Roles of Chatbots in Gamified Self-Regulated Learning System to Enhance Achievement Motivation of Learners in Massive Open Online Courses

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Abstract: The integration of self-regulated learning, which allows learners to set goals and plan their learning according to their needs and interests, with the concept of gamification creates challenges and engagement in learning. Additionally, the use of chatbots to provide real-time feedback can stimulate learning and significantly enhance achievement motivation in massive open online courses (MOOCs). In this study, we present a learning innovation system in the form of a gamified self-regulated learning (GSRL) system to address the low completion rate and high dropout rate of learners in MOOCs. Our system enhances learners' achievement motivation. The objective of this study is to examine important factors in the development of GSRL systems to enhance achievement motivation for MOOCs and to study the results of using the GSRL system with learners in higher education. This research adopts a research and development approach, collecting both quantitative and qualitative data. Quantitative data were collected from questionnaires, and qualitative data were collected from expert interviews to inform the design and development of the GSRL systems. Quantitative data collected from 898 higher education students were analyzed using confirmatory factor analysis. The GSRL system was then used experimentally with 205 Thai MOOC students. It was found that the overall achievement motivation following this study was significantly higher than the rate before studying. Classification by age showed that learners aged 20 years and older developed achievement motivation that was higher than that of those under 20 years old. The results of the analysis of the achievement motivation correlations in regard to learners' opinions and learning behavior observation found that learners with high achievement motivation tend to exhibit behaviors that reflect this.

Keywords: MOOCs, Achievement motivation, Self-regulated learning, Gamification, Wearable device

1. Introduction

Many countries around the world have been promoting educational innovation through the application of digital technology for learning at all levels to enhance lifelong learning (Jones and Sharma, 2019; Lara-Prieto et al. 2019; Xu et al., 2020; Li et al., 2022). The introduction of a range of portable electronic devices to the study context has changed the way in which students learn, allowing them to learn anywhere and anytime by using a variety of mobile devices. Students in the digital age expect interactive technology media and learning challenges (Shahmohammadi et al., 2017; Babic, Gaspar, and Satala, 2018), as well as flexible learning and the use of a learning system that can be accessed anywhere and anytime (Al-Soh and Zualkernan, 2017; Royal Thai Government Gazette, 2018; Xu et al., 2020). This accessibility leads to the development of achievement motivation among learners (Huang and Lin, 2017; Pambudi, Bachtiar, and Pradana, 2019). Instructors in higher education should be aware of learning environments that focus on the context of massive open online courses (MOOCs) to expand learning opportunities by means of mobile devices that the students already have. The bring your own device approach, combined with adult learning concepts such as self-regulated learning (SRL), will result in maximized learning potential (Khlaisang, 2013; Theeraroungchaisri and Khlaisang, 2019; Wong et al., 2019; Galindo, Romero-Rodriguez, and Montoya, 2019; Jansen et al., 2020; Lee, Watson, and Watson, 2020; Moreno-Marcos et al., 2020; Shi et al., 2024). On this note, a study from Malaysia examined the role of SRL in relation to student satisfaction with a Malaysian MOOC. The components of SRL consist of (1) time management, (2) planning, (3) self-evaluation, and (4) help-seeking. The results of this indicate that the SRL components apart from help-seeking are important factors for explaining learners' satisfaction in a MOOC (Zalli, Nordin, and Hashim, 2019).

In addition, research has been conducted on the relationship between self-efficacy, task value, and SRL in MOOCs at Midwestern University, USA, developed on the edX platform. The results showed a positive correlation between self-efficacy and the use of SRL. A positive correlation was also found between task value

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and the use of SRL. SRL use greatly depended on self-efficacy and task value. In addition, learners who had high task value showed statistically significantly higher average SRL learning scores than those who had low task value (Lee, Watson, and Watson, 2020). This result is in agreement with a study conducted at the Open University, UK, which investigated SRL in face-to-face language modules with MOOCs. The results showed that integrating MOOCs into instructional language modules could result in innovative and blended learning. This offers students a direct approach to instruction allowing them to continue in their independent learning. In addition, students have an online learning engagement that supports their SRL behavior while studying at their own pace and practicing their language skills (Gafaro, 2019).

Thailand Cyber University, a project developed under the Thailand Ministry of Higher Education, Science, Research and Innovation, launched a Thai MOOC in March 2017 on the Open edX platform, an open-source platform for digital learning that aims to empower sustainable lifelong learning in Thailand through the provision of free access to quality educational resources. This is a national platform for course content, learning activities, and evaluations, with over 1.5 million members enrolled and more than 1.4 million certificates issued, as of December 2022. The platform also hosts over 600 courses co-created by official partners from the public and private sectors within Thailand and internationally (Thammetar et al., 2022). However, tools are still lacking for increasing learning achievement rates and enhancing students' motivation for online learning. A review of the literature review on learning design in MOOCs in higher education showed that SRL is a learning process in which learners' ability to plan, supervise, monitor, and choose suitable learning strategies is influenced by motivation and the learning environment, thereby affecting their ability to achieve their desired learning goals (Boekaerts, 1999; Pintrich and Zimmerman, 2000; Boekaerts, Pintrich, and Zeidner, 2005; Boekaerts and Cascallar, 2006; Zakaria, Anas, and Oucamah, 2024). Gamification can be deployed to enhance the achievement motivation for learning. The use of game concepts for organizing activities may consist of components such as badges, competitions, participation, assigned tasks, and appropriate feedback for learning. Learners are entertained through participation and encouraged to learn (Ghasemi et al., 2011; Bipp and van Dam, 2014; Smith, 2015; Sharma and Sharma, 2018). However, even if the instructor uses SRL and gamification concepts in their instruction, a real-time tool to monitor individual progress in learning through MOOCs is still lacking.

