Inquiry-Based Learning for a Virtual Learning Community to Enhance Problem-Solving Ability of Applied Thai Traditional Medicine Students

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ABSTRACT
The recent growth in collaborative and interactive virtual learning communities integrating innovative digital technologies and contemporary learning frameworks is contributing enormously to the use of e-learning in higher education in the twenty-first century. The purpose of this study was to describe the development of a virtual learning community system within the Applied Thai Traditional Medicine (ATTM) instruction context. This started with collecting data from ATTM students (n=303) from eight universities in Thailand. In addition, experts (n=30) in various areas of ATTM, educational technology, and assessment participated in semi-structured interviews. Using the information obtained, an online learning community system guided by the Community of Inquiry (COI) framework which incorporated advanced virtual innovations such as inquiry-based learning (IBL) activities was consequently developed. Test score results of students obtained before studying via the ATTM VCOI system showed that the sample group of 39 ATTM students had an average score of ability in problem-solving at 16.87 with standard deviation at 3.25. After studying with the system, they achieved an average score of 18.41 with standard deviation at 3.05. The results indicate that average test scores were statistically different at a 0.05 level of significance ($t = -2.140$, $p = 0.03$). Furthermore, the results also point to efficacy in regards to teaching, social and cognitive presences. The data collected indicates that use of the ATTM VCOI system can lead to a more collaborative community learning environment that can enhance ATTM students' problem-solving ability and improve the effectiveness of online learning in higher education in general and in ATTM instruction in particular.

Keywords: Community of Inquiry, Inquiry-Based Learning, Multi-User Virtual Environment, Problem Solving Ability, Virtual Community of Inquiry

INTRODUCTION
Digital technology-enhanced online learning offers opportunities for both scholars and educators to enrich their learning environments and improve learning ability through the integration of state-of-the art digital technology and a contemporary learning approach which uses the proper theoretical framework. It is not surprising that an increased number of scholars and educators have become interested in designing online learning platforms such as virtual worlds (VWs), three dimensional (3D) environments, or multi-user virtual environments (MUVEs).

To improve online learning, technology-enhanced environments can be blended with an inquiry-based learning (IBL) approach to optimize the design and development of virtual online learning activities since IBL makes it possible for more meaningful and self-regulated learning by motivating learners to generate their own problem-solving procedures (Hwang, Tsai, Chu, Kinshuk, & Chen, 2012). Owing to the richness of virtual multimedia features, learners are able to take advantage of various synchronous and asynchronous communication platforms in order to collaboratively work together and exchange ideas and experiences through IBL procedures within the same 3D virtual learning environment. Recently, there have been attempts to appraise the effectiveness of virtual learning platforms through the Community of Inquiry (COI) framework which has increasingly been adopted to prescribe online learning effectiveness through the interplay of three core components: teaching, social and cognitive presences. The interrelationship among the three presences is most widely influenced by cognitive presence (Kozan & Richardson, 2014). Several studies have been conducted to employ the COI framework in virtual world-oriented activities to provide and promote social and collaborative activities among users through a wide variety of learning situations to yield more positive results (Pellas, 2016; Haynes, 2016; Burgess, Slate, Rojas-LeBouef, & LaPrairie, 2010; Dalgarno & Lee, 2010). Despite several COI models having been developed for educational use in a wide range of subjects, there remains a need for a virtual COI (VCOI) system which can be used in the teaching and learning of Thai Traditional Medicine (TTM).

TTM has been used to treat the health problems of Thai people for centuries. However, in recent years, TTM has become much more popular among Thai people who turn to it as an alternative to modern medicine as well as those who to preserve its practices. It is widely recognized that the local wisdom and experience in practicing TTM are disappearing and that there has been a substantial inter-generational loss of traditional medical knowledge. As such, many Thai universities now offer Applied Thai Traditional Medicine (ATTM) programs with the aim to produce professional ATTM personnel who possess the essential cognitive and interpersonal skills. As this becomes incorporated into the mainstream educational system, ATTM students will need to have the necessary information and communication technology (ICT) skills to enable them to acquire and share knowledge in the university environment so that they make an accurate diagnosis of health problem in real life. The accuracy of diagnosis is fundamental indication of the quality and standard of TTM which is being offered by Thai health care providers not only to treat Thai patients but as part of the country's mission to become a hub for medical and spa tourism in the South East Asian region (Hunter, 2012).

