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The Designing of Simulation Learning Environment to Enhance Scientific Explanation on the Topic of Acid-base for Grade 11 Students.

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Abstract

The purpose of this research was to design a simulation learning environment to enhance scientific explanation on the topic of acid-base for grade 11 students. The target group consisted of three experts, who reviewed for the designing a simulation learning environment to enhance scientific explanation. The study was survey research and there were development processes: 1) examining and analyzing the principles and theories, 2) reviewing literatures, 3) studying relevant contexts, 4) synthesis of framework for the designing of simulation learning environment and 5) development of simulation learning environment. Research instruments used included 1) simulated learning environment, 2) theory framework evaluation form and 3) learning environment evaluation form. The data was analyzed using basic statistics: mean, standard deviation and percentage. The study results revealed that the theoretical framework consisted of two components: 1) learning environment and 2) scientific explanation. The evaluated results of a theoretical framework for simulation learning environment to enhance scientific explanation on the topic of acid-base for grade 11 students from the experts found that the average mean ($\bar{X}$) was 0.84, standard deviation (S.D.) was 0.29, representing 83.35%. the process of designing a simulation learning environment to enhance scientific explanation found that the simulation learning environment consisted of six components: 1) simulated problem base, 2) scientific explanation, 3) resource, 4) scaffolding center, 5) collaboration and 6) coaching. Results of this found that the average mean ($\bar{X}$) was 0.88, standard deviation (S.D.) was 0.22, representing 87.51%.

Keywords: Simulation Learning Environment, Scientific Explanation, Constructivist Learning Environment

1 Introduction

In the present era of scientific advancements and global connectivity, a strong emphasis is placed on the development of education as a fundamental pillar for nurturing highly skilled human resources. This aligns with a 20-year research and innovation strategy that focuses on exploring innovative measures to ensure equal educational opportunities [1]. An evaluation of the competencies of international students has revealed that Thailand has room for improvement, as Thai students have obtained lower average scores compared to member

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countries of the Organization for Economic Cooperation and Development. This indicates a deficiency in the quality of Thai education, particularly in fostering scientific thinking skills that can be applied in real-life situations [2]. This observation is particularly relevant to the field of chemistry, which is inherently abstract and cannot be observed with the naked eye, posing challenges for students to comprehend and explain it effectively [3]. Scientific literacy encompasses three key components: scientific contexts, scientific knowledge, and most importantly, scientific competencies, which involve the ability to provide scientific explanations, evaluate and design scientific inquiries, and interpret data and evidence scientifically.

Therefore, researchers are interested in the ability to create scientific explanation, which is one of the competencies necessary of students in using knowledge and understanding, analytical thinking skills, and effective communication. This reflects the students' ability to link scientific ideas or principles to real-life phenomena or situations, to present issues, arguments, or their own decisions to the public [4]. One important method for developing learners to respond to changes in society is the creation of knowledge according to constructivist learning environments (CLEs), which is based on the constructivist theory. CLEs are a learning process in which teachers provide situations for learners to create knowledge by thinking, exploring, experimenting, and using various media and learning resources. [5] Currently, there are few integrated learning environments that include interactive simulations like PhET Simulation. It is an educational tool that presents online interactive simulations about science, mathematics, and chemistry, which can interact with users without any cost, and is based on educational research that covers and attracts students through game-like environments [6]. Therefore, to promote students' ability to develop scientific thinking processes, they must engage in hands-on experiences that allow them to face real-world situations. They will see that simulated learning environments have characteristics that respond to scientific explanation, particularly when considering the use of simulations as media to help develop learning environments to support efficient knowledge.

Therefore, based on the above reasons, the researcher is interested in conducting research on designing simulated learning environment to enhance scientific explanation on the topic of acid-base for grade 11 students. The results of this research will be used as a guide to further develop, promote, and support effective learning management in the future.

2 Research Method

The research methodology used in this study is survey research, which includes a development process consisting of 1) studying principles and theories, 2) reviewing relevant literature, 3) studying related contexts, 4) synthesizing theoretical frameworks of the simulated learning environment to scientific explanation, and 5) developing a simulated learning environment to enhance scientific explanation.

2.1 Target group

The target group for this study are three experts, who reviewed for the theoretical framework and designing simulated learning environment to enhance scientific explanation on the topic of acid-base for grade 11 students. (The experts are teacher in computer education, faculty of education, Khon Kaen University, Khonkaen, Thailand.)