Chatbots and wearable devices are in widespread use in daily life. Chatbots have been used throughout the commercial sector. Wearable devices (Zarouali et al., 2018; Pereira and Díaz, 2019; Van den Broeck et al., 2019), such as smart watches, can be used to control, track, and alert users in their daily activities, such as exercise (Souza et al., 2017; Pambudi, Bachtiar, and Pradana, 2019) and medical care, elderly health care in particular (Garg, 2018; Chung and Park, 2019; Sheth, Yip, and Shekarpour, 2019). However, this technology remains uncommon in education, especially in the Thai context. Thus, this study uses ubiquitous learning as a learning environment that employs computers able to access content anywhere and anytime. Learning environments can be altered in response to the real situation and to offer learning flexibility (Khlaisang, 2018). This provides students with the freedom to learn in an environment that is adaptable to their individual needs. Innovation in this research will help fulfill the process and increase achievement motivation. This can result in the success of learning in MOOCs as well (Sheth, Yip, and Shekarpour, 2019; Zobel, 2023).

This study was conducted to answer the following research questions: (1) What are the essential conditions and requirements for effectively implementing a gamified self-regulated learning (GSRL) system within the Open edX platform for MOOCs in Thailand, considering the principles of adult learning theory (andragogy) and personalized learning?; (2) What are the key factors influencing the development of GSRL systems that significantly impact achievement motivation among Thai learners in MOOC environments?; (3) How do the features of GSRL systems in ubiquitous learning contexts bolster achievement motivation in MOOC learners?; and (4) What is the impact of studying in a GSRL system on learners' achievement motivation in MOOC learning contexts, both before and after their engagement with the system? The theoretical framework of this study is shown in Figure 1.

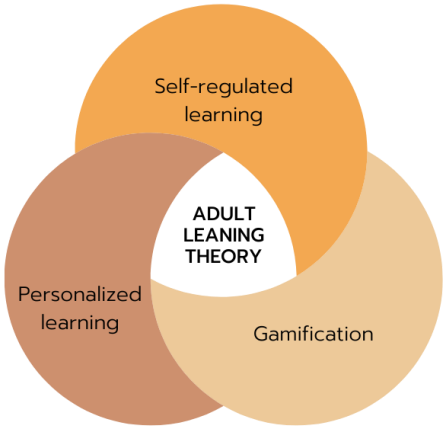

Figure 1: Theoretical framework

By combining Personalized Learning, Self-Regulated Learning, and Gamification, this theoretical framework supports the development of a dynamic and engaging educational environment. It encourages learners to take ownership of their educational journeys, fostering motivation, adaptability, and deeper learning experiences.

2. Literature Review

2.1 Andragogy and Personalized Learning

Personalized learning allows learners to develop basic knowledge, skills, and abilities at their own pace. This is consistent with the theory of andragogy, which suggests that adults learn from their individual experiences. As noted for both approaches, critical factors, such as time, access to learning resources, motivation, and available learning resources, significantly influence learners' learning (Wozniak, 2020). Stoten (2020) found that in a personalized learning context, learners set their own goals, which is the key principle in SRL and andragogy.

2.2 Self-Regulated Learning

SRL is the process by which learners learn, think, and act in the context of their study, entailing planning, following up, monitoring, evaluating, and selecting appropriate learning strategies. A strong degree of motivation and a suitable learning environment can enable learners to achieve their learning goals (Panadero, 2017; Stoten, 2020; Zimmerman, 2000). This aligns with the research by Shi et al. (2024), who studied the behavioral patterns of learners that led to successful learning in MOOCs. Their findings indicated that self-regulation was a crucial factor for successful learning. Similarly, Zhao et al. (2024) stated that self-regulated learning served as a mediator for controlling positive emotions in MOOC learning. Additionally, Han et al. (2023) investigated learners' needs in MOOCs and found that learners desired to use chatbots to help them access useful information for their studies.

2.3 Gamification

In gamification, elements, and mechanisms of gaming are used in other contexts, such as in education, to enhance attention and motivation, leading to behavior modification in the form of increased participation and engagement (Antonaci et al., 2017; Klamma and Arifin, 2017; Li et al., 2022). This aligns with the research by Cheng (2024), which studied the role of gamification and personalization in MOOCs. The findings showed that gamification and personalization could enhance learning engagement, learning persistence, and learning outcomes. Similarly, Zakaria, Anas, and Oucamah (2024) reviewed the literature on the use of gamification in MOOCs for boosting motivation and engagement and reducing dropout rates. The study found that gamification elements such as badges, levels, leaderboards, challenges, and rewards significantly affected student motivation and engagement and reduced dropout rates in MOOCs.

