The Development of Chemical-Literacy-Oriented Electronic Module on Battery Topic

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Abstract: Instructional materials of battery topic in the form of electronic modules as an application of the Voltaic cells and a Chemistry literacy oriented module was considered necessary. The Battery Concepts is important to be understood because it is related to modern technology and daily life. This study aimed to analyse the results of validity tests and the results of the electronic module feasibility test. The research method used was the Design Based Research (DBR) which consisted of two main stages. First, the product development stage that covered analysis, design, design development, and product development stages. Second, the product testing stage that covered the validity and feasibility tests of the generated module. The validation was done by three validators, covering both material and presentation aspects. The feasibility test was performed on students of Chemistry Education. Validation and feasibility results were declared valid and very feasible for the module to be used as a teaching material and a learning media. This was because the module showed not only text contents, but also images, animations, and videos which referred to the indicator of Chemistry literacy components. This research was done only until the second stage and it needed to be followed up to the next stage that is dissemination stage, so that the product could be implemented in general and wider scope.

1 INTRODUCTION

Learning chemistry is a part of science learning. Students' Chemistry literacy is part of the science literacy achievements. In the learning process, the selection of appropriate methods is required (Irwansyah et al., 2018). Moreover, appropriate teaching materials or media are needed to achieve learning objectives. Based on research, the process of learning using multimedia, such as electronic materials, can improve the quality of learning outcomes (Suartama, 2010, p. 260). The teaching materials can be used to develop the student's Chemistry literacy. As Toharudin et al. (2011, p. 205) stated, Chemistry literacy can be developed by making Chemistry-literacy-oriented materials that are developed based on certain criteria in order to obtain a good quality result.

One of the teaching material that can be developed by Chemistry-literacy-oriented method is electronic modules. As Farenta et al. (2016, p. 2) showed that compared to other media, electronic module has characteristics that can be developed on various materials and approaches of learning in accordance with the learning achievement goals. Electronic modules for Chemistry subject related to everyday life can be presented in the form of writing, drawings, diagrams, graphics, animations, videos and audios. The content presented is more interesting and easily understood by students. As stated by Ogunkola (2013, p. 265), developing science literacy in science learning could be done by connecting one concept of science with one topic that is up to date and interesting in everyday life.

The concept of Chemistry is very related to daily life (Aisyah et al., 2017; Irwansyah et al., 2018). For example, a battery topic that is the application of Voltaic cell concept. This battery topic can be used

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as one of the materials to develop students' Chemistry-literacy.

In previous study, Perdana (2017) has researched on the development of electronic modules on alkanes, alkenes, and alkalis topic using Learning Cycle 5E learning method. Another study by Nurlatifah (2013) has created an environment-based Chemistry-literacy-oriented electronic module of hydrocarbon. Previous studies tend to discuss the topics that are already in textbooks and convert them to electronic forms. In this study, Chemistry-literacy-oriented electronic module was developed on battery topic as the application of Voltaic cell. In battery textbook resources, this topic is rarely discussed in detail, even though the concept of the battery has a relationship with Chemistry technology associated with everyday life.

In this study also, the development of Chemistry-literacy-oriented electronic module on battery topic was done by analysing the results of validity test and feasibility test.

2 METHODS

The research method used was the Design Based Research (DBR) with series of ADDIE model steps (Analysis, Design, Development, Implement, and Evaluations) (Barab and Squire, 2004, p. 114).

The research procedure referred to procedure Design Based Research (DBR), electronic module according to Herrington et al. (2007), with the steps as follows: 1) preparation phase (Analysis), activities at this stage were the determination of subjects, lessons, competencies to be developed, learning achievement analysis, literacy analysis of science and Chemistry, formulation of title, collection of sources and materials, and selection of software; 2) design phase (Design), the activities included the collection of materials to be presented in science-literacy-oriented electronic module on the battery topic, such as text materials, phenomenon texts, images, animations, audios, and videos; 3) development phase (Development), this included selecting the title, making the flow chart, making content analysis and plan, storyboard preparation, and generating the electronic module products; 4) testing phase (Implementation), this included the validation of electronic module by media experts and topic experts, and the feasibility test to limited respondents and revision according to the test questionnaire result; 5) improvement phase / revision of product (Evaluations), this was the revision of the generated electronic module based on suggestion of improvements from both experts.

The research instrument used was the Likert enclosed type questionnaire with improvement suggestion that aimed to test the validity of each item of electronic module criteria. The Guttman scale form of questionnaire was used to find out the feasibility test seen from material presentation and display aspects.

