A 3D Multiuser Virtual Learning Environment and Learning Management System

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***Abstract*—The proposed 3D Multiuser Virtual Learning Environment and Learning Management System (3DMUVLE-LMS) is an electronic learning tool designed to give students different learning experience in order to increase their learning motivation. This research studied how a 3DMUVLE was implemented and used in a learning process. Based on Hedonic-Motivation System Adoption Model (HMSAM) assessment, the proposed system received positive responses by the students. Further, 78.08% of the students agreed that the system was related with 21st century skills. Compared to traditional learning, the students' learning outcome was improved; the average score of post-test increased from 59.38 to 75.63. The research showed that the proposed 3DMUVLE could become a good environment for 21st century learning.**

Keywords—21st century learning, VLE, LMS

I. INTRODUCTION

In the 21st century, the challenges and demands of life evolve and change faster than ever before [1]. The challenges and demands of the impact of technological developments and changes in people's behavior in the use of such technology, which is to communicate, collaborate, and to learn [2]. This results in an increase in the required skills needed to achieve success in career [3]. To face these challenges, education needs a greater emphasis on learning approach that can form the cognitive skills that will assist in conducting activities for solving problems using existing and new knowledge [4].

The ability is often referred to as 21st century skills. There is some organization that has redefined the concept for 21st century learning. One of them is the Organisation for Economic Co-operation and Development (OECD). Through Programme for International Student Assessment (PISA), OECD performs assessments on its member states. Thus far, Indonesia received below the average PISA rating [5]. This fact generates urgency to Indonesian students to learn to be qualified in the 21st century.

In this century, learning environment is not limited to the classroom. Learning is done not only in the classroom, but also outside the classroom, and also virtually [6]. New methods in teaching have been developed and implemented to complement the traditional methods that rely on the system of one way learning in the classroom [7]. The new paradigm in the application of models and teaching methods, such as active learning and student-centered education, have led to the birth and development of numerous innovations in teaching technology, such as such as a Virtual Learning Environment (VLE) in [7].

In general, VLE can be regarded as components that are used by students and teachers in various types of online interactions [8]. More complex one, VLE can covers online learning management, providing material delivery mechanisms, and assessment [9]. The importance of the use of VLE as it can accommodate the needs of each student and support the development of students as a whole [6]. Studying through a virtual environment can improve the quality of learning [10]. The use of VLE can help improve the skills and achievements of students [11] [12].

The proposed 3D Multiuser Virtual Learning Environment (3DMUVLE) is a further development of [7] to help students, especially high school students to study with 21st century learning paradigm, in order to increase 21st century skills. The system was tested by students in a public high school in Bandung, Indonesia.

II. LITERATURE REVIEW

A. Related Work

Research about using VLE has been done before. One of them is the research by August [13]. The research objective is to see potential of MUVE as learning environment for science, technology, engineering, and math learning. The research showed that students using MUVE as their supplement of their traditional learning have greater scores in knowledge test. It also showed an average score gain from 27.46 percent in the pre-test to be 69.67 percent in the post-test [13]. In [7], the authors showed an increase of motivation, efficiency, and post-test results.

B. The 21st Century Skills

The 21st century skills are skills and competence that enable people to take advantage of changes in social forms and contribute actively to the economic development in a system in which the main asset is knowledge [13]. The 21st century skill is also defined as an ability to obtain, collect, manage, evaluate the quality and relevance, and translates information from sources that are available [10].

The Assessment and Teaching of 21st Century Skills (ATC21S) was created by Cisco, Intel and Microsoft.

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ATC21S has synthesized the role of standards and assessment in promoting learning. ATC21S define 21st Century Skills into 10 skills grouped into 4 categories, as follows [15]: (1) Ways of Thinking, (2) Ways of Working, (3) Tools for Working, and (4) Living in the World. In the following section, these categories are related to the features of VLE, and used in the Evaluation section.

C. VLE

VLE is computer-based environment that allows interactions and encounters among participants and provides access to a wide range of resources [12]. Technology is a set of tools that are used to deliver instructional materials and facilitate communication between the participants. Interaction is the level of relationship and exchange of knowledge between learners and teachers [12].