3. GSRL System

Chatbots are considered a technology-enhanced learning tool in MOOCs that support personalized learning, encourage learners' engagement, and improve convenient access to information. This leads to an enhanced learning experience on MOOCs (Zobel, 2023), consistent with the aforementioned research. The GSRL system developed and deployed in this study is called iChat Smart. It aims to enhance the achievement motivation for

MOOC learners through an innovation in the use of wearable technology devices with the aim of tracking learning through the gamification. It acts as a personal assistant for students seeking to enhance their learning with the use of chatbots with a smart watch to set goals (iSet, iSchedule, iFollow), monitor learning progress, and receive automatic notifications (missions, levels, and badges). It has the following features and characteristics.

3.1 iChat Smart Helps and Facilitates Students

Students can communicate with chatbot on a smart phone via Facebook Messenger. A smart watch is connected through the Android wear application, which supports both Thai and English. From this, the system shows three menus for the students to choose from My Courses, Profile, and Goals and Settings (See Figure 2).

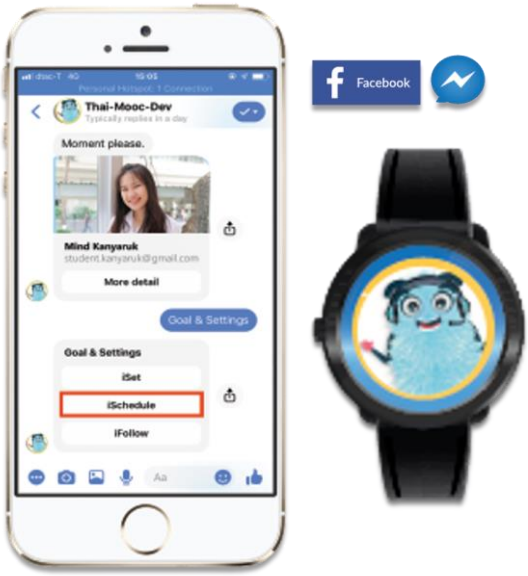

Figure 2: iChat Smart is a gamified wearable tracking tool developed to enhance learning engagement via a Chatbot personal assistant (goal setting through iSet, iSchedule, and iFollow; learning progress; and notifications in the form of missions, levels, and badges)

The chatbot system in this study had the role of a personal learning assistant able to be carried with students anywhere and used anytime, as many research studies found that it is helpful for students to use a tool that can monitor their learning and create motivation for learning (Winne, 2011; Adam et al., 2017).

3.2 iChat Smart Monitors Learning Process

When learners choose the My Courses menu, the chatbot system shows all the courses for which they registered. The sub-menus include More Detail and Learning Process, where students can view their progress in a course, whenever they wish. The system assigns levels and badges according to the concept of gamification (Ghasemi, 2011) in each course to create challenges and stimulate learning achievement motivation in learners (see Figure 3).

The Goal and Setting menu can be used by students to edit their profiles, create their class schedules, and set works for each course to which they are registered. Learners can use iSet to edit their profiles. Learners can create their class schedules and notifications in iSchedule. iFollow is used to create a class schedule and notifications in the form of a timetable. (See Figure 4).

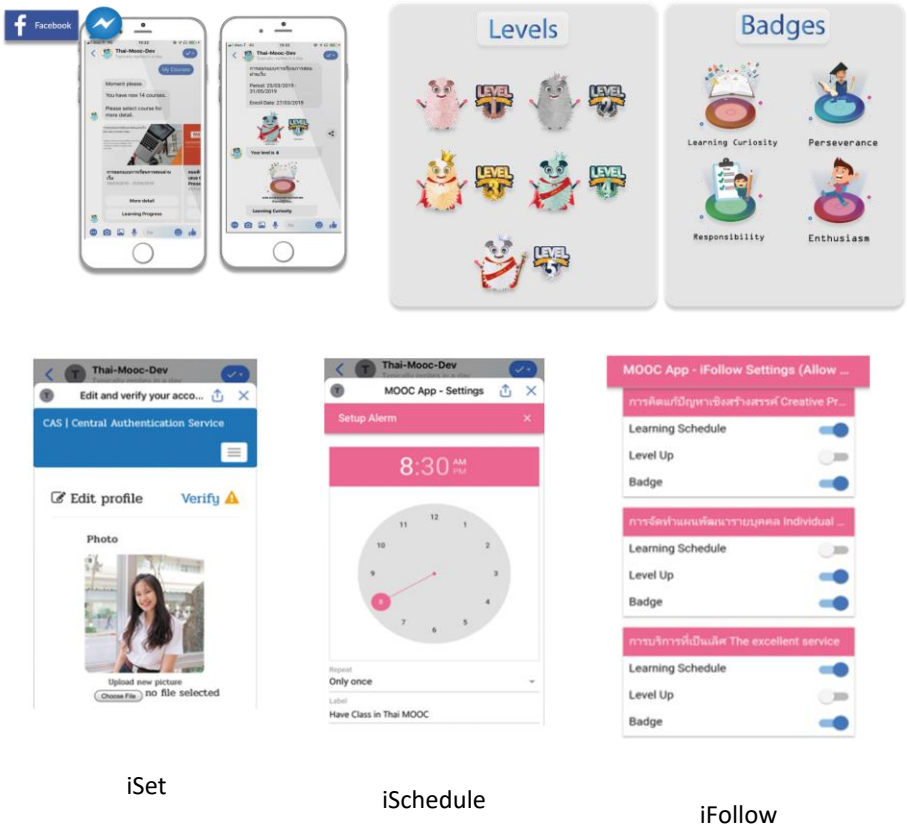

Figure 3: (Up) My Course menu, used to monitor learning progress and badges received. (Down) Goal and Setting menu, used to edit the Profile, create class schedule, and find assignments for each course registered

3.3 iChat Smart to Send Automated Notification

Learners can set the courses that they are registered to by using the chatbot with the smart watch. The smart watch application focuses on goals and settings in terms of learning goals and notifications to encourage students to learn continuously and achieve their learning goals (Figure 4).