According to Arikunto (2010, p. 154), the result of the Likert scale questionnaire addressed to the validators was processed by looking at the number of checks in each column, then multiplying the frequency in each column with the corresponding column values. The result of questionnaire rcalculated was compared with the value of rcritical resulting r = 0.30. If the value of rcalculated was greater than 0.30, then the criteria was valid, otherwise the criteria was invalid. The r calculation uses the following formula:

Declaration:
rcalculated : validity value
x : number of respondents answer quality
n : number of respondents
N : the biggest number of questionnaire

According to Rivai and Sudjana (2009, p. 44), the data processing on the Guttman scale questionnaire obtained from the test results to the limited respondents, was done by summing the entire value of the column and then converting it into a percentage. A module or electronic module has the eligibility criteria, with the following percentage qualification (%): 90-100 was declared very viable, 80-89 was declared feasible, 70-79 was declared less feasible, and < 60 was declared not feasible. The percentage was calculated by using the following formula:

Declaration:
% : the percentage of feasibility
: the number of respondents answering yes and no
N : the total respondents

The subject of the study consisted of subjects for validity and feasibility test which can be described as follows: 1) the subjects of validity test were a topic expert and a media learning expert (lecturer of Chemistry education and lecturer of Informatics departments); 2) the subject of the feasibility test were students of 4th and 6th semesters, as many as 10 students who have received the Voltaic cell material and its application.

3 RESULTS AND DISCUSSION

3.1 Validation Result of Chemistry-Literacy-Oriented Electronic Module on Battery Topic

After the development phase of the design and electronic module generation, validation was done by three people consisting of two experts in chemistry and one multimedia expert. The validation process was done by providing validation questionnaire to the validators to be filled after examining the electronic module thoroughly. This validation aimed to look at the extent to which the initial product could measure the criteria from the material content and presentation aspects. The validation result generally could be declared as valid from both aspects with some improvement suggestions.

Table 1: Validation Result of Presentation Aspect of the Electronic Module Per-page

No	Subject	V_1	V_2	V_3	$r_{calculated}$	$r_{critical}$	Result
1	The accuracy of the selection of battery application materials in life with the understanding of Chemistry literacy	5	4	4	0.86	0.30	Valid
2	The conformity of content with learning achievement indicators	4	4	4	0.80	0.30	Valid
3	The clarity of content description	4	4	4	0.80	0.30	Valid
4	The accuracy of the battery material presentation order	4	4	4	0.86	0.30	Valid
5	The conformity of phenomenas with the learning objectives	5	4	4	0.86	0.30	Valid
6	The conformity of the phenomena presented with the context of the battery topic	4	4	4	0.80	0.30	Valid
7	The ease of learning the battery topic	4	4	4	0.80	0.30	Valid
8	The conformity of the Quranic verse with the topic and the Chemistry literacy	4	4	4	0.80	0.30	Valid
9	The clarity of the Quranic verse	4	4	4	0.80	0.30	Valid
10	The content material fosters religious attitudes, cares about science and environmental and social attitudes	5	4	4	0.86	0.30	Valid
11	The conformity of questions with learning objectives	4	4	4	0.80	0.30	Valid
12	The problems presented cultivate an attitude of curiosity to science	4	4	4	0.80	0.30	Valid
13	The suitability of video content, images and other media with the concept discussed	4	4	4	0.80	0.30	Valid

Table 1 illustrates that the presentation aspect of the electronic module is valid and the electronic module is feasible on the material aspect to be used as a teaching material. The criteria with the highest average score of 0.86 are the accuracy of the selection of battery application materials in life with the understanding of Chemistry literacy, the accuracy of the battery material presentation order, and the conformity of phenomenas with the learning objective

Table 2: Validation Result of Presentation Aspect of the Electronic Module Per-page

No	Subject	V_1	V_2	V_3	$r_{calculated}$	$r_{critical}$	Result
1	The quality of image/video regarding the material is fairly good	4	4	3	0.73	0.30	Valid
2	An appropriate and attractive combination of color display	4	4	3	0.73	0.30	Valid
3	The conformity of text, image and video layout	4	4	3	0.73	0.30	Valid
4	The efficiency of text display	4	4	3	0.73	0.30	Valid
5	The clarity of text display	4	4	3	0.73	0.30	Valid
6	The module cover display	4	4	4	0.80	0.30	Valid
7	The clarity of instructions for module usage	4	3	4	0.73	0.30	Valid
8	The ease of using the module	4	3	4	0.73	0.30	Valid
9	The conformity of the language used with the formal rules of the good and correct Indonesian language	4	4	4	0.80	0.30	Valid
10	The suitability of the use of fonts type	4	4	3	0.73	0.30	Valid
11	The suitability of using fonts size	4	4	3	0.73	0.30	Valid

Table 2 illustrates that the electronic module presentation aspect has been valid and the electronic module is feasible to be used as a learning material of Chemistry application concept which is the battery topic. The criteria with the highest average score of 0.80 are the module cover display and the conformity of the language used with the formal of the good and correct Indonesian language rules.