Research questions:

1. What are the main components and processes necessary for the development of an ATTM VCOI system to be used to enhance Thai Traditional Medicine learners' problem-solving ability?
2. What are the results after implementing the developed ATTM VCOI system as a way to improve of Thai Traditional Medicine learners' problem solving ability?

Objectives:

1. To develop an ATTM VCOI system in order to strengthen the to problem-solving ability of Thai Traditional Medicine learners.
2. To test the developed ATTM VCOI system to enhance the problem-solving ability of the learners of Thai Traditional Medicine.

REVIEW OF THE LITERATURE

Community of Inquiry Framework

The Community of Inquiry (COI) framework developed by Garrison (2011) along with Garrison, Anderson, and Archer (1999) is based on three frameworks, including socio-constructivism, reflective thinking, and practical inquiry. The COI framework also comprises three main components: teaching, social and cognitive presences, based on the premise that learning takes place by way of the interaction. This framework has increasingly embraced the development of online learning environments to guide learners towards collaborative involvement in purposeful critical discourse and reflection on activities that construct personal meaning and ensure mutual understanding. Generally speaking, teaching presence is the ability to organize and monitor learning activities and environment in three respects: design and organization, discourse facilitation, and direct instruction (Stenbom, Hrastinski, & Cleveland-Innes, 2012). Social presence refers to the extent to which learners are able to present themselves socially and emotionally within a learning community by means of open communication, group cohesion, and affective expression (Garrison, Cleveland-Innes, & Fung, 2010). According to Richardson and Ice (2010), cognitive presence is considered the heart of the COI framework and is described through the Practical Inquiry Model of learning that consists of four phases: triggering, exploration, integration, and resolution. The categories and indicators of each of the three presences that form the COI framework are shown in Table 1.

Table 1: Community of inquiry categories and indicators (Garrison, 2011)

Presences	Categories	Indicators
Teaching presence	Design and organization	Setting curriculum and methods
	Facilitating discourse	Shaping constructive exchange
	Direct instruction	Focusing and resolving issues
Social presence	Personal/affective	Self projection/expressing emotions
	Open communication	Learning climate/risk-free expression
	Group cohesion	Group identity/collaboration
Cognitive presence	Triggering event	Sense of puzzlement
	Exploration	Information exchange
	Integration	Connecting ideas

	Resolution	Apply new ideas

There have been a number of different terms used to describe various inquiry activities in recent years, which make the core phases and processes of inquiry-based learning difficult for new designers and instructors to understand (Pedaste et al., 2015). Consequently, as the central learning method, IBL activities are essential developed to provide more authentic tasks or problems to maximize the effectiveness of students' learning. Dabbagh and Dass (2013) pointed out that it is necessary to place students in authentic environments where they can learn meaningfully by connecting their prior knowledge with the real-world events while engaging in learning activities. Such integration of collaboration and appropriately guided inquiry learning are increasingly being incorporated into MUVEs by researchers.

It is evident from the literature that the implementation of the COI framework into online learning has been well-documented. This indicates that the COI framework can serve as a reliable framework for appraising the extent of teaching, social, and cognitive presences in MUVEs (Mouzouri, 2016; Pellas, 2016; Shea & Bidjerano, 2009).

Educational MUVEs

Essentially, 3D educational MUVEs are employed to afford greater interaction among learners as well as other software-based agents, represented by characters called avatars, as part of an open-ended exploratory environment (Erlandson, Nelson, & Savenye, 2010). 3D MUVEs can be beneficial in both teaching and learning due to their various characteristics. As noted by Rahman (Rahman, Yahaya, Halim, & Phon, 2013), they offer a realistic and immersive virtual environment, provide a flexible and persistent environment, support verbal and non-verbal communication, and allow users to create and manipulate their world and virtual objects, including letting them adjust the point of view to see their world from different perspectives.

Furthermore, it is suggested that there are several variables that affect the development of COI-based MUVEs, for instance, computer self-efficacy (Pellas & Kazanidis, 2014), situational interest (Pellas & Kazanidis, 2014), teaching behaviors which increase social presence based on guiding discussion and giving feedback to support interaction and collaboration (Akyol & Garrison, 2011), and technology via the use of media and technology tools to prefigure social presence (Kim, Kwon, & Cho, 2011). Moreover, a number of researchers have proposed providing meaningfully situated learning environments in which students acquire problem-solving abilities and knowledge during their participation in gaming activities (Ata, 2016; Simsek, 2016; Pellas, 2016; Panagiotis, Michael, Chris, & Dennis, 2014; Pellas, 2014).