In a VLE, traditional learning environments are still there, however, it has changed shape or function. Learners are not learning from the ground up physically. Learners, obtain teaching materials and learning to communicate with friends through access-based interface to a computer on a network. Materials and teaching materials as a learning space, delivered in the form of text, hypertext, image, audio and video, animation and simulation. Learning schedule can be arranged by students or teachers independently.

Based on research conducted by Posey [16], VLE has the ability to meet the needs of students in the 21st century. VLE can increase some of the 21st century skills, including:

(1) Global Awareness, get information, and meet with many people from all over the world.

(2) Self-Direction, being able to learn on their own

(3) Information and Communication Technology Literacy, is able to use and get the latest information technology.

(4) Problem Solving Skills, in a discussion group or students to show their knowledge to solve problems

(5) Time Management, set the time of the grace period is set.

D. Learning Management Systems (LMS)

LMS is a web-based software application using a database on which various types of information are stored. LMS integrates interactive learning environments and administration and facilitate customized online instructional materials [17].

Framework for implementation of LMS has been developed by Dagada [18]. This framework has six processes. Each process has their activities and output. The process in this framework is Planning, System Study, System Analysis, Integration, Content Migration, and Training & Support. The LMS Implementation Framework can be seen in Fig. 1.

The most used LMS is Moodle. In Moodle, there is some activity which teacher and student can do. Almost all activities in real class are relevant with activities in Moodle.

E. Multi User Virtual Environment (MUVE)

MUVE is a term to describe massively multiplayer online role-playing games that allows multiple participants, represented as 3D digital versions of themselves (avatars) to interact simultaneously inside a virtual 3D world [19].

One of the engines of MUVE is Open Simulator. It can be used as a learning environment.

The proposed 3DMUVLE was developed using the Open Simulator, MOODLE, and SLOODLE. The Open Simulator provides the virtual world while MOODLE provides learning material contents. Both of them are linked using SLOODLE. SLOODLE is a module in MOODLE, yet it is also an object in Open Simulator.

F. E-Simulation Framework

E-simulation framework describes four dimensions of the development of a simulation. There is Scope, Experience, Mechanic, and Deployment [20]. This framework is used in implementation of the 3DMUVLE.

G. ADDIE Framework

ADDIE Model consists of five stages, which are analysis, design, development, implementation, and evaluation [21]. This framework is used for organizing the learning material within the 3DMUVLE.

III. METHOD

Framework is needed for helping identify the processes and activities for implementation. The framework developed by mapping ADDIE, LMS Implementation, and E-Simulation framework.

The combined framework consists of six main phases, which are Planning, Analysis, Design, Development, Implementation, Evaluation and Migration. This is shown in Table I. This framework is then used as a guide for implementation and evaluation of the proposed 3DMUVLE.

TABLE I
FRAMEWORK FOR DEVELOPING THE 3DMUVLE

Process	Activity	Output
Planning	• Identify Stakeholders • Form Advisory Committee • State Motivation for change	• Developer Team
Analysis	• Audience Analysis • Learning Analysis • Identify Legacy System transactions	• Audience Characteristic • Learning goal • Functional system requirement list
Design	• Learning Design	• Learning material

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Process	Activity	Output
	• System Design • Evaluation Scenario	• Architecture system and interface document • Evaluation document
Development	• Develop content learning • Develop Virtual Environment	• Virtual learning object • Virtual World
Implementation	• Installation • Distribution • Monitoring	• Process documentation
Evaluation	• Integration System Test • User Acceptance Test	• User Acceptance Test • Learning Result
Migration & Training	• Content Migration • Create Document Migration Document • Conduct Training	• Migration Document • Training Document

IV. Case Study

Math is chosen to be the case study for this research. Math is one of the key subjects in the 21st century learning. Math subjects are also rich in critical thinking and problem solving material. Evaluation was held in a high school in Bandung, Indonesia, involving 32 students.

Students in the 3DMUVLE represented by avatars. The avatar itself has three types depending on gender and role.

The material learning used for content learning in the system was taken from a book that students usually use. Learning material was represented by tutorial videos and 3D objects. In the virtual world, a virtual class represented a typical (but futuristic) class in a real life of an Indonesian school. There are two compartments in a class: one for learning and the other for quiz. Every activity in traditional class represented by an object in virtual world.