2.2 Researching tools

1. Method to determine Simulated learning environment to enhance scientific explanation on the topic of acid-base for grade 11 students.
2. Assessment form for experts to evaluated theoretical framework and designing of simulation learning environment to enhance scientific explanation.

2.3 Collecting data

The researcher collects data on designing a simulated learning environment to enhance scientific explanation on the topic of acid-base for grade 11 students. Details are as follows:
1. Study principles and theories related to the designing of a simulation learning environment to enhance scientific explanation, to be used as a basis for research.
2. Review the literature, including principles, theories, and research related to the designing of a simulation learning environment to enhance scientific explanation.
3. Study the contextual factors related to learning management, including learning methods, curriculum for the science and technology learning area, according to the Basic Education Core Curriculum of 2008 (revised in 2017).
4. Synthesize a theoretical framework. Design and develop a simulated learning environment
5. Evaluate and improve the proposed recommendations for the theoretical framework and simulation learning environment to experts for review of the coherence between the theoretical framework and the components of scientific explanation.

2.4 Data Analysis and statistic used

Analyzing the data on the compatibility of theoretical framework and designing of simulation learning environment to enhance scientific explanation by summarizing, interpreting. Data was analyzed using statistics such as mean, standard deviation and percentage.

3 Research Result

1. The researchers studied the theory and research related to learning environment, as well as the scientific explanation of students. The framework consisted of two components: 1) learning environment, which was designed based on the framework of Sumalee [5] and included the following components: problem base, resource, scaffolding center, collaboration and coaching; and 2) scientific explanation, which was based on the principles of McNeill [3] and included three components: 1) claims, which confirmed the conclusions of questions or phenomena; 2) evidence, which was scientific data; and 3) reasoning, which linked claims and evidence using scientific principles. The researchers synthesized the theoretical framework of simulation learning environment to enhance scientific explanation on the topic of acid-base for grade 11 students, as shown in Figure 1.

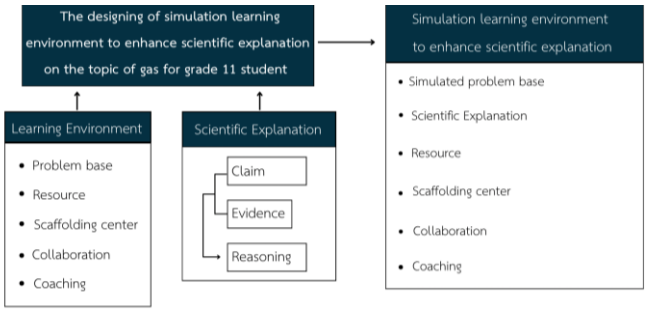


Figure 1: Shows the theoretical framework of simulation learning environment to enhance scientific explanation on the topic of acid-base for grade 11 students.

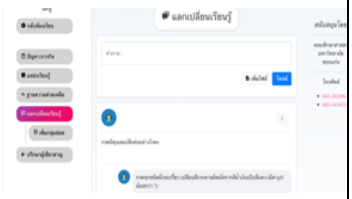
The effectiveness evaluation results of the theoretical framework of simulation learning environment to enhance scientific explanation on the topic of acid-base for grade 11 students by three experts showed that the overall score is at the level of (the average mean ($\overline{X}$) was 0.84, standard deviation (S.D.) was 0.29 representing 83.35 %), as shown in Table 1.

Table 1: Shows the results of the evaluation of the theoretical framework of simulation learning environment to enhance scientific explanation on the topic of acid-base for grade 11 students.

Assessment Items	Details of the theory	$\overline{X}$	S.D.	Percentage
1. Learning environment of Sumalee Chaijaroen [5]	1) Problem base	1.00	0.00	100
	2) Resource	1.00	0.00	100
	3) Scaffolding center	1.00	0.00	100
	4) Collaboration	1.00	0.00	100
	5) Coaching	1.00	0.00	100
	Summarize	1.00	0.00	100
2. McNeil's Scientific Explanation [3]	1) Claim	0.67	0.58	66.7
	2) Evidence	0.67	0.58	66.7
	3) Reasoning	0.67	0.58	66.7
	Summarize	0.67	0.58	66.7

