

Designing a Virtual Learning Environment System for Teaching Twenty-First Century Skills to Higher Education Students in ASEAN

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Published online: 14 March 2017

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Abstract The proliferation of digital media now allows for learning to take place anywhere and anytime. The use of mobile devices and 3D virtual classrooms provides an integrated environment for effective learning. This study aims to examine the necessary factors for developing an effective virtual learning environment (VLE) system and to examine the effectiveness of the VLE system developed to enhance the range of twenty-first century skills of higher education students in the Association of Southeast Asian Nations (ASEAN) community. As a part of this study, four hundred higher education instructors completed questionnaires which were analyzed statistically using Exploratory Factor Analysis to determine the core factors which were then incorporated into the development of a VLE system. The system was tested on a sample of 90 volunteer undergraduate students from 5 ASEAN member countries. Data analysis using dependent *t* test indicated that there was a statistical difference between pre and post self-assessment scores of the twenty-first century skills in learning and innovation at the 0.05 level of significance. The finding and result were consistent with and could be supported by the results of behavior and trace observations and project assignments. In this paper, the 7 elements of the VLE system and 7 steps involved in its development are discussed, in addition to proposals for further implementation.

Keywords Virtual learning environment · Twenty-first century skills · Higher education · ASEAN

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1 Introduction

At present, instructors in higher educational institutes are faced with the challenges of teaching the digital generation. Students of this generation expect to make full use of academic resources, and with the development of social networks and the more widespread use of mobile devices, they are able to take on more challenging assignments which require continual and immediate feedback. This is in contrast to traditional and conventional teaching methods which do not allow for such feedback, making them less effective in this respect (Khlaisang and Songkram 2013). It follows, therefore, that educational institutes and instructors should consider incorporating new technology such as mobile devices and 3D virtual classrooms to create a more modern environment for effective learning (Jenkins et al. 2005; Pellas and Kazanidis 2015; Tick 2013). The most effective learning environment should be open, active, creative, collaborative, and motivating, as well as respond to the needs of today's students by providing direct experience, immediate feedback, and flexibility of learning equipment (Khlaisang and Mingsiritham 2016; Tick 2013; Office of Higher Education Commission 2009; Weiss et al. 2006). Ultimately, VLE enhances creativity, problem solving skills, communication, and collaboration skills through the exchange of ideas, sharing of thoughts, and shared discovery, rather than through individual achievement learning alone. Online active learning and online activities-based learning have come to play a vital role in higher education, and have proven to not only enhance students' attention, but also improve a broad range of twenty-first century skills, especially in the areas of learning and innovation (Songkram 2010; Khlaisang et al. 2014).

VLE has now become an essential learning tool to facilitate learning and allow students to simultaneously collaborate with others as well as to construct their own knowledge without time and place constraints (Khlaisang et al. 2014; Pellas and Kazanidis 2015; Pellas et al. 2013). VLE supports learning activities within the classroom and independent learning outside of teaching sessions, enhancing the learning environment in both. Use of this method will undoubtedly continue to increase in the future (Khlaisang and Songkram 2013; Merlin 2012; Tick 2013). VLE encompasses a wide range of areas, including web pages, Learning Management System, Learning Content Management System, and three-dimensional learning environments. An important factor in the use of VLE is the social interaction occurring when students participate in tasks and activities (Tick 2013). This type of learning represents a change from static learning to dynamic learning, from isolated learning to interactive learning, from private learning to public learning, from hidden learning to visible learning, and from exclusive learning to inclusive learning (Weiss et al. 2006). These types of learning are provided by VLE (Khlaisang and Songkram 2013).

A learning environment driven by the use of a three-dimensional (3D) multi-user virtual world is one among many types of VLE that enhance learning by immersing students in learning experiences that stimulate interest, involvement, imagination, and interactivity. The present question is how VLE can be designed to impart ASEAN higher education students' twenty-first century skills to the learners. For this study, VLEs is defined as a learning environment which combines the benefits of a Learning Management System (Moodle) and 3D virtual world (OpenSimulator) to meet learners' needs, and LMS is mainly used to present the variety of content, i.e. e-books, streaming videos, and animation. More than anything else, learners can access the materials from anywhere, anytime, using all types of devices. In the study, the 3D virtual world was used to enhance collaboration and communication among ASEAN learners who could submit assignments and group projects, while allowing for other groups to review and give constructive feedback

from other locations (Jenkins et al. 2005; Khlaisang and Mingsiritham 2016; Khlaisang and Songkram 2013; Merlin 2012; Pellas and Kazanidis 2015; Tick 2013; Weiss et al. 2006). Accordingly, the aim of the study was twofold. First was to examine the necessary factors for the VLE system using Exploratory Factor Analysis. Second was to examine the effectiveness of the VLE system in enhancing learners' twenty-first century skills. Below are the guiding research questions.

1. What are the key factors that form the design of an effective VLE system for twenty-first century learning?
2. To what extent does the VLE system enhance the learning of twenty-first century skills?

2 Review of the Literature

The use of online learning in higher education teaching and learning has been supported and well documented in the literature. The application of VLE in UK higher education institutions can be easily seen in the subject areas of hospitality, leisure, sport, and tourism. Analysis of these systems shows that many of these institutes use various tools, including file servers, web pages, web-based discussion tools, and e-mail. The main objective has been to electronically deliver course materials and to provide additional experiences for students regarding their future career. Also, computer-mediated conferencing is generally used to replace small group tutorials, create problem-based learning, and provide feedback to students. Online learning is also used to provide library access and research links. The main factors in choosing the tools were the ease of use, cost, flexibility, functionality and range of features. However, there are challenges in VLE usage when learning communities have differing objectives, tools, and pedagogies (Haven and Botterill 2003). These findings are a concern to educational institutions who are interested in the idea of using VLE's in Thailand's higher education system. The idea of using Virtual Classrooms and Virtual Campuses is of interest to many educational institutions that are looking to expand their use in the near future. It should be also be noted that such systems can reduce facilities costs associated with traditional classrooms, travel expenses and other miscellaneous costs, as well as saving time for students (Boonyarit 2011; Juneit 2009).

The theoretical framework used in the design of the VLE focuses on the use of a 3D multi-user virtual world to engage students in stimulated learning experiences. This framework is based on the concepts of cognitivism and of individual learning, under which learners learn at their own pace from the structured design of the VLE system (Khlaisang and Mingsiritham 2016). Also, the VLE uses a constructivist approach with an emphasis on social mediated learning. Learners, in addition to constructing their own knowledge individually, joined meaningful learning activities via the ASEAN VLE system. Therefore, this study focused on individual learning at the beginning and then moved to social mediated learning throughout the rest of the learning process.