Problem Solving Ability

Various researchers have identified problem-solving ability as being at the heart of learning and thinking (Gunduz, Alemdag, Yasar & Erdem, 2016; Karyotaki & Drigas, 2016; Yoo & Park, 2014). According to the Qualifications Framework for Higher Education in Applied Thai Traditional Medicine, cognitive skill similarly refers to the ability to analyze scenarios based on proper knowledge and understanding of theories, principles, and processes so as to deal effectively with problems in various clinical situations. In view of this, it is clear that it is important to enhance TTM students' problem-solving ability (Yoo & Park, 2014; Hwang, Wu, & Chen, 2012) through IBL activities which can make learning more meaningful and self-directed by establishing problem-solving procedures. As a result, this study employed a 3D MUVE as the learning method so that learners could interact with various situated objects (including images, sounds, and other multimedia contents) while communicating and collaborating with other learners to diagnose and resolve clinical problems.

RESEARCH METHODOLOGY

Informants and Instruments

As research question one proposed the development of an ATTM VCOI system, this study gathered information from informants using various instruments. The instruments were incorporated into an application used by 303 ATTM students from eight different universities using a survey questionnaire. Other participants were: 15 ATTM experts, 10 educational technology experts, and 5 educational assessment experts, who participated in semi-structured interviews. By using these two main research instruments, this study obtained information which proved adequate for the analysis. The survey questionnaire consisted of both close-ended and open-ended questions focusing on demographic background, ICT background, situational interest, and collaborative style. This approach for evaluation was required to develop an appropriate design for a learning environment which enhances the learners' ability to solve problems. Moreover, the semi-structured interviews served as a way to elicit information from 30 experts regarding: the processes and components of activities to improve problem-solving ability through an ATTM VCOI system, the most suitable technology for the development of the system, and the roles of the system's members. In order to answer research question two, the ATTM VCOI system was tested with 39 third-year undergraduate ATTM students of the faculty of Applied Thai Traditional Medicine at

Mahasarakham University in Thailand, who were enrolled in the Applied Thai Medicine class.

Data Collection and Analysis

The data was collected over a period of two months, October to November 2013, with all questionnaires being delivered to all 303 ATTM students when they attended sport days at Thammasart University. After all participants checked off the closed-ended items, the results were summarized in percentages, as shown in Table 2. Responses to the open-ended questions were analyzed in a qualitative aspect.

Data collected from first to fourth year undergraduate students from eight different universities with programs in Applied Thai Traditional Medicine in Thailand (ATTM), ages from 18-23 years old, was analyzed to categorize the types of information resources appropriate to be used in the ATTM VCOI system. This system also needed to include technology that would encourage the exchange of information and communication of both among learners and between learners and instructors.

The semi-structured interviews were conducted with 30 experts in sessions of approximately two hours each in order to obtain the most accurate data. To better achieve this goal, all participants were recorded, and then all records were transcribed before being analyzed.

Table 2: Characteristics of learners and Need Assessment (n=303) in managing the ATTM VCOI SYSTEM

Characteristics of learners and Need Assessment	n	Percentage
1. Demographic		
Male	67	22.11
Female	236	77.89
2. ICT backgrounds		
Frequency of use of internet services:		
Surfing for information	272	89.77
Viewing images and multimedia content	245	80.86
Chatting	231	76.24
Participating in a Virtual classroom	186	61.39
Playing online games:	235	77.56
Playing role-play games	109	46.38
Playing simulation games	103	43.83
3. Situational interest	155	51.16
Learners' vocation		
Motivated problem-solving thinking & collaborative learning	178	58.75
Exchanged information and discussed in groups	167	55.12
Participated with experts in activities	166	54.79
Information resources suggested by learners to be included in the system:		
Texts		
Research articles	260	85.81
	131	43.23
4. Collaborative styles		
Students were interested in activities in which they were allowed to form their own groups	143	47.19
Instructors played important role in assisting learners during activities	186	61.38
5. Evaluation		
Related personnel in the evaluation:		
Instructors	247	81.52
Self-evaluation/assessment	194	64.03
Peers	130	42.90

The employment the ATTM VCOI system in the classroom was done in accordance with the research methodology suggested by Campbell and Stanley of One Group Pretest-Posttest Design to assess the students' ability before and after participating in the study over a six-week period. Records of pre- and post-tests were compared by means of t-test dependent to determine the development of learners' problem-solving ability. The ATTM VCOI system included a text chat feature so that users would have evidence of their participation. Coding was done based on category indicators for each presence of the COI framework, see [Table 1]. The coding procedure was to code the instructors and students' postings for each of three presences at the messagelevel as a unit of analysis.

