Designing Interactive Electronic Module in Chemistry Lessons

IOP Conf. Series: Journal of Physics: Conf. Series **895** (2017) 012009 doi:10.1088/1742-6596/895/1/012009

Designing Interactive Electronic Module in Chemistry Lessons

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Abstract. This research aims to design electronic module (e-module) oriented to the development of students' chemical literacy on the solution colligative properties material. This research undergoes some stages including concept analysis, discourse analysis, storyboard design, design development, product packaging, validation, and feasibility test. Overall, this research undertakes three main stages, namely, Define (in the form of preliminary studies); Design (designing e-module); Develop (including validation and model trial). The concept presentation and visualization used in this e-module is oriented to chemical literacy skills. The presentation order carries aspects of scientific context, process, content, and attitude. Chemists and multi media experts have done the validation to test the initial quality of the products and give a feedback for the product improvement. The feasibility test results stated that the content presentation and display are valid and feasible to be used with the value of 85.77% and 87.94%. These values indicate that this e-module oriented to students' chemical literacy skills for the solution colligative properties material is feasible to be used.

1. Introduction

As a part of science, Chemistry is directly related to its applications in everyday life. By studying chemistry, students are expected to learn about themselves and the environment, thus be able to apply the knowledge in daily life and in solving the problem as the further prospect of studying chemistry [1]. Chemical literacy skill is defined as the level of individual ability to have scientific knowledge and using it to think critically and creatively, and to analyze scientific phenomenon based on scientific evidence happening in daily life. Chemical literacy skill consists of four levels, namely 1) nominal literacy, capable of recognizing core concepts; 2) functional literacy, capable of determining core concepts; 3) conceptual literacy, capable of using chemical concept to identify phenomena happening in daily life; and 4) multidimensional literacy, capable of linking the concept and scientific inquiry to a decision-making process based on social point of view.

The implementation of information and technology develop rapidly in every aspect of life [2, 3]. Implementation of IT in a field of learning is believed to be able to improve student's learning ability [4]. Learning process by implementing IT will provide the learning materials using various media which will affect the student's learning achievement in a positive way [5], learning using multimedia has a positive effect on students' learning outcomes [6].

A module specifically supporting students' chemical literacy development has not been developed yet. Generally, the module and learning in chemistry lessons emphasize more on less applicative content aspects. One of the materials in high school chemistry lessons, relevant to be developed into a

module for chemical literacy development, is colligative properties of solutions. This material is a concept presenting properties and concepts based on principles and processes. Moreover, the learning of solution colligative properties is closely related to daily life, for example, the process of melting snow with salt. To make the learning process more significant, it is required a content presentation integrated to aspects of the scientific process, context and attitude. However, the learning of solution colligative properties emphasizes more on symbolic level and chemical calculation problem solving [7].

The colligative nature of the solution is a chemical matter that belongs to a type of concept that states the nature and concepts based on principles and processes. This material of colligative nature is closely related to daily life such as the melting process of snow by using salt. Consequently, it requires aspects of the scientific process, context, and attitude to make the learning process become meaningful. Nevertheless, the materials of colligative nature of solution usually emphasize on the level of symbolic and problem solving which focuses on the scientific content of the materials [7]. Science actually has a strategic function because it can be used to develop the students' potential and ability both in cognitive aspect (science content), psychomotor aspect (science process), and effective aspect (science attitude) [8]. Therefore, it is necessary to develop a module able to facilitate students' chemical literacy skills. Accordingly, an electronic module (e-module) is a good development choice since the conventional one (printed module) is less interactive and has a static or monotone pictorial display while e-module can interactively present materials featured by multimedia such as videos, animations, simulations, and question with a direct feedback [9]. Using multimedia can minimize the number of intrinsic and extrinsic cognitive burden so that it can facilitate the externalization of information thinking, memorizing and processing. Learning content becomes more dynamic, effective and enjoyable. The use of multimedia is considered capable of improving the level of learning outcome [5].