Figure 4: Real-time notification. Use of the smart watch focuses on goal and settings and notifications to encourage students to learn continuously and to achieve their learning goals

4. Method

This study is research and development (R and D) research comprising four stages: Stage 1—Instructors' and learners' opinions on the conditions and needs of the GSRL system. Confirmatory factor analysis (Hair, 2010) was conducted using multi-stage sampling by region, followed by quota sampling by region and simple random sampling. Data was collected from 898 learners nationwide. Stage 2—Development of the GSRL system and quality assessment by five experts. Stage 3—Implementation of the GSRL system. The system was tested with 205 learners selected through purposive sampling based on criteria such as readiness to use technology tools and willingness to participate in the research. Stage 4—Presentation and refinement of the GSRL system. The

results from Stage 3 were used to make improvements, and the system was evaluated and certified by five experts.

4.1 Stage 1: Instructors' and Learners' Opinions on the Conditions and Needs of the GSRL System

Quantitative data were collected from 898 higher education students via an online questionnaire, which comprised (1) basic information of the respondents, (2) conditions and needs for the development of the GSRL system using a 5-point rating scale, and (3) a study of confirmatory factors for the development of the GSRL system using a 7-point rating scale, and the validity was 0.99. The resulting data were analyzed using descriptive statistical analysis of PNI modified (Priority Needs Index Modified) to identify the needs based on students' assessments of the existing condition and the desirable condition, comparing the two to highlight the differences and determine the development needs (Wongwanich, 2019). Additionally, confirmatory factor analysis (CFA) was conducted for the development of the GSRL system. Qualitative data were also collected from experts.

4.2 Stage: 2 GSRL System Development

Information from Stage 1 was used to design a draft of the system features and interface. Five experts specializing in self-regulated learning, gamification, or MOOCs reviewed the draft and adjusted it according to their suggestions to develop the system and user manual. The evaluation tool used was a 5-point rating scale with a validity of 1.00. The data were then analyzed by calculating the mean and standard deviation (SD).

4.3 Stage 3: Using the Results of the GSRL System

The researcher tested the system with a sample of 205 students enrolled in three courses on the Thai MOOC platform: (1) CU 016 Academic Presentation Techniques, (2) CU 020 Web-Based Learning Design, and (3) SWU 011 Infographic Design. The development of gamification and instructional content relied on the voluntary contributions of instructors, emphasizing lectures and practical exercises. Subsequently, data were collected from learners using a self-assessment achievement motivation test, utilizing a 5-point rating scale covering aspects such as learning eagerness, diligence, and enthusiasm, both before and after the study period. The self-assessment instrument had a validity of 0.99. Behavioral observation and learning traces were conducted for each student in the Thai MOOC, employing a behavior observation form. Data were analyzed using one-way ANOVA statistics.

4.4 Stage 4: Presenting the GSRL System

The findings from Stage 3 were utilized to enhance both the GSRL system and its instructional manual. The system underwent evaluation by experts specializing in self-regulated learning, gamification, or MOOCs, utilizing the GSRL system validation form, a 5-point rating scale with a validity of 1.00. Data analysis involved calculating the mean and standard deviation (SD). Subsequently, the system was made accessible for download on the Google Play Store.

5. Results

The study of the GSRL system was to enhance the achievement motivation in reference to MOOCs to address the research goals. Basic information on respondents totaled of 898 students in this study is shown in Table 1.

Table 1: Basic information of questionnaire respondents (n = 898)

Details	**Percentage**
Age	
21 years	34.9
20 years	27.8
Less than 20 years old	20.8
More than 20 years old	16.5
Educational level	
Bachelor's degree	69.4
Below bachelor's degree	30.1
Graduate degree	0.5

Details	Percentage
University location	
Northeast	25.6
North	25.4
Central	24.6
South	24.4

5.1 Research Question 1: What are the Existing Conditions and Needs That can be met Using a GSRL System That can be Integrated Within the Open edX Platform for MOOCs in Thailand?

To address this question, research was conducted to establish the opinions of instructors and learners on the conditions and needs that can be met by the GSRL system. The study results are divided into two parts, with the following details:

1. Basic information on respondents. A total of 898 students (details in Table 1) participated, including 601 (66.9%) females, and 297 (33.1%) males. Of these, 88.8% reported that they had access to computers for their own use, 99.4% of which could connect to the internet. Then, 99.4% of respondents reported having a smartphone for their own use. Most respondents indicated that they used the Android operating system on their devices. The most commonly used wearable device was a smart watch that can connect to a smart phone and perform email and activity alert notification. Of the smart phones and wearable devices used by our respondents, 82.4% could connect to the internet. Respondents reported an average of 10.12 years of experience in using computers, 8.11 years of using smart phones, tablets, and wearable devices, and 9.54 years using the internet.

