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The Designing of Simulation Learning Environment to Enhance Scientific Explanation on the Topic of Gas for Grade 11 Students

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Abstract

The purpose of this research was to design simulation learning environment to enhance scientific explanation on the topic of gas for grade 11 students. The target group in this research consisted of three experts, who reviewed for the designing of simulation learning environment to enhance scientific explanation. The research model in this 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 for simulation learning environment. The research instruments were 1) simulated learning environment, 2) theory framework evaluation form and 3) learning environment evaluation form. The data were analyzed using basic statistics: mean, standard deviation and per-centage. The research results revealed that the theoretical framework consisted of two components: 1) learning environment and 2) scientific explanation. The evaluated results of theoretical framework for simulation learning environment to enhance scientific explanation on the topic of gas for grade 11 students from the experts found that the average mean ($\overline{X}$) was 4.84, standard deviation (S.D.) was 0.21, representing 96.9 %. And the designing of 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. And the results of this found that the average mean ($\overline{X}$) was 4.62, standard deviation (S.D.) was 0.33 and representing 95.2 %.

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

1 Introduction

Currently, humans live in a globalized society with scientific advancements. Education is a vital part of driving the environment in people's lives, aligning with the 20-year national strategy for developing and enhancing human resource potential on developing human potential in all dimensions and age groups [1], and responding to the changes in the 21st century learning development. Following the Ministry of Education aims to update the curriculum, enhance learners' skills, and utilize digital technology for a globalized learning experience [2].

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From the results of the Program for International Student Assessment (PISA), which is an assessment of student literacy in three parts, it can be said that the ability to explain science can be considered as part of scientific literacy. Scientific explanation was defined as the ability of students to use their scientific knowledge to write explanations about various phenomena that are logical and consistent [3]. Thai students' average science literacy score remained unchanged from 2000 to 2018, indicating a lack of progress. This suggests that the development of the ability to explain science has not been successful. Furthermore, from the study of the results of the 9 basic subject tests, it was found that the average score of chemistry among grade 12 students nationwide in 2565 was lower than the previous year. Although chemistry is an important branch of science for learning science, due to its abstract content and various exceptions, it can be difficult for students to understand. One of them is the topic of gas, which is considered an important foundation in the subject of chemistry, as it is the basis for other concepts such as chemical equilibrium. Additionally, it is found that learners often overlook their understanding of these concepts and instead focus on using formulas to solve problems [4].

The important method for developing learners to have the characteristics that respond to the aforementioned problems is to use Constructivist Learning Environments (CLEs), which focuses on allowing learners to create knowledge themselves and have direct interaction with various things. The teacher designs problem situations, there are learning resources, linking old knowledge to new knowledge, as well as providing assistance and advice to learners [5]. Currently, there are few integrated learning environments that include simulations. It is an educational tool that presents online interactive simulations about science, which can interact with users without any cost, based on educational research that covers and attracts students [6]. It is suitable for learning content in chemistry that is abstract. It can be seen that the integration of the learning environment with simulations is an educational innovation with characteristics that respond to self-directed knowledge creation. The focus is on providing learners with knowledge and understanding of science.

Due to the aforementioned reasons, the researcher is interested in studying the designing of simulation learning environment to enhance scientific explanation on the topic of gas for grade 11 students. The results of this research will be used as a guideline to develop, promote, and support effective learning management.

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 related to the designing of a simulation learning environment to enhance scientific explanation, 2) reviewing relevant literature, 3) studying contextual factors related to learning management, including learning methods and curriculum, 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 is three experts, who reviewed for the theoretical framework and designing simulated learning environment to enhance scientific explanation on the topic of gas for grade 11 students. (The experts are teacher in computer education, faculty of education, Khon Kaen University, Khonkaen, Thailand.)

2.2 Researching tools

1. Number Simulated learning environment to enhance scientific explanation on the topic of gas 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 gas for grade 11 students. The 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 basic for research.

2. Review the literature, including principles, theories, and research related to the de-signing 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 were analyzed using statistics such as mean, standard deviation and percentage.

3 Research Result

1. The theoretical framework of simulation learning environment to enhance scientific explanation on the topic of gas for grade 11 students. 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 learning environment [5] and included the following components: problem base, resource, scaffolding center, collaboration and coaching; and 2) scientific explanation, which was based on three components of scientific explanation [3] : 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 gas for grade 11 students, as shown in Figure 1.

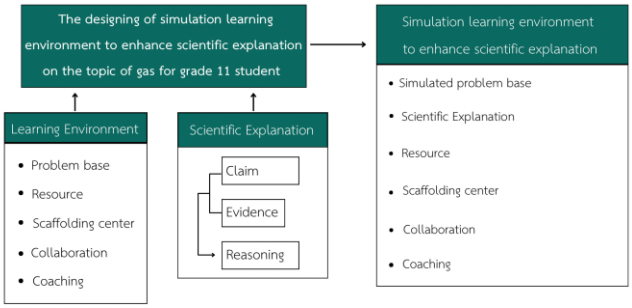

Figure 1: Shows the theoretical framework of simulation learning environment to enhance scientific explanation on the topic of gas for grade 11 students.