TABLE III
Learning in 3DMUVLE

Activity	3DMUVLE
Learning Content	Presenter (Video/Slide) or 3D Object
Interaction	Chat Friend list
Assessment	Quiz Chair Score Board
Administration	Reg-enroll booth
	Login area

1) *Presenter*

The SLOODLE presenter is a tool for creating presentations (for lecture, seminar or self-paced tutorial use) in Open Simulator. The presenter allows presentations to combine images, web-pages and videos by streaming the presentation content into Open Simulator using the media settings. See Fig. 1.

Presentations can be viewed in Open Simulator and/or in Moodle itself. The presenter can be set to allow any avatar - or only the owner - to control the presentation using the forward and back buttons.

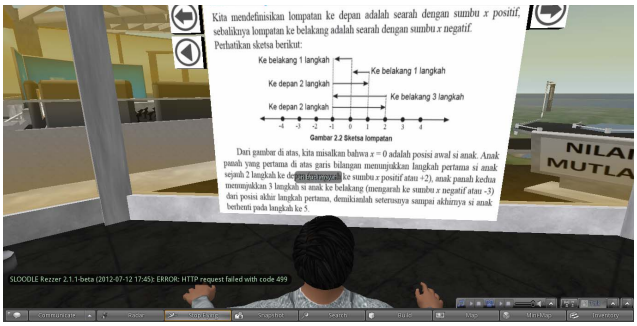

Fig. 1. Presenter.

2) *Quiz Chair*

There is another chair in Open Simulator that user can sit on it. This Quiz Chair is different. The chair connects quiz from Moodle and show it to the Open Simulator with two different ways, dialog or chat. When user who registered in the class of relevant quiz, the question will shown. See Fig. 2.

Fig. 2. Quiz Chair.

V. Evaluation

Evaluation was done by holding a workshop to 32 high school students. The instrument used for this test was referred to as HMASM models [22] that had been adapted to the context of testing [15]. The students were from different classes. The workshop was held for 4 sessions. Each session had 7-8 students. Meanwhile, the teacher taught the rest of students as usual in the class. The math topic used for testing was *Transformation Matrices* topic, namely translation.

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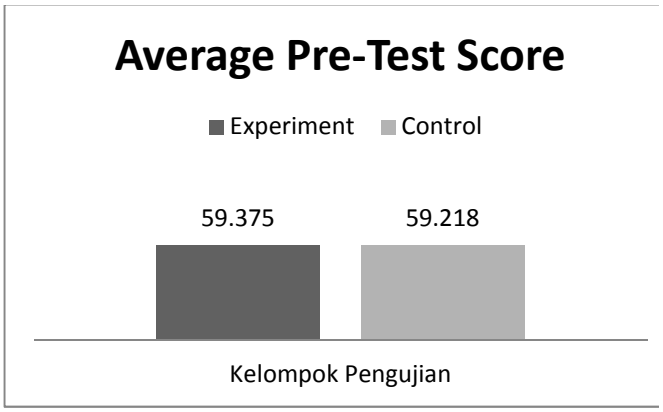
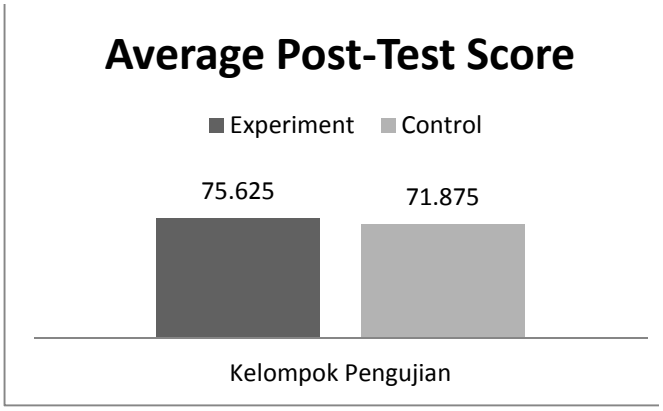
A. Knowledge Test Outcomes

Prior to the workshop, all students took a pre-test. After the learning and teaching, all students took a post-test. The score of each group was compared (see Fig. 3).

Students who learned using 3DMUVLE exhibited greater average score than students who learned traditionally. It had a gain of 3.6. Although this was a small number, the result showed that the proposed 3DMUVLE could make an impact in students' skills.