Numerous studies have demonstrated that learning in VLE enhances students' engagement, motivation, learning outcomes, as well as twenty-first century skills including creativity, problem solving, communication, and collaboration skills. For example, the research by Pellas and Kazanidis (2015) found that higher education learners achieved more positive learning outcomes and greater engagement when using the Second Life program in blended and online courses when compared to 2D technology due to the

existence of an identified reality where students could share experiences with others more easily with face-to-face online interactions. Also, when installing the viewer of a 3D virtual learning program, the 3D graphics will display a 3D real-world object on a 2D screen (Khlaisang and Mingsiritham 2013). The advantage of the 3D virtual learning environment over the 2D technology is that it provides an opportunity for learners to engage in interactive learning experiences. As such, 3D virtual worlds provide three fundamental components including (1) perception of 3D space, (2) avatars that serve as the 3D representations of users, and (3) an intelligent 3D chat environment that allows users to communicate with each other (Abdul Hamid et al. 2017).

Khlaisang and Mingsiritham (2013) presented positive results regarding effectiveness in academic performance when using VLE to promote collaboration and communication among higher education learners in the ASEAN learning community. The advantage of 3D learning mentioned above is congruent with the findings of Weiss et al. (2006), which revealed that collaboration and communication in VLE can be promoted by means of exchanging ideas, sharing thoughts, and exploring together. To strengthen international cooperation through VLE is relevant for the Thai government policy of supporting learning that integrates students more into the globalized world, i.e. global changes in the aspects of technology, society, knowledge-based economy, and the advancement of information technology—a major driving force in Thailand's education reform. It is also hoped that the use of VLE will lead to greater cooperation among countries in the ASEAN region which in turn should increase its global competitiveness. Interestingly, Barab et al. (2004) noted that VLEs might be considered as tools to strengthen ASEAN learning and innovation collaboration since they can increase the value of sharing and cooperation at the international level, particularly in regions with diverse cultures.

Also, it has been suggested that, to meet the lifestyle needs of digital learners, mobile and portable devices should play a key role in enhancing learners' individualized learning, allowing learning and collaboration to occur anywhere at any time without time and place constraints (Koskela et al. 2005; Khlaisang and Mingsiritham 2016). A recent study of Teo et al. (2014) found high competency in technology use to be associated with a high level of e-learning acceptance among Thai university students. This has been seen elsewhere as well, such as in a recent study in Brunei, which pointed out that perceived enjoyment is a significant predictor for both perceived ease of use and perceived usefulness of learning for students in a 3D virtual world. These findings also indicated that the user's confidence and enjoyment were factors significantly related to acceptance and attitude regarding use of 3D virtual learning spaces for education (Abdul Hamid et al. 2017). Therefore, as members of the ASEAN Community, Thai students in the twenty-first century will increasingly need to be able to learn, cooperate and communicate with non-Thais to produce desired outcomes and develop themselves to their full potential. This might be best achieved by allowing them to take a greater role in directing their own learning. The nature of learning in the twenty-first century therefore must connect students in a network of learning without boundaries supported by the use of modern technology (Khlaisang and Likhitdamrongkiat 2015; Panich 2012; Schrum and Levin 2009; Songkram et al. 2015).

The use of VLE to overcome barriers in teaching and learning among the ASEAN community has been previously documented (Khlaisang et al. 2014). Its use is also in line with the policy of the ASEAN Socio-Cultural Community (ASCC), which, starting in 2015, has the goal to create a caring and sharing people-centered regional community to improve the standard of living for ASEAN people. It also aims to promote the ASEAN Identity. To achieve this, education must focus on teaching learners to recognize and understand the society and culture of each of the other ASEAN countries. Accordingly,

education has to be managed to encourage the recognition and understanding of the region's various social and cultural aspects. This can be aided by emphasizing open learning through VLE, which can be viewed as the classroom of the future. This should aim at providing opportunities for learners to not only access a variety of information sources, but also widely interact in learning activities with students from different countries, and create lifelong and more efficient learning (ASEAN University Network 2012; ASEAN Secretariat 2009; Khlaisang 2012a, b; Songkram et al. 2015). At present in Thailand, learning in a traditional classroom setting is seen as being insufficient to meet the needs of higher education learners and various student-centered teaching methods and virtual learning tools are increasingly being used, including simulations and virtual libraries for research (Nakmanee 2010). Meeting the challenge of developing VLE for the ASEAN community lies in addressing differences in tools, pedagogy, and learning objectives, which will help provide the necessary skills of twenty-first century learners and lead to the further development of both Thailand and the wider ASEAN community.

3 Research Methodology

The research design used in this study is Research and Development (R&D) aiming to develop a VLE system to teach twenty-first century skills to higher education students in ASEAN. The details of the methodology are provided below:

3.1 Participants

A sample group of 400 higher education instructors was used to answer research question 1 regarding determining the elements that form the design of an effective VLE system for twenty-first century learning, and data was obtained using the Exploratory Factor Analysis method. The sample size (n) was determined by using G* Power with a confidence level at 95%, error at $\pm 5\%$, power of test at 0.95, medium effect size (0.25), with five analysis groups. There were 400 valid questionnaires, which were determined to be an appropriate sample size for generalized analysis. To answer research question 2, the sample group of 90 students from 5 ASEAN countries including Myanmar, Cambodia, Philippines, Vietnam, and Thailand were invited to test the VLE system. The group was comprised of undergraduate students using the criteria that he/she was interested in ASEAN cultural exchange, and had at least 5 years' experience in ICT.

3.2 Measurements

There were four instruments used in this study: a questionnaire, the LMS with plugins, the 3D virtual community, and evaluation forms. The questionnaire was used to answer research question 1. The results from the questionnaire (177 items) were used to determine the necessary factors for a VLE system that would enhance twenty-first century skills in learning and innovation. To answer research question 2, the LMS with plugins emphasizing individual learning was developed, while the 3D virtual community using OpenSimulator was used to support socially mediated learning. Both aimed to develop the learning and innovation skills of twenty-first century learners. To measure whether learners have achieved such skills, the learning outcomes of learning and innovation were assessed using the students' self-evaluation form. In order to confirm the results from the self-

evaluation, behavioral observations were recorded to gain insight into whether the VLE design supported the outcomes. Authentic assessment using a scoring rubric was also conducted to record the evidence for consistency with the observation record. The behavioral observation form used a 4-point scale (0, 1, 2, and 3), and the rubric for project assignments was divided into four levels (0, 1, 2, and 3).