2. Results of designing of simulation learning environment to enhance scientific explanation based on the theoretical framework synthesized in Figure 1, the researchers have designed simulations that focuses on the process of knowledge creation and scientific explanation. The model includes six components, as shown in Figures 2-7

Simulation Learning Environment	Example of design shot
2.1 Simulated Problem Base The simulated problem base (Figure 2) was designed based on the cognitive constructivism theory of Piaget [7], it is believed that when learners are stimulated with problem situations that create cognitive conflicts, or what is called an intellectual imbalance, it will encourage learners to engage in thinking processes. This is combined with simulation on computer in a realistic form by Heerman [8], which helps to develop learning and make it easier to understand complicated situations.	 Figure 2: Simulated Problem Base

2.2 Scientific Explanation This is a learning task designed to stimulate intellectual structures and promote the use of scientific explanation, as proposed by McNeil [3]. The task consists of three components: Claim, Evidence, and Reasoning, as shown in Figure 3.	 Figure 3: Scientific Explanation
2.3 Resource When learners enter the simulated problem situation and learning task that promotes their ability to explain scientifically, they must search for knowledge and solve problems using resources that collect content, information, and information such as e-books and multimedia. These resources will be used by learners use in problem-solving processes, based on the principles of the Constructivist Learning Environment [9], as shown in Figure 4.	 Figure 4: Resource
2.4 Scaffolding center The Scaffolding center (Figure 5) was designed based on the social constructivism theory of Vygotsky [10] which is necessary to assist learners, who are below the Zone of Proximal Development. It serves as a scaffolding for those who need guidance or cannot find a solution to solve problems by themselves. The format of the scaffolding center is based on the scaffolding principles of the open learning environment concept [11] to help promote learners' thinking skills, consisting of 1) conceptual scaffolding, which guides learners in what to consider when a problem is present (Figure 5a) and 2) strategic scaffolding, which provides learners with multiple and alternative approaches to solve a problem (Figure 5b).	(a) Conceptual Scaffolding  (b) Strategic Scaffolding  Figure 5: Scaffolding center
2.5 Collaboration Collaboration was promoted by the social constructivist theory of Vygotsky [10] which supports learners in exchanging experiences with others to expand their own knowledge. The design of learning environments using simulation scenarios provides opportunities for learners to exchange ideas with others. This collaborative learning approach helps learners to solve problems together and enhance their understanding of the subject matter, as shown in Figure 6.	 Figure 6: Collaboration
2.6 Coaching Coaching (Figure 7) based on the foundation of Situated Cognition and Situated Learning. These principles guide learning management according to constructivism, which has changed the role of teachers from simply imparting knowledge to "coaching" and helping learners. This is a way of training learners by giving them knowledge in a way that promotes thinking process and intelligence building, according to the principles of Cognitive Apprenticeship Coaching [12].	 Figure 7: Coaching

The effectiveness evaluation result of the designing of simulation learning environment to enhance scientific explanation on the topic of acid-base for grade 11 students by three experts found that the overall score was at the level of (the average mean ($\bar{X}$) was 0.88, standard deviation (S.D.) was 0.88, representing 87.51 %). The results are shown in Table 2.

Table 2: Shows the results of the assessment for the designing of simulation learning environment to enhance scientific explanation on the topic of acid-base for grade 11 students.

Assessment Items	Detailed simulated learning environment to promote the ability to explain in science.	$\bar{X}$	S.D.	Percentage
1. Simulated problem base	1) Problem base and learning tasks correspond to real context. Make learners wonder and encourage them to find answers.	1.00	0.00	100
	2) The simulated learning environment in a problem base help students to understand more problem base.	1.00	0.00	100
2. Scientific explanation	1) The learning task encourages students to have the ability to explain scientifically.	1.00	0.00	100
3. Resource	1) Learning resources are linked to various information, helping students have guidelines for finding answers to problem situations.	0.67	0.58	66.7
	2) Learning resources have sufficient information. Encourage learners to find answers from given problem situations and to be able to apply learning tasks.	0.67	0.58	66.7
4. Scaffolding center	1) Scaffolding center can support learners to create knowledge according to their needs and abilities.	1.00	0.00	100
5. Collaboration	1) Collaboration center supports the exchange of knowledge by allowing students to participate in exchanging ideas and solving problems together.	0.67	0.58	66.7
6. Coaching	1) Coaching or consulting experts encourages learners to come up with answers. Find solutions from learning tasks.	1.00	0.00	100
Summarize		0.88	0.22	87.51