Experience with chatbots was reported by 92.1% of the respondents, with Facebook being the most commonly used platform for engaging with them. In addition, 55.2% of respondents had studied via open online learning and 42.4% of them studied in a Thai MOOC (most commonly), followed by Khan Academy, Skillshare, and Coursera (least commonly). Most study for 1 hour, 1 or 2 times per week. The topics that the respondents studied most were primarily computer related, followed by science and foreign languages. Most respondents studied freely gain more knowledge in the course in which they are interested, as well as to apply and extend their knowledge and conveniently access information and knowledge at all times, respectively.

It was found that most participants, 86%, were successful in their studies in MOOCs. The factors resulting in learning success were concentration and focus on education, followed by diligence and self-discipline, as well as learning media that is well designed and interesting. It was found that lack of discipline in education, fatigue, and discouragement are the top factors in lack of success in studying in the MOOC context, followed by a lack of concentration and inattention and poor internet connections.

2. The condition and needs of the GSRL system analysis was used to identify needs. By this means, it was determined that students needed to learn more in the context of ubiquitous learning. Students had experience in learning through the use of wearable devices, such as a smart watch, and use self-direction for learning.

5.2 Research Question 2: What are the Important Factors in the Development of a SRL System (or GSRL System) That can Affect Achievement Motivation for Learners who are Engaged in Thai MOOC Online Learning?

A CFA was conducted on the design of the GSRL system. The results showed that systems can be comprised of eight components, including 1) teaching methods and technology that support achievement motivation (TEACH), 2) a ubiquitous environment (ENVI), 3) meaning and the concept of gamification (CONCEPT), 4) wearable device (WEAR), 5) learning planning (PLAN), 6) gamification itself (GAME), 7) the learning process (LEARN), and 8) learning goals (TARGET), as shown in Figure 5.

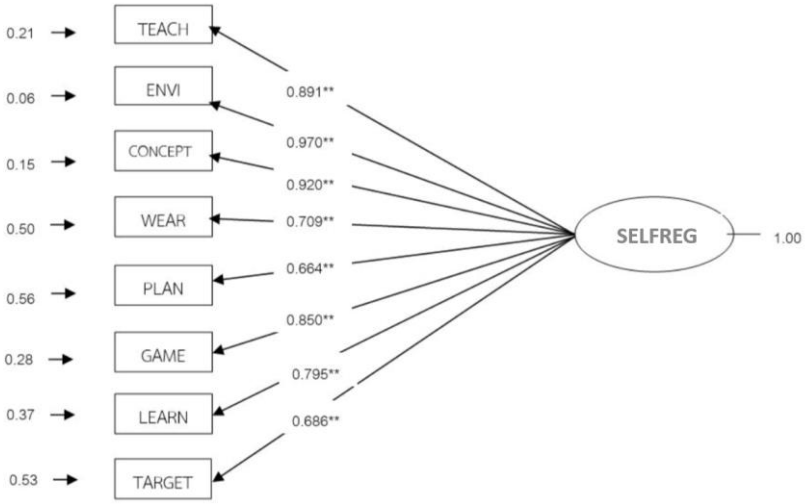

Figure 5: Confirmatory factor analysis of the design of the GSRL system

5.3 Research Question 3: What are the Necessary Features of a GSRL System in the Context of Ubiquitous Learning to Strengthen Achievement Motivation for MOOC Learners?

The GSRL system adopted in this study, called iChat Smart, was designed to enhance the achievement motivation of MOOC learners. Its design and development were in line with the eight components reported by CFA. Thus, the system consisted of four sub-systems: (1) a chatbot system for administrators and instructors, (2) a chatbot system for users (students), (3) a smart watch OS, and (4) a back office (web browser).

The system attributes have three parts, namely, (1) the plug-in program for instructors and learners in Thai MOOCs, (2) a chatbot system using Facebook Messenger that is linked to the Thai MOOC fan page, and (3) a notification system alerting students via wearable devices on the Android operating system, which is provided in terms of a collaboration between a chatbot on Facebook Messenger and an Android smart watch that allows users to receive notifications from Thai MOOCs in a convenient way. User information, registered courses, and learning progress can be viewed. The application can be downloaded from the Google Play Store.

Using iChat Smart, course instructors can set schedules, levels, and badges, according to the learner's progress or when learners are able to complete assignments via the web application. Students can choose to follow the instructor's schedule or edit the schedule in a way that is more convenient to them. In addition, iChat Smart is compatible with the use of Facebook Messenger on a mobile device or on a computer, via the Facebook website. Students can track their learning progress during the course. The levels and badges that students earn are shown in Figure 6 and 7.