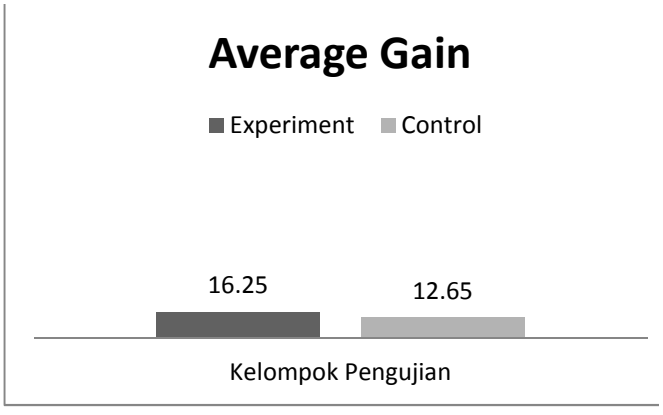


Fig. 3. Knowledge Test Outcomes.

B. Learning Tools

Utilization of Presenter to be used for knowledge transfer tool and learning material object was divided into three questions. The result shows that 65.63% students agreed that presenter in the 3DMUVLE can be used as a learning tool. See Table IV.

TABLE IV
PRESENTER RESPONSES

Scale	P1	P2	P3	Sum	%
Strongly Agree	5	8	8	1	21.88
Agree	15	11	16	42	43.75
Neutral	12	10	8	30	31.25
Disagree	0	3	0	3	3.13
Strongly disagree	0	0	0	0	0.0
Total	32	32	32	96	100

Evaluation regarding Quiz Chair to be used as evaluating study result object was executed into three questions. It can be seen from Table V that 77.09% students agree that presenter in the 3DMUVLE can be used as learning evaluation tools.

TABLE V
QUIZ CHAIR RESPONSES

Scale	Q1	Q2	Q3	Total	%
Strongly Agree	11	12	10	33	34.38
Agree	18	10	13	41	42.71
Neutral	2	9	8	19	19.79
Disagree	1	1	1	3	3.13
Strongly Disagree	0	0	0	0	0.0
Total	32	32	32	96	100

C. 21st Century Skills

Assessment for 21st Century skills was based on the ATC21S skills criteria. Criterium of Ways of Thinking was chosen for the assessment. Students took self-assessment questionnaires about the relation of the 3DMUVLE to the 21st century skills. The results showed that 69.79% students agreed that the 3DMUVLE has a potential to improve their 21st century skills. See Table IV.

TABLE VI
21ST CENTURY SKILLS RESPONSES

Criteria	Center Tendencies			Dispersion			% Mode
	Mean	Median	Mode	Range	S.Dev	Variance	
Creativity	4	4	4	2	0.67	0.45	78.13
Innovation	3.78	4	4	3	0.71	0.49	68.75
Critical Thinking	3.72	3.5	3	2	0.81	0.66	50.00
Problem Solving	4	4	4	2	0.72	0.52	75.00
Learning to Learn	4.13	4	4	2	0.75	0.56	78.13

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Criteria	Center Tendencies			Dispersion			% Mode
	Mean	Median	Mode	Range	S.Dev	Variance	
Metacognition	3.96	4	4	2	0.78	0.61	68.75
Average							69.79

D. The 3DMUVLE in General

Students responses related to the 3DMUVLE were evaluated using HMSAM instruments. Result in Table VI showed that 78.08% students agreed that the 3DMUVLE worked and met the requirements as a learning tool.

TABLE IV
GENERAL RESPONSE

Criteria	% Acceptance
Joy	90.63
Control	75.01
Focused Immersion	75.57
Temporal Dissociation	87.5
Curiosity	76.57
Perceived Ease-of-Use	68.75
Perceived Usefulness	75.01
Behavioral Intention to Use	75.57
Average	78.08

VI. CONCLUSION

As the positive results showed, the 3DMUVLE has a great potential as a learning tool. However, using the 3DMUVLE posed newly discovered problems, such as the infrastructure limitation (computer and network capacity) and students' behavior. These expose a future work. Research on the effects of the 3DMUVLE on students' behavior needs to be examined further.

REFERENCES

[1] D. Varnava-Marouchou, "21st century trends in education: implications for learning and teaching in higher education," in *Information Technology Based Higher Education and Training (ITHET)*, 2004.

[2] D. Miller, "Developing 21st Century Skills Through the Use of Student Personal Learning Networks," in *Dissertation*, 2009.