RESULTS AND DISCUSSION
The research results and discussion are divided into 2 parts according to the research question. The details are as follows:
(1) The input and processes of the VCOI was done by using the results of the survey questionnaire and the semi-structured interviews which were developed and further used for the design of the main process for development of the VCOI system. Then, the system design of ATTM VCOI was developed as a workflow to show the processes to enhance problem-solving ability for learners as shown in Figure 1.

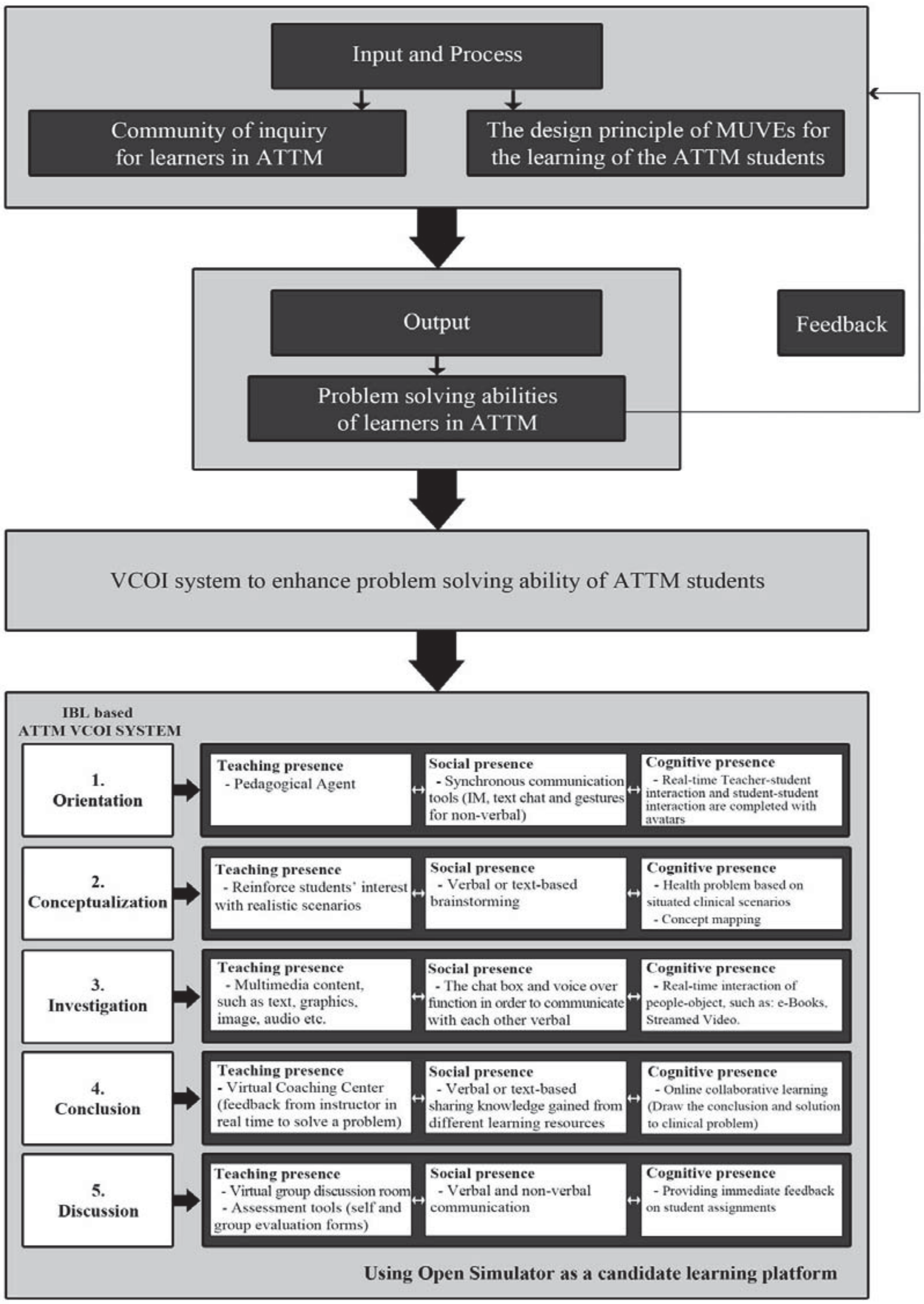

Figure 1: Workflow of the ATTM VCOI system to enhance problem solving ability

The design and development process of ATTM VCOI SYSTEM to enhance problem solving ability and learning activities included 5 stages: Orientation, Conceptualization, Investigation, Conclusion, and Discussion. Details of each stage were as follows.

Stage1 aims to inform students about the learning method, roles of teachers and students, learning period, and the use of learning resources and communication tools. First of all, students have to create their own avatars, practice the avatars' navigational skills and visit virtual scenes in order to become familiar with the ATTM VCOI environment for effective learning of the ATTM VCOI system. To trigger teaching presence, teachers have to develop curriculum that meet ATTM students' needs and TTM learning objectives and guide students in how to do group collaborative IBL activities in the ATTM VCOI system. To trigger social presence, the ATTM VCOI system allows students to openly express their emotions through their self-representation avatars. When students have questions about the ATTM VCOI system, this will lead to a sense of puzzlement that triggers cognitive presence.

Stage2 is intended to situate clinical activities or events that kindle students' curiosity and motivate them to diagnose and resolve clinical problems. To trigger teaching presence, teachers and students are present in the virtual Inpatient Department (IPD) scene as avatars. Teachers inform students about content and objectives of activities and criteria for evaluating activities and also suggest learning resources. Activities within the virtual ATTM learning classroom should be adapted to students' ability and interest as well as TTM curriculum objectives so that students are more actively engaged in the assigned activities. The virtual ATTM learning classroom triggers social presence by providing richly emulated, real-time interaction among participants through, for example, interactive text or voice communication. To enhance cognitive