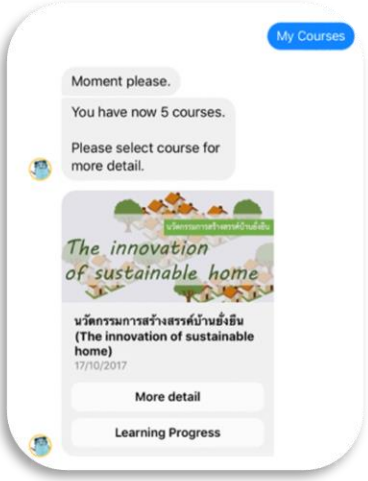

Figure 6: Chatbot system (via Facebook Messenger application) for students

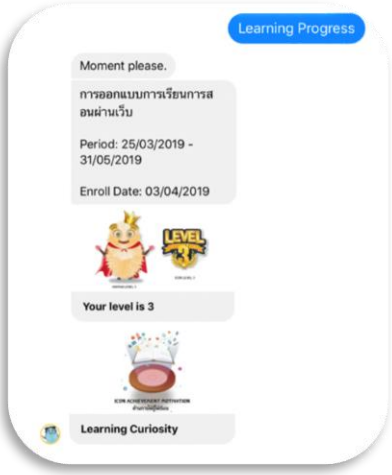

Figure 7: Example of earning levels and badges of students through the chatbot

In the diagrams and components of the iChat Smart system, Figure 8 shows the logical view, Figure 9 shows the use case, and Figure 10 shows the data dictionary for the iChat Smart system.

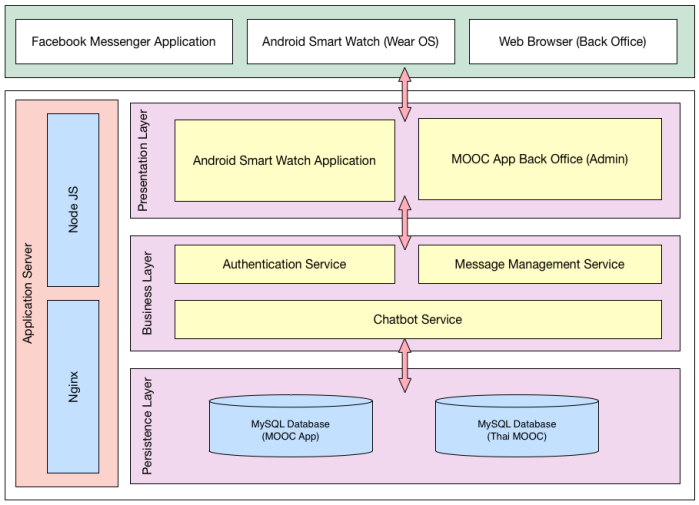

Figure 8: Logical view of the iChat smart system

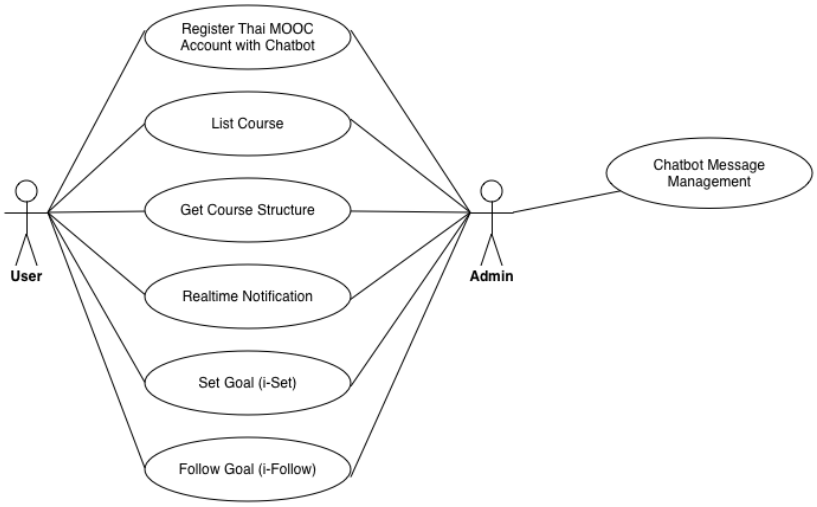

Figure 9: Use case of iChat smart system

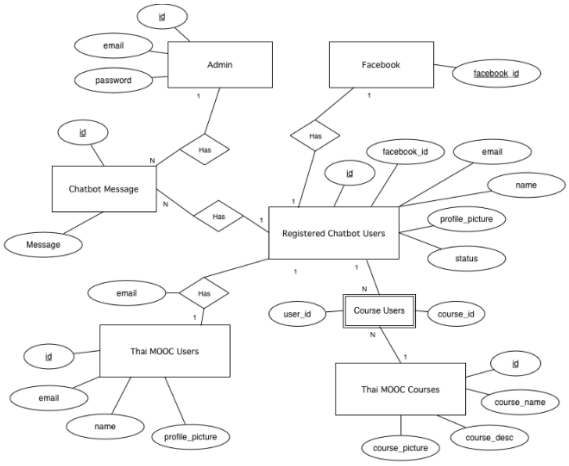

Figure 10: Data dictionary of iChat smart system

5.4 Research Question 4: To What Extent and how do Learners who Study With the GSRL System Have Different Achievement Motivation in MOOC Learning Before and After Studying

The researcher used the concept of gamification through using badges and levels to show learning progress and to create achievement motivation for learners. The researcher divided the achievement motivation into four areas, as follows: (1) inquisitiveness, (2) diligence, (3) learning creativity, and (4) enthusiasm. The results of research step 3 were used to address this question. The results for using the system according to the self-assessment of the learners are shown in Table 2.