4 Summary and Discussion

4.1 Discussion

The study found that the theoretical framework consists of two components: 1) the learning environment of Sumalee [5] and 2) the scientific explanation of McNeil [4], which is consistent with the research of Charuni about the learning environment to enhance analytical thinking in computer classroom [13]. The research of Wanpen studying the relationship between scientific explanation and students' biological conceptions [14]. Results of these research projects confirm that these theories and principles are used as components in synthesizing the theoretical framework of the learning environment design. The results show that the designed and developed learning environment is of high quality. In addition, the research has also designed simulation learning environment to enhance scientific explanation on the topic of acid-base for grade 11 students, which consists of six components: 1) simulated problem base, 2) scientific explanation, 3) resource, 4) scaffolding center, 5) collaboration and 6) coaching. In this research, there is a difference from previous research in that the problem base is designed in the form of simulation to enhance scientific explanation of students. The results of synthesizing theoretical frameworks for designing of simulation learning environment to enhance scientific explanation on the topic of acid-base for grade 11 students are in accordance with principles and theories in all components. This study focuses on synthesizing theoretical frameworks and designing of simulation learning environment that are important factors for use in designing and developing of simulation learning environment to enhance scientific explanation on the topic of acid-base for grade 11 students, based on a clear and systematic study for future effectiveness. This can be used for designing and developing a simulation learning environment in the future.

4.2 Summary

From research to synthesis of theoretical frameworks for simulation learning environment that are important factors for use in designing and developing simulation learning environment to enhance scientific explanation on the topic of acid-base for grade 11 students, consisting of two components: 1) Simulation learning environment, and 2) Scientific explanation. The design of simulation learning environment to enhance scientific explanation on the topic of acid-base for grade 11 students, consisted of six components: 1) simulated problem base, 2) scientific explanation, 3) resource, 4) scaffolding center, 5) collaboration and 6) coaching.

5 Suggestion

The principles and theories should be a basic for designing educational interventions that respond to the learning needs of students in different contexts.

References

[1] NESDC, "National Strategy 2018 – 2037," 20 Apr. 2022; http://nscr.nesdc.go.th/ns/

[2] IPST, "The Institute for the Promotion of Teaching Science and Technology," 15 Apr. 2022; https://www.ipst.ac.th/pisa

[3] K. L. McNeill, "Inquiry and Scientific Explanation: Helping Students Use Evidence and Reasoning," ResearchGate, 2008, pp. 123-125.

[4] IPST, "Science and Technology Education Promotion Institute," 15 Apr. 2022; https://pisathailand.ipst.ac.th/issue-2018-26/

[5] S. Chaijaroen and A Maneeratan, "Designing the Framework of Constructivist Web-Based Learning Environment to Enhance the Analytical Thinking," Journal of Education, vol. 27, no. 1, 2016.

[6] N. Jansoon and N. Rakbamrung, "TPACK in chemistry classroom using PhET interactive simulations," Journal of Science and Science Education, vol. 1, no. 1, 2018.

[7] J. Piaget, "Cognitive Development in Children: Development and Learning," Journal of Research in Science Teaching, vol. 2, 1964, pp. 176-186.

[8] B. Heermann, "Teaching and Learning with Computers: A Guide for College Faculty and Administrators," Jossey-Bass, 1988.

[9] S. Chaijaroen, "Education Technology and Instructional System Development," Faculty of Education, Khonkaen University, 2004.

[10] L. S. Vygotsky, "Mind in society: The development of higher psychological processes," Cambridge, MA: Harvard University Press, 1978.

[11] M. J. Hannafin, "Open-ended learning environment: Foundation, assumptions, and implications for automated design," New York: Springer-Verlag, 1999, pp. 101-129.

[12] A. Collins and P. Duguid, “Situated cognition and the culture of learning,” Educational Researcher, vol. 18, no. 1, 1989, pp. 32–42.

[13] C. Samat and S. Chaijaroen “Design and development of constructivist augmented reality (AR) book enhancing analytical thinking in computer classroom,” Proc. 2019 ICITL Conf. 2019, pp. 175-183.

[14] W. Khamthet, “Assessment of the ability to explain science through context-focused problems of biology teacher students,” Journal of Education, vol. 31, no. 3, 2020.