This article carries the research study and the development aiming to create a product 'e-module' or electronic module oriented to students' chemical literacy skill concerning the topic of colligative properties of solutions

2. Methodology

The making process of e-module of solution's colligative nature uses design-based research method [10] [11]. Overall, this research undertakes three main stages, namely, Define, in the form of preliminary studies; Design, designing e-module; Develop including validation and model trial. Instruments used in this research consist of e-module storyboard and questionnaire. The storyboard is arranged as a guideline on e-module production. The production of e-module should be in line with the flowchart in order to make it easy to understand and perform and follow by user thoroughly and significantly. Criteria used in this e-module development are interaction model and functionality [4]. Flowchart and storyboard are made separately for each topic. Before e-module is made, the storyboard is reviewed first by experts. The questionnaire is used to determine the feasibility of e- module. The feasibility test is done by expert validators, consisting of 1 multimedia expert and 2 study field experts. Aspects asked in the questionnaire are the opinions of experts about the quality and aspects of the material present in the e- module. Furthermore, limited trials were conducted to 20 students to know the opinions of users regarding the ease to master the concept and use e- module oriented to students' chemical literacy skills.

3. Result and Discussion

E-Module presents materials of colligative properties of solutions, including four scientific aspects i.e. scientific context, process, content, and attitude. The development model of e-module consists of three stages: 1) presenting authentic problems (scientific context) in daily life in the form of videos or related pictures; 2) using the scientific context to develop the process aspect of the targeted skill by presenting the process of how an event occurs that is related to the context; 3) developing aspects of scientific attitude by giving some problems in terms of social, economic and environmental matters to

make students able to argue scientifically. By using these ways, the scientific oriented of the e-module characteristic can be fully pursued [12]. This e-module also implies that technology should be highly adaptable and applicable by ignoring environmental effects [13]. Based on the analysis result of the concept and discourse of each topic, the learning objectives of and students' chemical literacy skill developed are set. The analysis result becomes a guideline to determine and identify main elements to be displayed in e-module. The following is the resume of the analysis result of the objectives and chemical literacy developed.

Table 1. Learning Objectives and Chemical Literacy on Solution Colligative Properties Material

Sub-Materials and Learning Objectives	**Chemical Literacy Developed**
Saturated Steam Pressure Reduction of Solutions (ΔP): Describing the phenomenon of steam pressure reduction of solutions	Process : Concluding Context : Aquarium illustration videos and questions Content : related to evaporation Attitude : Material explanation Growing high curiosity
Freezing Point Depression of Solutions (ΔT_f): Analyzing the objectives of using salt to melt snow based on the concept of freezing point depression of solutions	Process : Predicting Context : Videos about melting snow with salt and Content : questions relating to chemical literacy Animations about freezing point of Attitude : solvents and solutions with explanation Growing high curiosity
Boiling Point Elevation of Solutions (ΔT_f): Analyzing cooking process based on the concept of boiling point elevation of solution	Process : Concluding Context : Videos about cooking water and instant noodle, and questions relating to chemical Content : Literacy as well. Animations about boiling point of Attitude : solvents and solutions with explanation Considering an efficient cooking technique
Osmotic Pressure of Solutions (π): Analyzing the process of sea water purification based on the concept of reverse osmosis principle.	Process : Concluding Context : videos about sea water purification questions relating to chemical literacy Content : Animations about reverse osmosis with explanation Attitude : Being aware of the importance of clean water supposed to be used wisely

The development of *E-module* at each topic follows the storyboard arranged [14]. The main pages of e-module for the topic of colligative properties of solutions consist of:

a. Home: Menu, containing links and materials profiles listed in the electronic module, which user can choose to learn. This display is similar to the table of contents of books.
b. Instructions for use: Instructions about how to use *e-module*.
c. Learning Objectives: chemical literacy indicators, consisting of 10 indicators relating to scientific process and attitude skills.
d. Material pages carry the concept of colligative properties of solutions based on chemical literacy indicators i.e. students' scientific process, context, content, and attitude.
e. On pages carrying process, aspect is animation, video or pictures relating to materials presented.
f. On pages carrying context, aspect is animation, video or pictures relating to materials presented.
g. Learning evaluation pages contain ten question, each, about colligative properties of solutions. The question refers to targeted learning objectives. The student must answer the questions one by one because if they skip even just one, they will not be able to continue or go to the next question automatically. After answering all questions, they will get a feedback in the form of a score and a note whether they are a success or not.
h. Evaluation pages of scientific attitude contain 16 questions about the scientific attitude toward phenomena happening in daily life. Those questions are related to phenomena happening in daily life. Once they answer all questions, they will get a feedback in the form of a note whether they have already had scientific attitude or not