Table 2: Using results of the system according to learners' self-assessment (N = 205)

Achievement motivation	Before studying		After studying		Analysis of differences before and after studying	
	Mean	SD	Mean	SD	t	sig
Inquiring	2.071	.667	4.563	.378	56.329	.000
	(low)		(highest)			
Diligence	1.859	.522	4.585	.463	76.576	.000
	(low)		(highest)			
Learning creativity	1.808	.573	4.644	.458	69.688	.000
	(low)		(highest)			
Enthusiasm	2.215	.556	4.532	.452	57.642	.000
	(low)		(highest)			
Overall	1.988	.470	4.581	.387	89.551	.000
	(low)		(highest)			

These results show that learning on the GSRL system produces a higher achievement motivation than that for MOOC learning. The results also showed that learners aged 20 years and older had greater achievement motivation before and after studying than those aged 18–20 years. It was also found that learners aged 20 years and older had higher achievement motivation before and after learning in all four areas than those aged 18–20 years, with statistical significance at a significance level of .05.

The analysis of learners' achievement motivation through observing their learning and working behavior, showed that learners' overall achievement motivation is high level. Learners had a high level of achievement motivation in the areas of diligence, learning creativity, and enthusiasm. Inquisitiveness was at a moderate level.

The learners who had high achievement motivation according to a self-assessment had behaviors that reflected high achievement motivation as well.

6. Conclusion and Discussion

6.1 Important Factors in the Development of the GSRL System That Affect Achievement Motivation in MOOC Learning

The researcher integrated self-regulation with the concept of gamification the in design and development of the system. Self-regulation is a learning process that enables students to make plans, monitor their progress, and adopt learning strategies that are appropriate to their needs to achieve their learning goals. There are notifications delivered via mobile devices and that link to students' social media accounts to provide convenient and quick access. The gamification concepts generally adopted in teaching and learning, such as the use of badges, activity participation, and levels are seen. Using this approach, students can come to enjoy learning and participate in activities, leading to continuous learning to enhance the achievement motivation. This is consistent with the conclusions of research (Ortega-Arranz et al., 2019) on the behavior and perceptions of students toward receiving badges in open online learning, combining the concept of gamification. The results of the study showed that the number of badges the students receive from their activities can increase students' learning engagement and motivation in their open online learning. The research uses VR in MOOC learning. The major challenges to delivering learning experiences in MOOC settings are the availability and accessibility of technologies and supportive resources. In addition, learners can control their pace of learning. The results showed that the experimental group reported statistically higher levels of motivation than the control group. Thus, immersive learning positively contributed to learners' motivation and enjoyment (Ip et al., 2019).

Ubiquitous learning is another factor that helps promote achievement motivation for learners. It enables learners to easily access learning anywhere and anytime through the use of mobile devices. In this study, a chatbot was developed and applied in the delivery of a MOOC. It acts as a personal learning assistant, allowing students and instructors instant access to information (Bii, Too, and Mukwa, 2018). It reports learning progress and provides advice and details on learners' lessons connected to the social networks that the students use. Students can connect with the chatbot via a smart watch, including the receipt of notifications on activities and receiving badges from open online learning activities. This is in accordance with the results of previous study (Buchem et al., 2015) describing the use of wearable technologies in teaching and learning to increase learning opportunities.

6.2 Design and Development of the GSRL System

Here, the researcher examined the data that were collected from learners' questionnaires. The results of the analysis of the needs of the self-regulated system and the concept of gamification in the context of ubiquitous learning were used to design a self-regulated system and enhance the achievement motivation for MOOC. An expert evaluation found that our GSRL system overall had a system design and function that was suitable, attractive, modern, easy to use, and uncomplicated. It was assessed as practical and able to help stimulate and enhance achievement motivation at the highest level. However, the experts provided additional suggestions on how to make message more concise and to enlarge font size to make it easier to read. The researchers then adjusted the text in the chatbot to make it more concise and easier to understand. In addition, the menus were designed to allow learners to easily access resources by with the use of a chatbot via a smart watch. The badges were designed to be interesting to stimulate and enhance learners' motivation. This is consistent with the findings of Aladwani (2006) and Arain et al. (2019), who studied the factors affecting higher education learners' satisfaction with online learning. The results showed that the quality of information, the quality of the system in terms of the flexibility and ease of use, and the quality of the screen design affected the satisfaction in using m-learning of students. In addition, research has investigated the 3S method, as used in learning via MOOCs on edX/open edX. The 3S applications of social, sentiments, and skills showed that it can enable instructors to understand learners' behaviors, including the increase of activity near critical dates. It also benefits teachers through increasing their awareness of problems in acquiring certain skills. In addition, this allowed the functions to be implemented regarding the participation in the course, response times, messages with more votes or responses, the sentiments that users exhibited in their posts, and the skills that produced a higher level of debate in the course (Moreno-Marcos et al., 2019).

The researcher applied self-regulation in terms of the development of the system. Self-regulation is a process where learners learn through planning, setting study goals, and monitoring their own progress to achieve objectives. This can help learners have learning discipline and become successful in MOOCs. This is consistent with the research of Min and Foon (2019), who described self-regulation as an important process for online open learners. This research divides self-regulation into three areas, consisting of behavior, emotions, and thinking processes. for the emotional responses in this study were as follows: learners were interested, enjoyed learning,

and prioritized their goals. Further, their behaviors were organized: students managed their own study time and applied the knowledge gained from MOOCs in daily life. Finally, learners developed their own learning goals and expectations for academic achievement.