3.3 Procedure

The research study started by collecting questionnaires from 400 higher education instructors in May–October 2013. Then, the VLE system was designed, developed, and tested starting in November 2013 and finishing in June 2014. To achieve the goal of the study, the research was divided into 2 major phases. The details are as follows:

Phase 1 of the study aimed to determine the necessary factors for a VLE system to enhance twenty-first century skills in learning and innovation for higher education learners in the ASEAN cultural community using Exploratory Factor Analysis (EFA). In this phase, the related literature was reviewed by analyzing and synthesizing concepts, theories, and research on (1) skills in learning and innovation, (2) VLE system to be used as basis for identifying the input, process, output, and feedback of the system, and (3) teaching pedagogy, including teaching principles, teaching methods, teaching strategies and techniques in the context of VLE to enhance skills in learning and innovation. The information was used as basic information to create a framework for the VLE then a beta system. Then a questionnaire was developed based on the information. The data obtained from the questionnaire was analyzed using the Exploratory Factor Analysis (EFA) method to identify the key factors of the VLE framework. The quality and appropriateness of the VLE framework was examined by experts who were executives or instructors in VLE in the ASEAN region. Then, the beta of the VLE system was developed.

Phase 2 of the study aimed to examine the effectiveness of the VLE system for enhancing of higher education learners' twenty-first century skills in learning and innovation in the ASEAN cultural community. In this phase, a study of the use of the system was conducted by purposively selecting a sample group of undergraduate students from the universities which were well versed in Information and Communication Technology on a voluntary basis. There were 90 students participating with the requirement that each group had to have representatives from at least three ASEAN countries. The sample group studied using the developed VLE System for one semester. The research results were divided into five parts: Part 1 demographic information, Part 2 analysis results of the ability of skills in learning and innovation, Part 3 analysis results of learning behavior and trace observation in the virtual learning environment, Part 4 analysis results of assignment project of skills in learning and innovation, and Part 5 analysis results of the opinion survey of the VLE.

4 Results

The research results were divided into two sections according to the guiding research questions. The details are as follows:

4.1 The Underlying Factors that Form the Design of the Effective System for Twenty-First Century Learning

The research results were presented to answer the research question one, what are the necessary factors that form the design of an effective system for twenty-first century learning?, the data collection of 400 returned questionnaires was used. The data showed that most respondents were between 31 and 40 years old (48.75%), and had a master's degree as the highest education level (54.25%), followed by doctoral degrees (44%). Most were lecturers (70.25%), followed by assistant professors (24.75%). Most respondents worked in public and autonomous universities (51%), followed by Rajabhat Universities (46%). The majority had teaching experience of at least 6 years (30.25%), followed by 6–10 years (28.50%) (Fig. 1).

The data obtained from the questionnaire was analyzed using the EFA method to identify the key factors. According to the EFA on the elements of learning activity and technology in the context of VLE to enhance skills in learning and innovation, such skills included basic statistics of each item of skills in learning and innovation. It was found that the average scores of 177 items of the skills were between 3.335 and 4.483 and the standard deviation was between 0.693 and 1.047. Then factor analysis was conducted by extracting factors using Principal Component Analysis and Orthogonal Rotation Analysis with Varimax method. Among 117 variables, there were 11 factors weighted more than 0.50 but with less than three variables, including factors 9, 10, 12, 13, 14, 15, 16, 17, 18 and 19. It was determined that each factor had to have more than three variables. Therefore, these factors were removed. The remaining 9 prominent factors included 1, 2, 3,

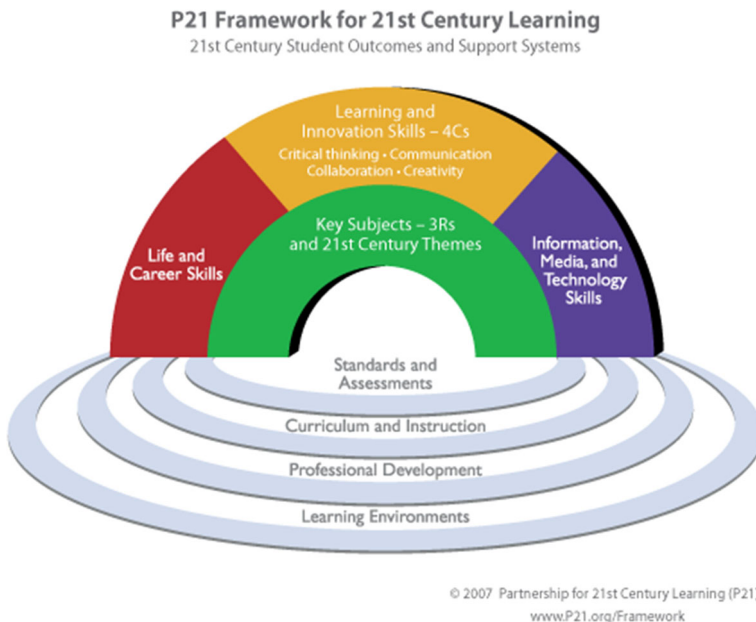


Fig. 1 Framework of twenty-first century learning focusing on four core areas including. (1) key subjects, (2) life and career skills, (3) learning and innovation skills, and (4) information, media, and technology skills (<http://www.p21.org>)

4, 5, 6, 7, 8, and 11, accounting for 93 variables in total. Then the researcher analyzed the factors using the scree test as shown in Fig. 2.

Figure 2 shows the eigenvalues of the skill factors of learning and innovation. Using the scree-test, it was found that there were nine distinct factors, including 1, 2, 3, 4, 5, 6, 7, 8, and 11, which was consistent with the analysis of Orthogonal Rotation using the Varimax method. Then the factors were named from the analysis of the nine factors using the weight of the factor and the content as a whole in the factor. Details are as follows.

Factor 1 had 37 variables with factor weight between 0.516 to 0.854 and eigenvalues at 42.990. It consisted of 1 variable on teaching method which was 28, 9 variables on teaching techniques which were 45, 46, 55, 58, 60, 61, 62, 63, and 69. There were 27 variables on technology which were 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108 and 109. Therefore, this factor was named “*Technology Usage*” since it was found that technology variables were the most frequent and had the highest total weight.