Materials of nature colligative of the solution shown in four menus, which consist of four different themes namely aquarium, snow melting, cooking process, and osmotic reverse. Each theme explains sub concept of Saturated Steam Pressure Reduction of Solutions (ΔP), Freezing Point Depression of Solutions (ΔTf), Boiling Point Elevation of Solutions (ΔTf), and Osmotic Pressure of Solutions (π). The materials also are shown in four aspects namely scientific context, scientific process, scientific content, and scientific attitude that oriented to chemical literacy. One part that belongs to scientific context is sea water purification by using the technology of osmotic reverse and shown in the video. The visualization of scientific context aspects from osmotic reverse theme can be seen in figure 2.

Figure 1. Title Part

Figure 2. Scientific Context Aspects in Osmotic Reverse Theme

Furthermore, scientific context aspects can be explained by presenting an osmotic reverse process that belongs to scientific process aspects. Meanwhile, scientific content aspects can be explained by presenting sub microscopic animation of osmotic reverse aspects. The visualization of scientific content aspects from osmotic reverse theme can be seen in figure 3.

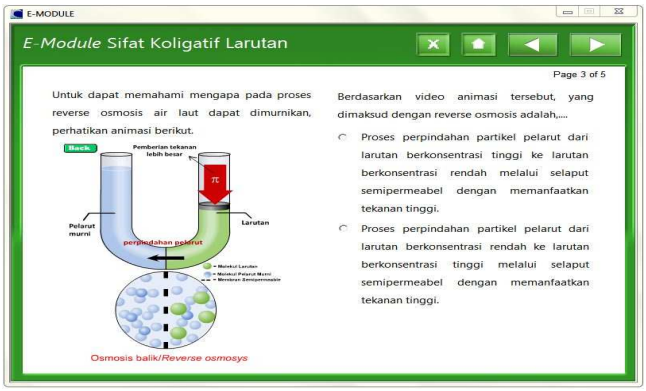

Figure 3. Scientific Content Aspect in Osmotic Reverse Theme

Visualization of the content in *e-module* is generally presented in the form of video or animation with text or pictures with text. The use of this visualization aims to make the user understand the content presented in *e-module*. Feasibility test of this e-*module* is done through two stages namely expert validation and limited trials. There are three validators consists of two chemistry experts and one multi media expert have done the validation. Moreover, a revision over e-module draft has been made based on suggestions given. Then, feasibility test is done in small scale (limited trial) to 20 respondents selected randomly. These trials are done by giving questionnaires and showing e-module completely to respondents in order to obtain an assessment about the ease of using e-module and the ease of understanding the materials presented. The tabulation results of the limited trial data conducted to 20 respondents can be seen in table 2 and table 3. Table 2 gives an overview of respondents' assessment of e-module on the aspect of the material content presentation. The explication of the material description and the suitability of the test questions with the learning objectives appear to be the most prominent criteria.

Table 2. The Percentage of Limited Trial Result on Material Content Aspect

No	Statement	Agreement (%)
1.	The explication of material description	100
2.	The depth of the materials	90
3.	The provision of examples and exercises based on the learning objectives	95
4.	The suitability of the questions with the learning objectives	100
5.	The provision of feedback for students' learning motivation	70
6.	The explication of the targeted learning objectives	85
7.	The ease of learning the materials	70
8.	The suitability of the material presentation order	95
9.	The explication of Al-Quran verses relating to the materials	85
10.	The suitability of the macroscopic presentation	85
11.	The suitability of the submicroscopic presentation	85
12.	The suitability of the symbolic presentation	80
13.	The feedback for the evaluation of attitude and learning performed by students	75
	Average	85,77