presence, teachers can encourage students to connect their knowledge and experience gained in situated clinical scenarios in the ATTM VCOI system. In this stage, students formulate all possible hypotheses about health problems based on situated clinical scenarios. To generate the social presence, students can express and brainstorm opinions to explain situated clinical problem scenarios and the best opinion will be acknowledged and praised by group members. To trigger the teaching presence, teachers can give positive feedback to students to encourage them to do challenging activities and the virtual ATTM learning environment has enough places, such as group discussion rooms for students to chat, interact, and discuss clinical problems together in group. Teachers can recommend learning resources, such as concept mapping, for students to seek information to make hypotheses and form group ideas regarding identifying problems and causes.

Stage3, after students form possible hypotheses about clinical problems, they will seek further information to support their hypotheses. To promote teaching presence, teachers guide students to discover and construct knowledge on their own through group work within the ATTM VCOI system that offers not only knowledge but entertainment as well. In each clinical scenario, students are asked if they understand the scenario. When students answer correctly, teachers reward them to enhance students' leaning motivation. To promote social presence, students can share knowledge gained from different learning resources to reach mutual agreement among group members. Students can refer to those information resources when they raise questions or respond to questions. To promote cognitive presence, teachers can promote students' self-regulation by encouraging students to successfully solve problems on their own instead of providing them with answers. In this way, students have to the opportunity to ponder and reflect on the problems with group members.

Stage4, after gathering information, students use the information to justify their hypotheses in the conclusion-drawing stage. To promote teaching presence, students draw a conclusion based on collected information to support the hypotheses. Teachers can provide more knowledge from various resources and set up a coaching center where students can ask for advice from experts. To promote social presence, students can consult teachers about possible solutions to clinical problems. To promote cognitive presence, students discuss advice received from experts for further clarification and then draw conclusions and propose solutions to clinical problems.