Factor 2 had 15 variables with factor weight between 0.505 to 0.796 and eigenvalues at 10.470. It consisted of 5 variables on teaching models which were 3, 8, 11, 12, and 13. There were 8 variables on teaching methods which were 20, 22, 23, 24, 25, 30, 31 and 33. There were 2 variables on teaching techniques which were 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108 and 109. Therefore, this factor was named “*Teaching Methods*” since it was found that teaching method variables were the most frequent and had the highest total weight.

Factor 3 had 11 variables with factor weight between 0.672 to 0.851 and eigenvalues at 5.423. It consisted of 2 variables on teaching models which were 15 and 16. There was 1 variable on teaching method which was 36. There were 4 variables on teaching techniques which were 74, 75, 76 and 77. There were 4 variables on technology which were 110, 111,

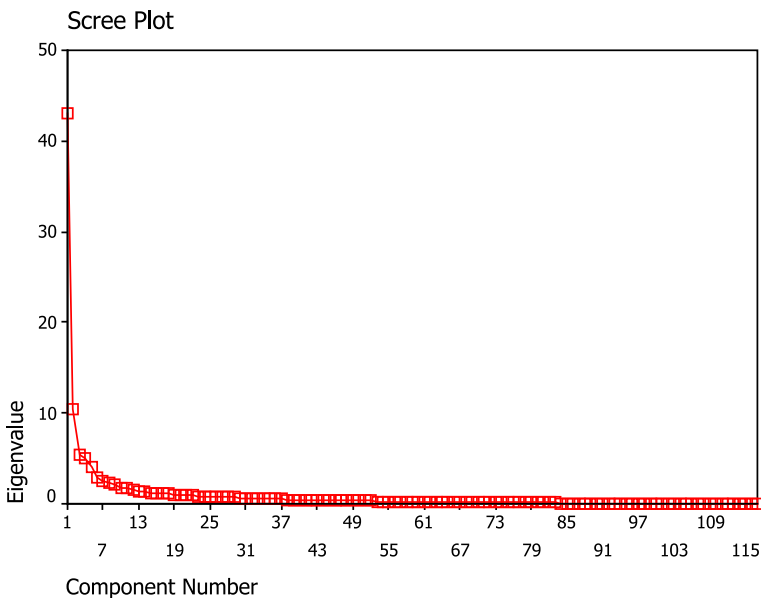


Fig. 2 Eigen of skills in learning and innovation

112 and 113. It was found that teaching technique and technology variables were equally frequent. Therefore, this factor was named “*Participation by Using Technology*”.

Factor 4 had 9 variables with factor weight between 0.563 to 0.693 and eigenvalues at 4.942. It consisted of 9 variables on teaching strategies/techniques which were 43, 49, 50, 51, 65, 66, 67, 71 and 72. It was found that teaching strategy/technique variables were the most frequent and had the highest total weight. Therefore, this factor was named “*Teaching Strategies*”.

Factor 5 had 5 variables with factor weight between 0.565 to 0.857 and eigenvalues at 4.035. It consisted of 4 variables on teaching strategies/techniques which were 79, 80, 81 and 82. There was 1 variable on technology which was 117. Therefore, this factor was named “*Scaffolding*” since it was found that the variable “teaching strategies/techniques” supported by the concept of scaffolding was the most frequent and had the highest total weight.

Factor 6 had 5 variables with factor weight between 0.537 to 0.823 and eigenvalues at 2.971. It consisted of 1 variable on teaching model which was 19. There was 1 variable on teaching method which was 39. There were 3 variables on technology which were 114, 115, and 116. It was found that technology variables were the most frequent and had the highest total weight. Therefore, this factor was named “*Supporting Technology*”.

Factor 7 had 3 variables with factor weight between 0.501 to 0.578 and eigenvalues at 2.497. It consisted of 3 variables on teaching technique which were 54, 56, and 57. It was found that teaching technique variables were the most frequent and had the highest total weight. Therefore, this factor was named “*Teaching Techniques*”.

Factor 8 had 4 variables with factor weight between 0.580 to 0.740 and eigenvalues at 2.233. It consisted of 1 variable on teaching model which was 18. There was 1 variable on teaching method which was 40. There were 2 variables on teaching techniques which were 41 and 78. It was found that teaching technique variables were the most frequent and had the highest total weight. Therefore, this factor was named “*Collaborative Data Analysis*”.

Factor 9 had 4 variables with factor weight between 0.520 to 0.698 and eigenvalues at 1.716. It consisted of 2 variables on teaching models which were 14 and 17. There were 2 variables on teaching methods which were 37 and 38. There were 2 variables on technology which were 41 and 78. It was found that teaching model and teaching method variables were equally frequent. Therefore, this factor was named “*Teaching Principle*” (Table 1).

Based on the analysis using the EFA method, 9 factors were used to design the VLE system to teach twenty-first century skills to higher education students in ASEAN. The VLE system has been designed and developed accordingly. In fact, the system consisted of three main components: technology, learning activities, and elements and steps. Technology focused on learning environments, learning resource tools, and learning tools. Learning activities consisted of the 3 modules designed to enhance all sub skills of the twenty-first century skills in learning and innovation including creative thinking and innovation, critical thinking and problem solving, and (3) communication and collaboration. The details of each component are presented in Fig. 3.

To determine the steps involved in the system, the nine underlying factors identified in the EFA were proposed and confirmed by the team of 15 experts being lecturers and administrators from various educational institutes. Based on the experts’ opinions, the system was slightly modified by combining a few overlapping factors resulting in the seven factors and seven steps. The revised factors included (1) VLE System in the ASEAN cultural community, (2) collaborative tools to enhance creative thinking and innovation, (3) cognitive tools to enhance critical thinking and problem solving, (4) communication

Table 1 Factors and meaning

Factors affecting the design of the virtual learning environment system for teaching twenty-first century skills to higher education students in ASEAN