Table 3. The Percentage of Limited Trial Result on Display Aspect

No	Statement	Agreement (%)
1.	The ease of using e-module	90
2.	The explication of *E-module* instructions for use	85
3.	The quality of pictorial display presented in relation to the materials	95
4.	The explication of the animation presented in relation to the materials learned	85
5.	The explication of the video in relation to the materials learned	100
6.	The attractive and appropriate color composition	70
7.	The explication of addition value given by pictures to the materials learned	90
8.	The explication of modeling or animation	85
9.	The explication of links available in e-module	85
10.	The suitability of music played	70
11.	The use of the right and correct Bahasa Indonesia	95
12.	The simple yet fascinating e-module design	75
13.	The appropriate layout of font and pictures	100
14.	The use of appropriate font type and size	100
15.	The consistency of button used	85
16.	The explication of navigation buttons	90
17.	The efficiency of text	95
	Average Percentage	87,94

4. Conclusion

The making process of *e-module* consists of analysis, design development, product production, validation, and feasibility test. The visualization and presentation of the concept used in *E-module* refer to learning model oriented to chemical literacy skill with presentation order including scientific context, proses, content, and attitude. Validation result done by chemistry and multi media expert shows that all criteria dividing into two aspects, material content presentation and display, are valid. Feasibility test result states that the material content presentation and display are valid and feasible to use with the value 85,77% and 87,94%. Based on the percentage value, e-module is declared feasible to be used as learning media.

References

[1] S.-Y. Lin, "Chemical Literacy and Learning Sources of Non-Science Major Undergraduates on Understandings of Environmental Issues," *Chemical Education Journal*, vol. 13, no. 1, 2009.

[2] A. Pamoragung, K. Suryadi and M. A. Ramdhani, "Enhancing the Implementation of e-Government in Indonesia Through the High-Quality of Virtual Community and Knowledge Portal," in *6th European Conference on e-Government*, Marburg, 2006.

[3] C. Slamet, A. Rahman, M. A. Ramdhani and W. Darmalaksana, "Clustering the Verses of the Holy Qur'an using K-Means Algorithm," *Asian Journal of Information Technology*, vol. 15, no. 24, pp. 5159-5162, 2016.

[4] M. A. Ramdhani and E. R. Wulan, "The Analysis of Determinant Factors in Software Design for Computer Assisted Instruction," *International Journal of Scientific & Technology Research*, vol. 1, no. 8, pp. 69-73, 2012.

[5] M. A. Ramdhani and H. Muhammadiyah, "The Criteria of Learning Media Selection for Character Education in Higher Education," in *International Conference of Islamic Education in Southeast Asia*, Malang, 2015.

[6] I. Farida, "The Importance of Development of Representational Competence in Chemical Problem Solving Using Interactive Multimedia," in *International Seminar on Science*

Education, Bandung, 2009.

[7] T. Widhiyanti, "Pembelajaran Berbasis Teknologi Informasi untuk Meningkatkan Pemahaman Konsep dan Keterampilan Berpikir Kritis Siswa pada Topik Sifat Koligatif Larutan," Universitas Pendidikan Indonesia, Bandung, 2007.

[8] Mundilarto, "Pendekatan Kontekstual pada Pembelajaran Sains," Sleman Yogyakarta, 2005.

[9] M. D. Gall, J. P. Gall and W. R. Borg, Educational Research: An Introduction, New York: Longman, 2003.

[10] S. Barab and K. Squire, "Design-Based Research: Putting a Stake in the ground," *J. Learn. Sci*, vol. 13, no. 1, p. 1–14, 2004.

[11] T. D.-B. R. Collective, "Design-based research: An emerging paradigm for educational inquiry," *Educational Researcher*, vol. 32, no. 1, p. 5–8, 2003.

[12] R. Marks and I. Eilks, "Promoting scientific literacy using a sociocritical and problem-oriented approach to chemistry teaching: Concept, examples, experiences," *Int. J. Environ. Sci. Educ*, vol. 4, no. 3, p. 231–245, 2009.

[13] M. A. Ramdhani, H. Aulawi, A. Ikhwana and Y. Mauludin, "Model of green technology adaption in small and medium-sized tannery industry," *J. Eng. Aplied Sci*, vol. 12, no. 4, p. 954–962, 2017.

[14] I. Binanto, Multimedia Digital – Dasar Teori dan Pengembangannya, Yogyakarta: ANDI, 2010.