6.3 Discussion of the use of the GSRL System

Data were collected from 205 students in higher education in all four regions of Thailand: north, central, northeast and south. The students were divided into two groups by age: 18–20 years and older than 20 years. The assessment results of achievement motivation according to the opinions of learners before and after studying showed that learners had higher achievement motivation after studying with the MOOC used in this study than before, in terms of diligence, learning enthusiasm, creativity for learning, and eagerness, with statistical significance at the level of .05. This shows that a self-regulated system that combines the concept of gamification can enhance learners' achievement motivation in MOOCs. This is consistent with other research, performed by Ortega-Arranz et al. (2019), which found that students had higher motivation and behavior to continue in open online learning from the use of badges. Onah et al. (2019) found that learners were more attached to digital MOOCs through the use of a self-regulated system. In addition to applying self-regulation and gamification concepts in teaching and learning, the researcher considered that the designed contents, activities, and missions, as well as the conditions for obtaining badges and levels, are also important to creating achievement motivation for students in open online learning.

Taking into account the achievement motivation assessment by age group, both in terms of the assessment based on the opinions of the learners and the observation of behavior in studying and working found that students aged 20 years and older were more motivated than those aged between 18–20 years before and after studying. This may be because older learners have greater experience and knowledge, enabling them to have different levels of motivation. Therefore, in the design MOOCs, it is important to be aware of the differences in learners, factors in continuous learning, learning engagement, and learners' achievement motivation (Lerís et al., 2016; Brooker et al., 2018).

In addition, it was found that learners in the northeast region had a much higher achievement motivation both before and after studying than those in other regions. In achievement motivation, diligence and enthusiasm showed statistically significant differences at the .05 level. It was found that the difference in learners' achievement motivation in a pre- and post-test in the areas of diligence, inquiring, and learning creativity were significant at the .05 level. Eagerness in study before and after studying were not significantly different at the .05 level, possibly because of artifacts in the students' response to the questionnaire. It was found that students had high interest in MOOCs, resulting in eagerness before and after learning. This is consistent with the findings of Lerís et al. (2016), who investigated students' personal interests of in course selection and activity participation in MOOCs. However, for the achievement motivation from observing working and studying behavior during activities by region that students in the northeast region had higher achievement motivation than those in other regions. All four regions had statistically significant differences between before and after the course at the .05 level. This may be because students were able to manage their own learning themselves using the chatbot's notifications. The learners were able to participate in activities, track their learning progress, gain level promotions levels, and obtain badges from doing activities in open online learning that is convenient, easy to access, and fast. This is consistent with the work of Onah et al. (2019), who designed MOOCs by showing the learning progress of the learners in which students can manage their own study time to promote self-regulation behavior.

Taking into account the results of achievement motivation through observing study behavior while doing activities, it was found that the overall achievement motivation of learners was at a high level. It was found that diligence, learning creativity, and enthusiasm were at a high level. Inquisitiveness was at a moderate level. This may be because the learners had different learning contexts and different amounts of time to do learning activities. This is consistent with the findings of Lan et al. 2019 and Min and Foon (2019), who found that learning behavior while doing activities, in terms of setting goals, planning studies, managing time, and reflecting on one's own activities, had an effect on MOOC learners.

The analysis of achievement motivation conducted here from response data from learners and observations of learning behavior while participating in MOOC activities showed that the average scores of all pairs were significantly related at the .05 level, indicating that where learners had high achievement motivation die to self-assessment, their behavior would also reflect high achievement motivation. The self-regulated system combined with gamification via iChat Smart, a chatbot that connects via a smart watch to the Facebook Messenger that students use in daily life, enabling students to access activity alerts and details of the courses easily, as well as

giving them the opportunity to earn badges for activities and their online learning in MOOCs. Learners were able to design their learning and manage their time freely, resulting in higher achievement motivation. Therefore, behavior in learning while participating in the online learner activities, such as involvement in activities, exchanging opinions between students and instructors, conducting self-evaluation, using a chatbot and wearable devices for learning, and performing activities to collect badges and levels are behaviors that reflect that achievement motivation also increased. This is consistent with the work by Sharma and Sharma (2018), who applied self-regulation to analyze the behavioral, emotional, and intellectual adherence of open online learning and research by Lan et al. (2019) that used gamification in MOOCs.

As the conclusion and discussion above highlighted the positive impact of combining self-regulation and gamification (iChat Smart) on achievement motivation in MOOC learning, it is necessary to emphasize this positive impact further. Additionally, the functionality of iChat Smart could be enhanced according to user needs, such as improving the current rule-based chatbot system. With recent technological advancements, the potential of this chatbot could be optimized to design more personalized learning management and interact with users as a learning assistant and in conversational forms using generative AI. Enhancing these capabilities would help engage learners and boost their achievement motivation. Furthermore, future research directions may cover adaptability to meet the needs of diverse users, support all devices, and address other relevant learning outcomes. Additionally, studying the long-term effects of using such a chatbot with the aforementioned functions would be worthwhile.

Authors' contributions

JK and PK conceptualized and designed the experiments, conducted them, analyzed and interpreted the data, contributed reagents, materials, analysis tools, or data, and wrote the paper. All authors have read and approved the final manuscript.

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