Factors		Meaning
Factor 1	Technology usage	The use of technology to enhance twenty-first century learning skills focusing on the two types of learning environments included (1) 3D virtual community (OpenSimulator) and (2) LMS (Moodle) as online learning resources
Factor 2	Teaching methods	The active learning methods used in learning activities to enhance twenty-first century learning skills consisted of the 3 modules designed to enhance all sub-skills of twenty-first century skills in learning and innovation. The modules were: (1) activities using collaborative tools to enhance creative thinking and innovation (2) activities using cognitive tools to enhance critical thinking and problem solving (3) activities using communication tools to enhance communication and collaboration
Factor 3	Participation using technology	The particular learning tool technology used to enhance learning participation comprised: (1) collaborative tools—an online drawing tool, web applications, and social media (2) cognitive tools—mind mapping, search engine, and presentation programs (3) communication tools—chat, blog, wiki, web video conferencing, and social media
Factor 4	Teaching strategies	The particular strategies in order to enhance particular sub-skills of twenty-first century skills in learning and innovation included but were not limited to: (1) activities focusing on brainstorming strategies aiming to enhance creative thinking and innovation (2) activities focusing on analyzing strategies aiming to enhance critical thinking and problem solving (3) activities focusing on group work strategies aiming to enhance communication and collaboration
Factor 5	Scaffolding	The learning steps included (1) preparation, (2) identifying a topic or issue to be studied, (3) collecting and analyzing data, (4) synthesizing data, (5) creating innovation and learning, (6) evaluating, and (7) presenting. Prompt assistance was provided to learners throughout the process
Factor 6	Supporting technology	The various learning resources used included but were not limited to e-books, streaming video and open content
Factor 7	Teaching techniques	The teaching techniques were used which support the selected teaching methods and teaching strategies. These are grounded in principles of the individualized learning approach and collaborative learning approach in order to enhance learning of twenty-first century skills in learning and innovation. The techniques included but were not limited to interaction techniques and guided questioning techniques
Factor 8	Collaborative data analysis	The online instructional activities aimed for ongoing collaboration using data analysis to examine the effectiveness of such collaboration to enhance twenty-first century learning. In this study, the analysis data were collected from the VLE system, comprising the results from LMS and 3D virtual world

Table 1 continued

Factors affecting the design of the virtual learning environment system for teaching twenty-first century skills to higher education students in ASEAN

Factors	Meaning
Factor 9 Teaching principles	Principles applied in the study were individualized learning by using a self-paced learning approach through the use of the VLE system. Such an approach allowed learners to be responsible and able to learn at their own pace. Meanwhile, the social mediated learning using a collaborative learning approach was introduced for learners to participate in the 3D virtual world to increase the sense of belonging and to be involved in this learning community

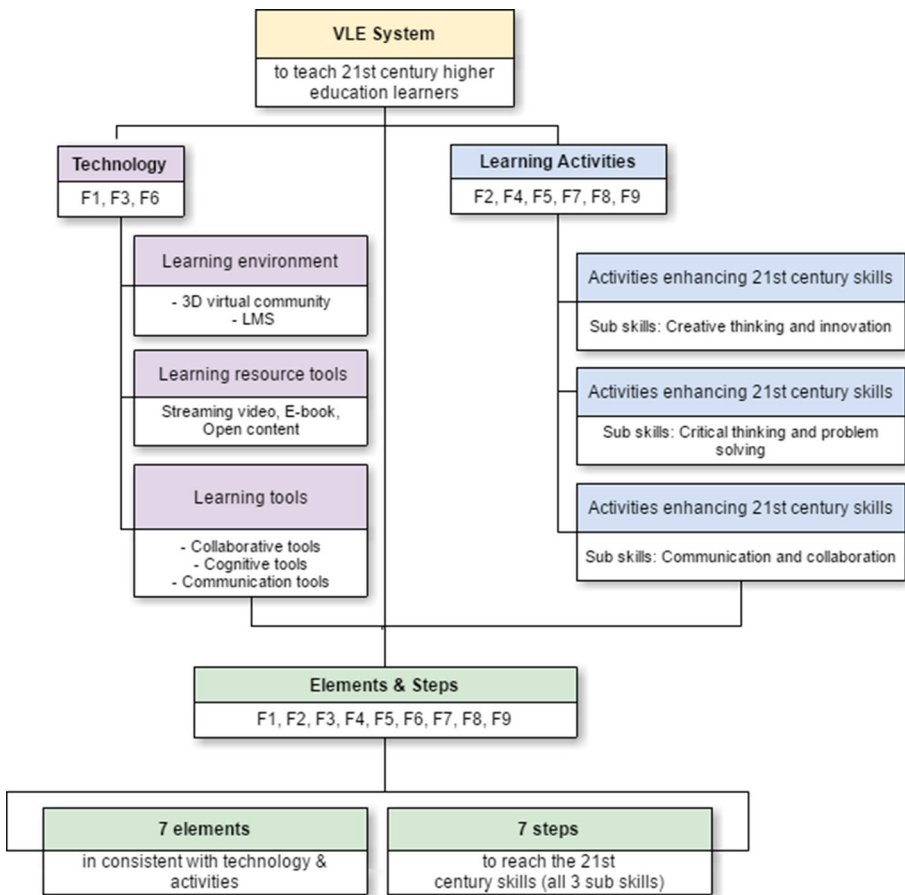


Fig. 3 Relationships among factors including technology factors, learning activity factors, and elements and steps of the model

tools to enhance communication and collaboration, (5) online teaching methods, (6) online teaching strategies, and (7) online learning resources. The seven steps included (1) preparation, (2) identifying a topic or issue to be studied, (3) collecting and analyzing data, (4) synthesizing data, (5) creating innovation and learning, (6) evaluating, and (7) presenting. Based on the factors and steps of the system, the details of the learning activity plan to enhance 3 sets of sub-skills of twenty-first century skills in higher education students are set out in Table 2.

For the purposes of this study, VLEs can be defined as a learning environment combining the benefits of a Learning Management System (in this case Moodle) and 3D virtual world (OpenSimulator in this case) to meet learners' needs. While the 3D virtual world (Figs. 4, 5) was mainly used as an online learning community, the LMS (Figs. 6, 7, 8, 9) was used as an online learning resource for learners in the community. Together, Figs. 4, 5, 6, 7, 8, 9 show the VLE system design

4.2 To What Extent Does the VLE Enhance the Learning of Twenty-First Century Skills?

To answer research question two, to what extent does the VLE enhance the learning of twenty-first century skills?, the effectiveness of the VLE system of the ASEAN cultural community was assessed using the results of 90 students who participated in the study with the condition that each group had to have representatives from at least three ASEAN countries. The twenty-first century skills comprised 3 sub-skills including (1) creative thinking and innovation skills, (2) critical thinking and problem solving skills, and (3) communication and collaboration skills. The instruments used to in the study to assess learners' twenty-first century skills in learning and innovation were the LMS with plug-ins to enhance learning and innovation skills, the 3D VLE using OpenSimulator, and evaluation forms including the students' self-evaluation form, the behavioral observation form, and the rubric for project assignments. The research results are divided into five parts detailed as follows:

4.2.1 Part 1 Demographic Information

Data analysis of the sample group of 90 students found that most were from Thailand (60.00%), and were female (65.56%). Most were 20 years old (27.78%). The majority of them had GPA between 3.01 and 3.50 (38.89%), and majored in Technology-English (24.44%). Most had been using a computer for 6–10 years (51.11%), had been using the Internet for 6–10 years (67.78%) and had experience of using a virtual classroom for 1 year (55.56%). In addition, Fig. 10 shows information about nationalities of the sample group, while Fig. 11 presents the experience of using the virtual classroom of the sample group.