Stage5, the ATTM VCOI system can promote teaching presence when teachers encourage students to criticize, question, and express opinions between presenters and audience. Social presence can be enhanced through authentic, formative and summative assessment in the ATTM VCOI system. It is also important to assess to what extent students learn and use IBL processes. Each group can present its work and answer questions in a virtual exhibition scene in the ATTM VCOI system. This helps students in each group exchange ideas and knowledge. To promote cognitive presence, students explain and demonstrate problem-solving steps derived from principles and ideas that connect what they learn with what they will face in real life situations.

The ATTM VCOI system was designed based on the contemporary COI framework and uses Open Simulator software and the IBL approach to assist in virtual online learning for the purpose of increasing learners' problem-solving ability. Drawing upon the COI framework, the ATTM VCOI system allowed collaboration among learners through all five stages of IBL procedures in the virtual 3D interactive learning environment. The collaboration consequently triggered the presence of COI and eventually led to the enhancement of learners' expected ability.

The activities focus on not only problem-solving ability, but also collaboration skills. Virtual scenes, such as an herb garden, discussion room, virtual Inpatient Department, etc. and some collaboration tools are shown in Figures 2-5.

Figure 2: ATTM VCOI system developed by using Open Simulator showing a mini map of an island and an herb garden

Figure 3: ATTM VCOI system developed by using Open Simulator showing the avatar of students while discussing in a discussion room

Figure 4: ATTM VCOI system developed by using Open Simulator showing the avatar of students while diagnosing and resolving clinical problems

Figure 5: Collaboration tools such as Google Drawing to form hypotheses and group ideas

Notably, the results from previous case studies (Pellas, 2016; Berns, Gonzalez-Pardo, & Camacho, 2013; Vosinakis & Koutsabasis, 2012) show that virtual world open code is suitable for supporting various types of educational activities and raising interaction and motivation in learners as well as enhancing problem-solving ability. A number of studies (Pellas, 2016; Khlaisang & Mingsiritham, 2016; Pellas, 2014; Rico, Martínez, Alaman, Camacho, & Pulido, 2011) have indicated that Open Simulator, one of the most commonly used open source VWs which is equipped with necessary multimedia tools to accommodate learners in group-based activities. This ATTM VCOI system was developed using Open Simulator is open source software that allows users to develop and use programs (the developer prepared the program, including Imprudence 1.3.2, OpenSim0.731, using C# language and ran it on Mono or Microsoft.NET using MySQL database). The program development incorporated the concept that learning occurs in the interaction between learners and learning environment or other learners. The system provides more visual and realistic situations according to the different learning models such as classrooms, libraries, discussion areas, etc.; it also allows for different forms of expression according to the different learning resources, such as video clips, e-books, images, texts, etc. Learners are able to have cognitive experience which is similar to the real world and understand issues more easily. The system encourages students to explore dangerous health problems which are unable to be recreated in the classroom. In this, learners can obtain cognitive and emotional experience by participating in inquiry activities. In the ATTM VCOI system, there are many virtual characters, including instructors, peers and experts, and students can learn and practice in a natural and friendly atmosphere. In addition, the system provides opportunities for students to learn through collaboration and allows them to study together by completing collaborative IBL activities in a virtual environment at different times and from different locations. To this end, the development of an ATTM VCOI system to enhance problem-solving ability should consist of various learning activities with various forms of supporting media. Students will learn by active participation via modern digital media which will not only improve their communication and collaboration skills, but also enhance cognitive skills and learning achievement which can be promote their lifelong learning throughout the learning system similarly to the study of Khlaisang and Mingsiritham (2016).

(2) A comparison of problem solving ability test results before and after studying through the designed ATTM VCOI system was done to examine the effectiveness of the system. The results of the pre-test showed that the sample group of 39 students had average scores of problem-solving ability at 16.87 with standard deviation at 3.25. After studying, they had an average score of 18.41 with standard deviation at 3.05. The results of the test before and after studying with the ATTM VCOI system using independent t-test indicated that the average problem-solving ability test score had a statistical difference at a 0.05 level of significance ($t = -2.140$, $p = 0.03$) as shown in Table 3.

Table 3: The difference between pre and post scores of problem solving ability

Assessment	n	$\bar{x}$	S.D.	t	P
Pre-test	39	16.87	3.25	-2.140	0.03
Post-test	39	18.41	3.05		

*p<0.05

Such results are congruent with the literature indicating that the use of 3D virtual world to enhance the cognitive skills of higher education learners, self-paced learning, and lifelong learning in Thailand's education context (Songkram, Khlaisang, Puthaseranee, & Likhitdamrongkiat, 2015; Songkram & Puthaseranee, 2015).