[3] Partnership for 21st Century Skills, "21st century skills, education & competitiveness : A resource and policy guide," pp. 7-9, 2008.

[4] I. Yengin, "Using educational technology to create effective learning societies in 21st century," *Information Technology Based Higher Education and Training (ITHET),,* pp. 1-7, 2014.

[5] OECD, Education at a Glance 2014 : Highlights, OECD Publishing, 2014.

[6] Partnership for 21st Century Skills, "Learning Environments: A 21st Century Skills Implementation Guide," 2015.

[7] H. Achiruzaman and Y. Rosmansyah, "A framework for 3D virtual game using MOODLE, SLOODLE and Open Simulator: Case Study: Training of house building data collecting by National Statistical Office (NSO), Government Agency, BPS - Statistics Indonesia," in *International Conference on Information Systems and Information (ICITSI)*, Bandung, 2016.

[8] M. Weller, Virtual Learning Environments: Using, choosing and developing your VLE, Oxon: Routledge, 2007.

[9] Menacer, M.; Arbaoui, A.; Al Mogbel, A., "Concepts and Architecture of a Dedicated Virtual Learning Environment for Quran and Its Sciences," *Advances in Information Technology for the Holy Quran and Its Sciences (32519), 2013 Taibah University International Conference,* pp. 362-365, 2013.

[10] Pacific Policy Research Center, 21st Century Skills for Students and Teachers, Honolulu: Kamehameha Schools, Research & Evaluation Division, 2010.

[11] A. A. Alhogail and A. A. Mirza, "Implementing a Virtual Learning Environment (VLE) in a Higher Education Institution: A Change Management Approach," *Journal of Theoretical and Applied Information Technology,* vol. 31, no. 1, pp. 42-52, 2011.

[12] G. Piccoli, R. Ahmad and B. Ives, "Web-Based Virtual Lerning Environments: A Research Framework and a Preliminary Assesment of Effectiveness in Basic IT Skills Training," *Management Information Systems Research Center, University of Minnesota,* vol. 25, no. 4, pp. 401-426, 2001.

[13] S. E. August, M. L. Hammers, D. B. Murphy, A. Neyer, P. Gueye and R. Q. Thames, "Virtual Engineering Sciences Learning Lab: Giving STEM Education a Second Life," *IEEE Transactions on Learning Technologies,* vol. 9, pp. 18-30, 2016.

[14] OECD, "21st Century Skills and Competences for New Millennium Learners in OECD Countries," *OECD Education Working Papers,* p. 41, 2009.

[15] Assesment and Teaching of 21st Century Skills, "Defining 21st Century Skills," 2010.

[16] G. Posey, T. Burgess, M. Eason and Y. Jones, "The Advantages and Disadvantages of the Virtual Classroom and the Role of the Teacher," *Southwest Decision Sciences Institute Conference,* 2010.

[17] D. Ifenthaler, "Learning Management System," in *Ecyclopedia of the Sciences of Learning*, London, Springer, 2012, p. 1925.

[18] R. Dagada and P. Mungai, "Learning Management System Implementation Framework for Higher

978-1-5386-0475-5/17/$31.00 ©2017 IEEE

Education-Case of University of the Witwatersrand," *International Journal of e-Education, e-Business, e-Management and e-Learning,* vol. 3, no. 2, pp. 151-154, 2013.

[19] M. N. DeMers, "Linking MUVE Education and Best Educational Practices," in *Nulti-User Virtual Environments for the Classroom: Practical Approaches to Teaching in Virtual Worlds*, Hershey PA, Information Science Reference, 2011, p. 1.

[20] J. Cybulski, "A Framework for Designing Mainstream Educational E-Simulations," in *Professional Education Using E-Simulations: Benefits of Blended Learning*, Hershey, Business Science Reference, 2012, p. 293.

[21] R. S. Nadiyah and S. Faaizah, "The Development of Online Project Based Collaborative Learning Using ADDIE Model," *Social and Behavioral Sciences,* vol. 195, pp. 1803-1812, 2015.

[22] P. B. Lowry, J. Gaskin, N. Twyman, B. Hammer and a. T. L. Roberts, "Proposing the hedonic-motivation system adoption model (HMSAM) to increase understanding of adoption of hedonically motivated systems," *Journal of the Association for Information Systems,* vol. 14(11), pp. 617-671, 2013.

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