4.2.2 Part 2 Analysis Results of the Ability of Skills in Learning and Innovation

The comparison results between the ability of skills in learning and innovation before and after studying shows that the sample group of 90 students had an average score of skills in learning and innovation at 3.14 with standard deviation at 0.67. After studying, they had an average score of 4.33 with standard deviation at 0.35. The results of the test of the differences between average scores of skills in learning and innovation before and after

Table 2 Relationship among technology factors, learning activity factors, and learning outcomes

Technology factors		Learning activity factors		Learning outcomes
Learning environment	Learning resources	Learning tools	Learning activity plans	
1. Moodle 2. OpenSimulator	1. Interactive video streaming 2. E-Books 3. Online open content	1. Collaborative tools including an online drawing tool, web applications, and social media	1. Preparation (technology and content) (IL, M) 2. Choosing an issue or topic to be studied (IL, M) 3. Brainstorming (GL, OS) 4. Creating an innovative project (GL, OS) 5. Checking (GL, OS) 6. Evaluation (GL, OS) 7. Presentation (GL, OS)	Sub-skills of twenty-first century skills in learning and innovation Creative thinking and innovation skills
1. Moodle 2. OpenSimulator	1. Interactive video streaming 2. E-Books 3. Online open content	2. Cognitive tools including mind mapping, search engine, and presentation programs	1. Preparation (technology and content) (IL, M) 2. Choosing an issue or topic to be studied (IL, M) 3. Collecting information (IL, M) 4. Analyzing information (GL, OS) 5. Seeking solutions for the studied issue or topic (GL, OS) 6. Evaluation (GL, OS) 7. Presentation (GL, OS)	Critical thinking and problem solving skills
1. Moodle 2. OpenSimulator	1. Interactive video streaming 2. E-Books 3. Online open content	3. Communication tools including chat, blog, wiki, web video conferencing, and social media	1. Preparation (technology and content) (IL, M) 2. Choosing an issue or topic to be studied (IL, M) 3. Setting working rules (GL, OS) 4. Studying information and sharing ideas (GL, OS) 5. Working on an assignment (GL, OS) 6. Evaluation (GL, OS) 7. Presentation	Communication and collaboration skills

IL Individual learning; *M* Moodle; *GL* group learning; *OS* OpenSimulator

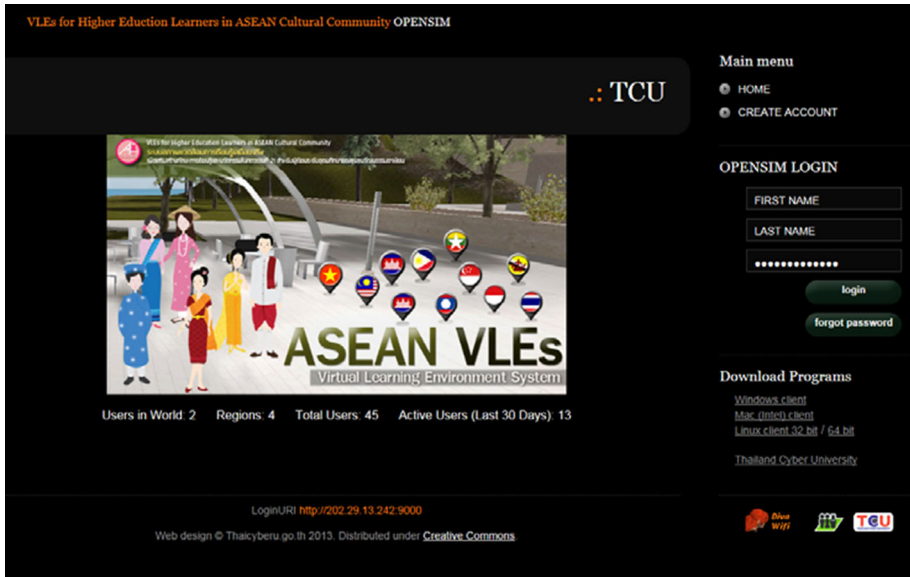


Fig. 4 VLE system developed using OpenSimulator, an open source virtual learning environment, used as an online learning community to enhance twenty-first century skills in learning and innovation for higher education learners in the ASEAN cultural community



Fig. 5 3D virtual learning community in OpenSimulator (open source software)



Fig. 6 VLE system developed using Moodle, an open source learning management system (LMS) with plug-ins, used as an online learning resource for learners in the community to enhance skills in learning and innovation for higher education learners in the ASEAN cultural community

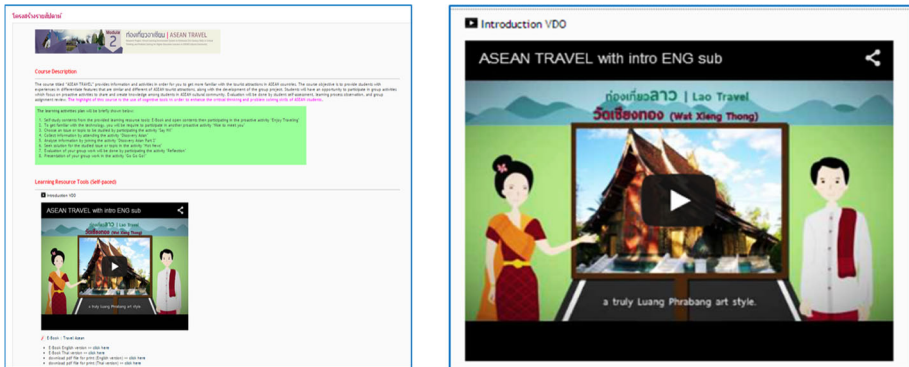


Fig. 7 Sample of streaming video, one of the online learning resources, designed for Moodle

Fig. 8 Sample of an e-book, one of the online learning resources, designed for Moodle



Fig. 9 Sample of open content, one of the online learning resources, designed for Moodle