The effectiveness evaluation results of the theoretical framework of simulation learning environment to enhance scientific explanation on the topic of gas for grade 11 students by three experts show that the overall score is at the level of (the average mean ($\overline{X}$) was 4.84, standard deviation (S.D.) was 0.21 and representing 96.9 %), 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 gas for grade 11 students.

Assessment Items	Details of the theory	$\overline{X}$	S.D.	Percentage
1) Learning environment [5]	1. Problem base	4.67	0.58	93.3
	2. Resource	5.00	0.00	100
	3. Scaffolding center	4.33	0.58	86.7
	4. Collaboration	5.00	0.00	100
	5. Coaching	5.00	0.00	100
	Summarize	4.80	0.23	96.0
2) Scientific Explanation [3]	1. Claim	5.00	0.00	100
	2. Evidence	5.00	0.00	100
	3. Reasoning	4.67	0.58	93.3
	Summarize	4.89	0.19	97.8
Summarize		4.84	0.21	96.9

2. The 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

<table>
<tr><th>Simulation Learning Environment</th><th>Example of design shot</th></tr>
<tr><td>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.</td><td> 
Figure 2: Simulated Problem Base</td></tr>
<tr><td>2.2 Scientific Explanation

This is a learning task designed to stimulate intellectual structures and encourage student’s thinking to explain a phenomenon by using three components of scientific explanation, as proposed by McNeil [3] : 1) The claim makes a conclusion that addresses the problem, 2) The evidence supports the student’s claim using scientific data and 3) The reasoning links the claim and evidence, which shows why the data counts as evidence to support claim, as shown in Figure 3.</td><td> 
Figure 3: Scientific Explanation</td></tr>
<tr><td>2.3 Resource

When learners enter the simulated problem situation and the 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.</td><td> 
Figure 4: Resource</td></tr>
<tr><td>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 problem by themselves. The format of the scaffolding center is based on the scaffolding principles of the open learning environment concept [11] to help promote learner’s thinking skills, consisting of 1) conceptual scaffolding, which guides learners in what to consider when a problem is given (Figure 5a) and 2) strategic scaffolding, which provides learners with multiple and alternative approaches to solve a problem (Figure 5b).</td><td>(a) Conceptual Scaffolding
 
(b) Strategic Scaffolding
 

Figure 5: Scaffolding center</td></tr>
</table>

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.

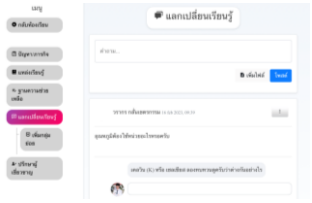

Figure 6: Collaboration

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 providing assistance, knowledge, feedback and advice to learner 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 gas for grade 11 students by three experts found that the overall score was at the level of (the average mean ($\bar{X}$) was 4.62, standard deviation (S.D.) was 0.33 and representing 95.2 %). 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 gas 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. Encourage learners to find answers.	5.00	0.00	100
	2) The simulated learning environment in a problem base help students to understand more problem base.	4.67	0.58	93.3
2. Scientific explanation	1) The learning task encourages students to have the ability to explain scientifically.	4.33	0.58	86.7
3. Resource	1) Learning resources are linked to various information, helping students have guidelines for finding answers to problem situations.	4.67	0.58	93.3
	2) Learning resources have sufficient information. Encourage learners to find answers from given problem situations.	5.00	0.00	100
4. Scaffolding center	1) Scaffolding center can support learners to create knowledge according to their needs and abilities.	5.00	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.	4.67	0.58	93.3
6. Coaching	1) Coaching or consulting encourages learners to come up with answers. Find solutions from learning tasks.	4.00	0.00	100
Summarize		4.62	0.33	95.2

4 Summary and Discussion

4.1 Discussion

The synthesis of theoretical framework for the simulation learning environment to enhance scientific explanation on the topic of gas for grade 11 students was analyzed based on research findings and studies of theoretical principles related to designing learning environments and scientific explanation. This was used as the foundation for developing a theoretical framework. The study found that the theoretical framework consists of two components: 1) the learning environment of Sumalee Chaijaroen [5] and 2) the scientific explanation of McNeil [4], which is consistent with the research of Charuni Samat studying about learning environment to enhance analytical thinking in computer classroom [13]. The research of Wanpen Kumthet studying the relationship between scientific explanation and students' biological conceptions [14]. From this below research, which shows 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 gas 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 gas 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 gas for grade 11 students, based on a clear and systematic study for future effectiveness. This can be used for designing and developing of 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 of simulation learning environment to enhance scientific explanation on the topic of gas 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 gas for grade 11 students, consisting 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.

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