Each IBL procedure in the ATTM VCOI system supports teaching, social, and cognitive presences of the COI framework through evidence that can be traced back as it appeared in key words, phrases, paragraphs and concepts. Table 4 illustrates the coding scheme for each presence.

Table 4: Coding scheme for each presence of the COI framework

The COI Presences	Indicators	Examples
Teaching presence	Design and organization Facilitating discourse Direct instruction	"Learner 1 asked a staff member whether he/she could answer a question posted in front of an herb garden. Then, the staff member allowed them to do so with the promise of a reward for the correct answer. Simultaneously, learner 1 came up with 'ginger,' whereas learner 2's answer was 'garlic'.
Social presence	Personal/affective Open communication Group cohesion	"Learner A voted X as a nominee for president and Y as a nominee for secretary. Learner Z agreed with the nominee X but B as a nominee for secretary and learner Z asked for others' opinions to agree on her vote. Learner Y agreed with learner Z"
Cognitive presence	Triggering event Exploration Integration Resolution	"Learner 1 was diagnosing one patient, 'what seemed to be the problem?' The patient told learner 1 that he had been suffering from left rib pain. Learner 2 jumped in to ask about how serious was it"

Such evidence also appeared in previous studies of ATTM VCOI systems (McKerlich, Riis, Anderson, & Eastman, 2011), in which the existence of three COI presences were observed and it was concluded that the COI model was suitable for evaluating educational events in MUVEs. Overall, the COI presences are considered to be key for students' engagement in the course discourse and activities (Mouzouri, 2016).

CONCLUSION

This study aimed to develop a virtual Community of Inquiry system based on the COI framework. The Open Simulator software and IBL approach were also employed to further the development of the tool used in the study—the ATTM VCOI system. The results from this study showed that the main components necessary for the development of an ATTM VCOI system include (1) the components of teaching and learning management (learner's role, instructor's role, learning environment, learning resources, reinforcement and motivation); (2) the components of tools for teaching and learning management (virtual learning environment, learning management system, e-books, streaming video, communication and collaboration tools); (3) the components of problem-solving ability (learner's skill of identifying, hypothesizing, gathering and concluding the problems); and (4) the components of feedback (formative and summative assessment). In addition, this study also found five IBL main stages: Orientation, Conceptualization, Investigation, Conclusion, and Discussion with seven sub-stages: Questioning, Hypothesis Generation, Exploration, Experimentation, Data Interpretation, Communication, and Reflection that are necessary for the development of an ATTM VCOI system. Each main and sub-stage had trigger teaching presence, social presence and cognitive presence of every testing subjects in this study.

In this study, the results showed that the Applied Thai Traditional Medicine learners had significantly improved in problem-solving ability by comparing the scores of problem-solving ability test prior and after implementing the developed ATTM VCOI system. Furthermore, after implementing the developed ATTM VCOI system, the results had also shown the evidence that the system is able to trigger teaching presence, social presence and cognitive presence similar to the studies of Mouzouri (2016), Gutierrez-Santiuste and Gallego-Arrufat (2014). As a result, the developed ATTM VCOI system was used as a supplementary online learning platform for courses related to TTM focusing on the enhancement of learners' problem-solving ability. The ATTM VCOI system also resulted in a collaborative community learning environment that not only improved learner's problem-solving ability, but also optimized the effectiveness of online learning in an ATTM higher education setting.

LIMITATIONS AND RECOMMENDATIONS

There are several limitations and recommendations in this study. First, the participants in this study included only undergraduate students and all of them have registered as full-time. It is recommended that further study should be conducted with participants who are not full-time students as these students in this study were very accustomed to the test-based environment. It is anticipated that those not accustomed to such an environment may demonstrate a greater increase in statistic means. Next, the time-frame to collect data in this study was only six-week period between pre- and post- test. Further study might investigate the effects of the implementing ATTM VCOI system on the learner's ability in a longer time-frame period in order to have a better understanding of the system. Last, the participants in this research were only Applied Thai Traditional Medicine students. In this, Thai culture might affect the study results since Thai teaching culture does not allow students to have much participation in the class comparing to those western countries' teaching styles. Therefore, further study should include participants from various countries in order to get the overall perspectives of the VCOI system.

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