Fig. 10 Nationalities of the sample group

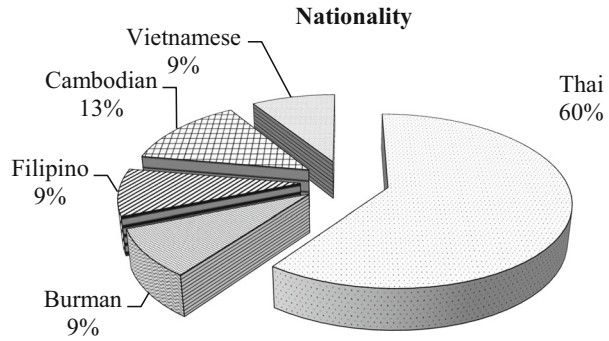


Fig. 11 Experience of using the virtual classroom of the sample group

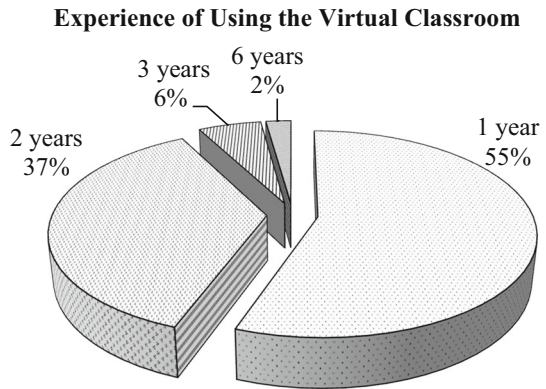


Table 3 The difference between pre and post self-assessment scores of learning and innovation skill

Assessment	n	\bar{x}	SD	t	p
Pre-test	90	3.14	0.67	-13.161	0.00
Post-test	90	4.33	0.35		

* $p < 0.05$

studying using independent t test indicate that average achievement test score had a statistical difference at the 0.05 level of significance ($t = -13.161, p = 0.00$) as shown in Table 3.

4.2.3 Part 3 Analysis Results of Learning Behavior in the Virtual Learning Environment

The observation of behaviors and trace observation of the development of skills in learning and innovation throughout the study by the experts show that overall behaviors were at a very good level ($\bar{x} = 2.78$, S.D. = 0.42). The evaluation of each aspect found that the identifying of a topic or issue to be studied had the highest average scores ($\bar{x} = 2.86$, S.D. = 0.35), followed by presentation ($\bar{x} = 2.84$, S.D. = 0.36) and preparation ($\bar{x} = 2.83$, S.D. = 0.37), respectively.

4.2.4 Part 4 Analysis Results of Assignment Project of Skills in Learning and Innovation

In the study using the VLE system, the researchers divided the sample group of 90 students into 18 groups of 5 people. The experts evaluated the project assignment of the sample group and it was found that the scores of each group were at the highest level ($\bar{x} = 2.52$, S.D. = 0.61). The evaluation of each aspect found that the skills in learning and innovation had the highest scores ($\bar{x} = 2.54$, S.D. = 0.61), followed by elements of the project assignment ($\bar{x} = 2.53$, S.D. = 0.60), and submission and completion of assignment ($\bar{x} = 2.48$, S.D. = 0.69), respectively. There were 10 groups that had the assignment scores at the highest level and 8 groups that had the assignment scores at a high level.

4.2.5 Part 5 Analysis Results of the Opinion Survey on the Virtual Learning Environment

After the sample group studied using the VLE system, the researcher conducted an opinion survey of the sample group. It was found that the overall opinion was at the highest level ($\bar{x} = 4.54$, S.D. = 0.54). As for the scores of each aspect, the usage had the highest average scores at ($\bar{x} = 4.61$, S.D. = 0.49), followed by learning activities ($\bar{x} = 4.58$, S.D. = 0.50), and content at ($\bar{x} = 4.57$, S.D. = 0.51), respectively.

5 Discussion

This study focused on the development of a VLE system to enhance twenty-first learning skills and also to enable learners to better understand and comprehend the various ASEAN socio-cultural aspects by managing the teaching and learning proactively. Using the VLE system, learners from ASEAN countries participated in a group-work collaboration through online communication tools in a 3D virtual learning community. This method is consistent with the results of Tick (2013), who pointed out that a key factor in VLE is the social interaction occurring when students participate in joint tasks and activities. The research also focused on developing a VLE system that can be accessed through various types of mobile devices including smart phones and tablets, so that students can access learning anywhere and anytime for collaborative work. This also allowed feedback and reflection from instructors to be communicated in a timely manner. The average scores of skills in learning and innovation before and after studying indicate that the average achievement test score had a statistical difference at the 0.05 level of significance which is consistent with the findings of Weiss et al. (2006), which posited that VLE promoted

learning collaboration and communication skills by means of exchanging ideas, sharing thoughts, and exploring together. The expected results of this research focused on both enabling students to learn about the society and culture of other ASEAN countries and specifically provided the opportunity for Thai learners to share their culture with others while broadening their own understanding of ASEAN countries. At the same time, this allowed them to gain skills in learning and innovation necessary in the twenty-first century to help prepare them to become leaders within the ASEAN community. Development of the VLE system in this study took into account the findings of Haven and Botterill (2003) regarding the challenges of creating a VLE for learning communities with different objectives, including appropriate tools and pedagogy and different learning objectives. The VLE design in this study addressed the learning needs in the ASEAN cultural community and the lifestyle of the digital generation to enhance and develop twenty-first learning skills, which include real time communication, immediate feedback, and mobility in learning equipment for an open, active, creative, collaborative, and motivated learning environment (Khlaisang and Mingsiritham, 2016; Tick 2013; Weiss et al. 2006).

Use of VLE to enhance individual learning is consistent with the goals set by the Office of Higher Education Commission, Bureau of International Cooperation Strategy to improve Thai higher education in preparation for the ASEAN Economic Community in 2015. The Second 15-year Long Range Plan on Higher Education of Thailand (2008–2022) emphasizes the management of higher education with the focus on the development of cognitive skills which are higher-order thinking, such as creative thinking, problem solving, critical thinking and innovation, while also expanding knowledge of technology. Such goals necessitate changes in teaching at the university level to produce graduates who are ready to expand their knowledge and use innovative thinking (Songkram 2011). Incorporating active learning to achieve this will require that instructors not merely pass on knowledge to students but guide and direct them to gain knowledge individually. The use of appropriate technology and active learning will enable students to learn meaningfully and enthusiastically through various activities, such as brainstorming activity, to develop important and necessary knowledge and skills. Active learning that takes place via a student-centered teaching method involves activities that develop a new learning environment and interactive learning that will enable students to use every skill; speaking, listening, reading, thinking, and writing and encourage them to participate in activities and solve problems by self-learning. The teaching focus under this method requires a clear learning plan regarding both content and activities, for example, use of authentic content and activities, such as Problem Based Learning, Project Based Learning, and Case Based Learning activities. By so doing, the systematic design of a learning plan providing clear-cut steps of instruction would be provided and instructor and learner roles be observed (Songkram 2012; Khlaisang, 2012a, b).