The result of electronic module validation showed that all criteria of assessment on material content and presentation aspects were valid with average value of the $r_{calculated}$ between 0.73-0.86, which is bigger than the $r_{critical}$ value, 0.30. The value of $r_{calculated}$ was compared with the value of $r_{critical,}$ if the value of $r_{calculated}$ is more than 0.30 the the criterion was considered valid, otherwise it's not valid (Arikunto, 2010, p. 154).

a. **Feasibility Result of Chemistry-Literacy-Oriented Electronic Module on Battery Topic**

After all the aspects of electronic module were declared valid at the validation stage, feasibility test was conducted on small scale (limited trial) to 10 randomly selected students of Chemistry Education Department that had studied the concept of Voltaic cell application. This trial was conducted by giving questionnaire and showing the electronic module thoroughly to the respondent in order to obtain an assessment of material content and presentation aspects of the electronic module.

Table 3: Analysis Result of the Feasibility Questionnaire Content Delivery Aspect of the Electronic Module

No	Subject	YES		NO
		R	%	R
1	The suitability of phenomenon of battery application in life with Chemistry literacy	10	100	0
2	The selection accuracy of the battery application topics in life with Chemistry literacy	10	100	0
3	The clarity of the battery topic material	10	100	0
4	The conformity of questions related to the battery material with the learning achievements goals	9	90	1
5	The clarity of feedback on battery related questions	9	90	1
6	The suitability of video and image presentation related to the battery material	10	100	0
7	The ease of learning the battery material	10	100	0
8	The accuracy of the presentation order of the battery material	10	100	0
9	The clarity of Quranic verses relating to the battery material and Chemistry literacy	10	100	0
10	The suitability of the problems difficulty level with the level of student thinking	9	90	1
11	The delivery of feedback on the questions	8	80	2
Average Percentage			95	

Table 3 provides an overview of respondent assessment of the electronic module content delivery aspect on the battery topic. 100% of the respondents agreed on the suitability of phenomenon of battery application in life with Chemistry literacy, the selection accuracy of the battery application topics in life with Chemistry literacy, the clarity of the battery topic material, the suitability of video and image presentation related to the battery material, questions related to the battery material with the ease of learning the battery material, and the accuracy of the presentation order of the battery material. On the criteria of the conformity of learning achievements goals, the clarity of feedback on battery related questions, the suitability of the problems difficulty level with the level of student thinking, as many as 90% of the respondents agreed. As for the delivery of feedback on the questions, 80% of the respondents agreed.

Table 4: Analysis Result of the Feasibility Questionnaire Content Presentation Aspect of the Electronic Module

No	Subject	YES		NO
		R	%	R
1	The ease of using the electronic module	10	100	0
2	The clarity of the electronic modules instruction	10	100	0
3	The quality of images and supporting images in accordance with the material presented	10	100	0
4	The quality of videos and animations used in accordance with the material presented	7	70	3

No	Subject	YES		NO
		R	%	R
5	An appropriate and attractive combination of color display	10	100	0
6	The suitability of the language used with the good and correct Indonesian language rules	10	100	0
7	The attractive and compelling design of the electronic module	10	100	0
8	The appropriate layout of text, images, videos, and animations	9	90	1
9	The suitability of the use of font type and size	9	90	1
10	The suitability of the screen size of the electronic module	10	100	0
11	The ease and clarity using the navigation keys	10	100	0
12	The efficiency and clarity of text usage	10	100	0
Average Percentage			96	

Table 4 provides an overview of the respondents' assessment of the presentation aspects of the electronic module on the battery material. 100% of respondents agreed to these criteria: the ease of using the electronic module, the clarity of the electronic modules instruction, the quality of images and supporting images in accordance with the material presented, an appropriate and attractive combination of color display, the suitability of the language used with the good and correct Indonesian language rules, the attractive and compelling design of the electronic module, the suitability of the screen size of the electronic module, and the ease and clarity using the navigation keys. For the appropriate layout of text, images, videos, and animations, and the suitability of the use of font type and size criteria, 90% of respondents agreed. The quality of videos and animations used in accordance with the material presented, received the smallest assessment with only 70% of respondents agreed.

The results obtained from the feasibility test of the Chemistry-literacy-oriented electronic module on the battery topic received a good response from the respondents. In general, respondents' response who 95% agreed to the content delivery aspect and 96% agreed to the presentation aspect, could be categorized as very feasible and the module is ready to be used as a learning source. An electronic module or module has the elegibility criteria with the following percentage qualifications (%): 90-100 is very viable, 80-90 is declared as eligible, 70-79 is declared as sufficient enough, 60-69 is declared as less feasible, and < 60 is declared as not feasible (Rivai and Sudjana, 2009, p. 45).

4 CONCLUSIONS

The results obtained from the validation and feasibility tests of the Chemistry-literacy-oriented electronic module on the battery topic were declared valid and very feasible to be used as a source of instructional materials and electronic media in Chemistry learning. This research was only done until the second phase. For the future, the next phase, the dissemination of the electronic module is needed so that it can be implemented in a general and bigger scope.

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