 ± 11.25		

* $p < 0.05$

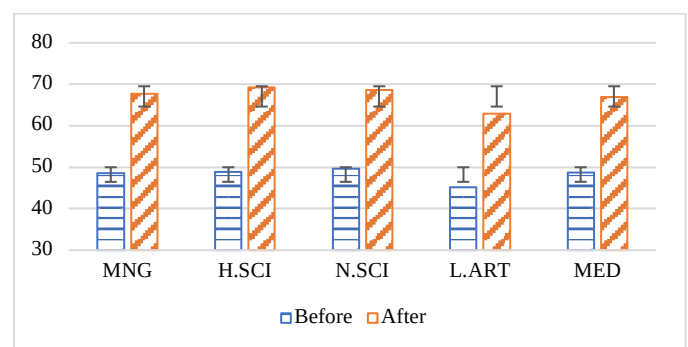


Figure 8. Difference of exam scores by fields of study

B. Students who Passed the Exam

The system not only helps improve the exam scores but also help increase the number of students who passed the exam. As illustrated in Figure 9, it was found that the number of students who passed the exam from MNG, H.SCI, N.SCI, L.ART, and MED has increased by 12.40, 17.98, 23.17, 27.85 and 32.47 percent, respectively.

This result confirmed that the proposed system could help the students passed the minimum requirement of the exam and finally passed the exam.

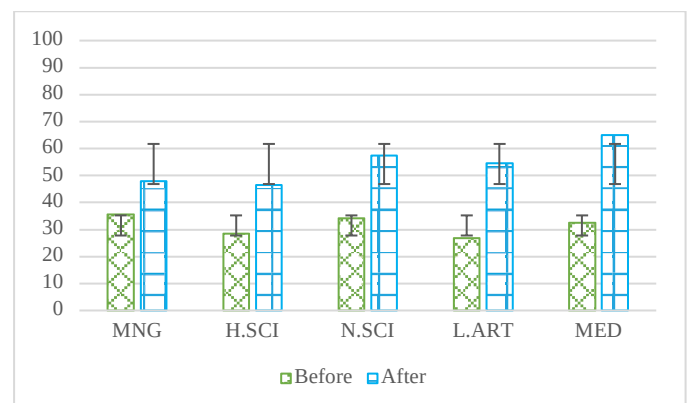


Figure 9. Percentage of number of students who passed the exam by fields of study

V. CONCLUSION AND DISCUSSION

A. Summary

Owing to the low rate of students who passed the exit exam on IT literacy, it is necessary to have an effective tutoring system which can help students to review and refresh their body of knowledge and understanding. Therefore, this study proposed the development of an online web-based tutoring system by following the software development lifecycle. The adaptive module has been designed and embedded in the system to provide a more meaningful learning experience. Moreover, the system has been implemented and tested before using by the enrolled exam students. Based on the exit exam results, it was found that the students had improved their exam results significantly after experiencing the proposed system; accordingly, the number of students who passed the exam has been increased.

B. Discussion

The findings of this study show that an embedded adaptive mechanism plays a vital role in analysing students' learning experience and providing more personalized activities [30]. Moreover, this tutoring system was designed by taking the actual context of the users and the problem of the university's exit exam into consideration. This analysis phase is significant to the success of the system, which was in agreement with many studies [31], [32]. Although the system could help the students to improve the exam results, the number of students who passed the exam can be further improved by considering more personalized features [33].

C. Recommendation and Guideline

It is recommended that the proposed system can be applied with other courses, while the learning materials and activities need to be prepared by corresponding teachers. The conditions and configurations of the system can be changed. While using in the production stage, it is essential to have the experienced technician or administrator to maintain the performance of the system; meanwhile perform the backup regularly. To avoid the dissatisfied experience, the instruction and manual to use the system need to be provided to the students, teachers, and admins; moreover, the training could be considered additionally.

D. Limitation and Future Study

The system proposed in this study remains some limitations which can be further improved. First, the adaptive mechanism should consider more learning factors rather than the exercise's scores only. Second, some features did not work well on mobile; therefore, it needs more functionality to support the better mobile learning experience [34]. Besides, further studies can be done by investigating the relationship between the learning results and time spent on the system and taking learning data into depth analytics and visualization [35].

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Dr. Charoenchai Wongwatkit is a lecturer at School of Information Technology, Mae Fah Luang University, Thailand. He earned Ph.D. in Science and Technology Education from Mahidol University, Thailand in 2016 and M.En. in Information System from Inje University, South Korea in 2010. In 2014, he joined research exchange program in National Taiwan University of Technology and Science, Taiwan. His research interests and publications include interactive learning environment, mobile and game-based learning, artificial intelligence in education, and interactive media and business information system.