This is also consistent with the research of Songkram et al. (2015) in which an e-learning system was developed to enhance the cognitive skills of higher education learners to address important goals in Thai education, including education reform, self-paced learning, lifelong learning that emphasizes preparing learners to use new technology, and the Thai Qualifications for Higher Education Framework goals on cognitive skills development. In addition, it is hoped that the knowledge gained from this research will be used to advance educational technology and communications studies by presenting an example of the integration of educational technology and education science into teaching and learning. The proposed e-learning system comprised 4 major parts: (1) Input consisting of elements including learner's role, instructor's role, learning environment, learning resources, and motivations, (2) Process being the processes of instruction including

analytical thinking process, creative thinking process, scientific thinking process, systematic thinking process, and applicative thinking (this process uses the results of e-Learning system in BLE and e-Learning in VLE of sub projects to analyze and develop the proper e-Learning system), (3) Result being cognitive skills, and (4) Feedback being the evaluation of the system. The proposed system was tested to determine its effectiveness. The e-learning system in a Blended Learning Environment (BLE) was tested with the sample of 120 higher education students in Health Science, Science and Technology, and in Social Sciences and Humanities disciplines in one semester of academic year 2012, while the e-learning system in Virtual Learning Environment (VLE) was also tested by 120 students in Health Science, Science and Technology, and in Social Sciences and Humanities disciplines in one semester of academic year 2012. The subjects used in the research were selected by purposive sampling method with the required qualifications.

On the other hand, the results of this research emphasizing social mediated learning are consistent with the research of Khlaisang (2012a, b) on customized design of a VLE system based upon a constructivist approach for knowledge construction in higher education. In that study, three pedagogical blended e-learning models were proposed to effectively be integrated in higher education. The models included (1) Collaborative Discussion-Based Learning model (CDBL), (2) Collaborative Project-Based Learning model (CPjBL), and (3) Collaborative Problem-Based Learning model (CPBL). The research found that an effective online learning environment using appropriate cognitive tools would improve learners' cognitive ability, especially higher level knowledge including analyzing, evaluating, and creating. This is also consistent with the research of Koraneekij and Khlaisang (2015) on the development of learning outcomes based an e-portfolio model emphasizing cognitive skills in a customized VLE system for undergraduate students at the faculty of education of Chulalongkorn University. Those results showed that using an e-portfolio model emphasizing cognitive skills in a pedagogically-blended e-learning environment for undergraduate students consisting of 6 elements and 8 steps would help develop problem solving, creative-thinking skills, and critical thinking skills. Taking these two sets of research findings together, it can be seen that VLE systems which incorporate blended learning can help fulfill the goal of improving twenty-first century skills in higher education, especially regarding the creation of knowledge and development of cognitive skills.

6 Limitations and Future Research

In this study, limitations and future research can be addressed in terms of the representative sampling of population. Most of the sample group of ninety students were from Thailand (60.00%), and the rest were chosen from four different countries using the snowball sampling method. Perhaps if there were representative from all ASEAN countries, the results presented might have been different, especially in terms of collaborating and disseminating of a group innovation. The learning activities were also limited to three ordinary ASEAN topics in order to draw on the basic understanding among ASEAN countries. The topics included ASEAN food, ASEAN travel, and ASEAN etiquette. In the future, more complex ASEAN topics should be explored, for example, educational systems, to find commonalities among ASEAN countries which it is hoped will lead to further collaboration and innovative projects. In addition, this study focused solely on the quantitative data analysis with some content analysis from the focus group. Further investigation into

the qualitative data analysis might be valuable in order to obtain broader findings which may help support cooperation and communication within the ASEAN community (Figs. 12, 13).

Another limitation of this study is that its findings are not directly supported by other studies due to the factors taken into consideration when using LMS for teaching and learning purposes. For example, Asiri et al. (2012) looked at internal variables which consisted of attitude towards the use of LMS, beliefs toward e-learning, and competence

Fig. 12 Sample of a student group project from the ASEAN travel learning module, virtual field trip (<http://www.youtube.com/watch?v=mpvZ0keJdew>)



Fig. 13 Sample of a student group project from the ASEAN Etiquette learning module, interactive poster (<http://www.youtube.com/watch?v=GSsUD07wz7c>)



level in using LMS, while external variables included the barriers faced by faculty members and demographic factors. The barrier variables were divided into 3 sub-domains, namely, organizational barriers, technological barriers, and social barriers. The demographic factors included gender, experience in using computers as well as training and attending workshops. Therefore, the results of Asiri et al. (2012) focused more on readiness of the instructors in both internal and external variables for successful use of VLE in higher education, while in this study, greater emphasis was placed on the preparation of technology tools and teaching methods and strategies that would enhance learners' twenty-first learning skills. This difference in focus may be due to the fact that the study by Asiri et al. was conducted in 2012. Since then, new and innovative educational technologies have been developed which play an increasingly greater role in higher education teaching and learning while also being easier to use, minimizing the importance of variables relating to individual instructors.

7 Conclusion

The aim of this research study was to develop a VLE system to teach twenty-first learning skills to ASEAN higher education students using the Research & Development (R&D) method. The study also aimed to enable learners to better understand and comprehend the various ASEAN socio-cultural aspects. It is believed that this research will be beneficial for developing VLE systems to teach twenty-first century skills focusing on learning and innovation for higher education learners with a specific focus on developing students to be productive citizens within the ASEAN Socio-Cultural Community and thus promote a strong ASEAN identity by managing the teaching and learning proactively. Such VLE systems can enhance learners' skills in two ways. Firstly, learners can study the various types of individualized online content provided through the Learning Management System (LMS) as their virtual classroom at their own pace without limitation of time, place, and device. Secondly, learners can participate in group-work collaboration through online communication tools in a 3D virtual learning community focusing on social mediated learning where the real-time communication is emphasized.

Acknowledgements This paper was a part of the project funded by the National Research Council of Thailand (NRCT) in 2013. The authors would like to express our sincere appreciation to NRCT for their support. Sincere thanks must also go to Chulalongkorn University and the Thailand Cyber University Project who are the supporting institutes. Special thanks also go to all advisors, scholars, and experts for their help and support in developing new knowledge via this project to strengthen the educational technology and communications field.

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