E-MODULE INNOVATION AS A LEARNING SOLUTION FOR CHEMISTRY COURSE DURING THE PANDEMIC BASED ON PROBLEM-BASED LEARNING

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Submission date: 20-Feb-2022 02:43PM (UTC+0700)
Submission ID: 1766501308
File name: E-MODULE_INNOVATION_AS_A_LEARNING_SOLUTION.pdf (320.39K)
Word count: 4437
Character count: 24801

J. Pijar MIPA, Vol. 16 No.4, September 2021: 459-465 ISSN 1907-1744 (Print)
DOI: 10.29303/jpm.v16i4.2747 ISSN 2460-1500 (Online)

E-MODULE INNOVATION AS A LEARNING SOLUTION FOR CHEMISTRY COURSE DURING THE PANDEMIC BASED ON PROBLEM-BASED LEARNING

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Acceped: August 06 2021. Approved: Sept 01 2021. Published: Sept 04 2021

Abstract: Chemistry e-modules based on *Problem-Based Learning (PBL)* are teaching materials based on electronic learning models or *e-learning* as a solution during the Covid-19 pandemic for students to learn independently. The purpose of this study is to assess PBL-based academic e-modules from the aspect of validity and feasibility in achieving its learning objectives. The approach used is *development research* according to the Thiagarajan model. The results showed that at the *define* stage, an analysis was conducted on the Curriculum 13 (K13) module of the Ministry of Education and Culture (*Kemendikbud*) with the material "chemical bonding" of Grade X at SMAN 3 Lembar. Furthermore, a module designed using an electronic display integrated with the PBL model was done at the *de*sign stage. Meanwhile, the expert validation result obtained an average of 0.86, categorized as valid and feasible criteria at the development stage. The result of students' responses obtained 72.73% (good criteria), and the result of the chemistry teachers' responses obtained 88.06% (very good criteria). The PBL-based Chemistry e-module on chemical bonding material is feasible as a Chemistry learning solution for Class X of SMAN 3 Lembar.

Keywords: *e-module, Problem Based Learning (PBL), chemical bonding, Covid-19 Pandemic*

INTRODUCTION

The Industrial Revolution 4.0 has fundamentally resulted in changes in the way humans think, from conventional to digital [1-3]. Changes in the Industrial Era 4.0 require the world of education to innovate learning by integrating it with technology and information [4-5]. Thus, optimal use of multimedia can positively impact learning processes and outcomes [7-8].

The use of multimedia in Chemistry learning is a means of displaying chemistry's characteristics, such as macroscopic, submicroscopic, and symbolic, by combining multimedia elements [9]. Regarding the diversity of learning media as technological products, electronic modules or e-modules provide convenience for users to obtain learning materials through access to smartphones, tablets, and laptops [10].

The learning module is designed as a source of independent learning for students. The electronic design module has the aim that learning is not teacher-centered but student-centered. In this case, learning using e-modules can increase students' motivation and interest in learning [11-13]. Modules in the learning process can facilitate students in learning independently and face-to-face [14-15].

Electronic modules have relevance to learning that prioritizes problem-solving or Problem-Based Learning (PBL). In PBL learning, students form small groups and present open-ended problems to solve and answer questions [16-17]. The PBL method is designed to activate and construct prior knowledge. It is related to real-world learning, where the teacher functions as a facilitator for students to develop their knowledge base [18]. According to Botty & Shahrill, Problem-Based Learning is learning-oriented towards providing problems to achieve the desired learning objectives [19]. Giving problems as an orientation to learning is a simulation for students in dealing with everyday problems so that they are encouraged to learn independently.

Problem-Based Learning, according to Mariani et al., is as follows: (1) giving problem-oriented tasks to students, (2) organizing students to conduct research, (3) assisting individual and group investigations, (4) presenting the results of discussions, and (5) evaluate the results of the solution [20]. According to Wood, the purpose of PBL learning is that students can use problems in everyday life as triggers to achieve learning goals. Thus, the problem is not only solved but can also be used to improve student understanding [21]. In general, PBL involves the main question or problem posed by the teacher, which then students work together and decide the appropriate strategy to solve the problem [22-23].

PBL-based electronic modules can help students improve problem-solving skills, critical thinking skills, and intellectual skills [24]. In addition, the use of PBL-based e-modules can improve science processing skills [25]. PBL-based e-modules can improve concept mastery and help students learn independently [26]. Learning using PBL-based e-modules can help students express, argue, solve, or discuss problems in learning [27].

Chemistry learning requires learning innovations through PBL-based electronic

modules. However, the design of Chemistry learning during the Covid-19 Pandemic has not yet developed many electronic-based learning integrated with the PBL model, especially high schools such as SMAN 3 Lembar where information technology has not yet become a necessity in the learning process. Meanwhile, during the Covid-19 Pandemic, electronic-based learning is a solution to overcome the limited face-to-face time at school. Therefore, This study aims to determine the feasibility of a PBL-based e-module that can be used as an alternative to distance learning during the pandemic.

RESEARCH METHOD

This research is conducted at SMAN 3 Lembar in May 2021. The population in this study are all students of Class X of Science Department of SMAN 3 Lembar with a total population of 22 people. The sampling technique used is the saturated sampling technique. Saturated sampling is a sampling technique using all members of the population. It is because the population is relatively small, with less than 30 people. Thus, the sample in this study is all students registered as Class X students of the Science Department of SMAN 3 Lembar, totaling 22 people.

The variable in this study is the PBL-based Chemistry e-module innovation on chemical bonding material for Class X of the Science Department. The approach used was *the development research approach*. The steps of development research in this study follow Thiagarajan et al., i.e., the 4D Model consisted of stages: *define, design, develop,* and *disseminate* [28].

In the *define* stage, a preliminary-to-final analysis and material analysis of the PBL-based Chemistry e-module on chemical bonding materials is conducted. Analysis of the material is carried out through library research activities on the books and modules used by SMAN 3 Lembar. The analysis results are used as a reference in the preparation of the e-module content framework, which describes the overall content of the material included in the e-module, complete with the learning flow and display design of the PBL-based Chemistry e-module teaching material.

In the "design" stage, the initial preparation of the e-module format is carried out with the help of Microsoft Word. After that, the file is converted to pdf format. Furthermore, the pdf module is turned into an interactive e-module with the help of Flip PDF Professional software. The function of the software is to convert the initial format of the module in pdf format into electronic form with videos, moving animations, pop-up images, and interactive practice questions. The output of Flip PDF Professional software can be accessed online (in *html* form) or offline (in *exe* form). Here is the online access link of https://online.flipbuilder.com/wndty/cimj/.

After compiling materials and making PBL-based Chemistry e-modules, the "develop" stage is conducted, i.e., a feasibility test with expert validation tests and limited trials. The expert validation test in this study is conducted with the help of 3 material-expert lecturers to determine the suitability of the PBL-based e-module content developed with the expected goals and make improvements to the products that have been developed. After the examiner states that the media is feasible to use, then the learning media can be predicated as "valid," and the limited trial is then conducted. In this study, a limited test is conducted on the responses of 22 students of Class X SMAN 3 Lembar and 16 Chemistry teachers. Furthermore, the fourth stage in this study (disseminate) is a broad test. However, this research is limited to the "develop" stage, which is to produce a product in the form of a PBL-based Chemistry e-module.

Aiken's V analysis is used to test the validity of the product, and then the results are consulted and displayed in the Aiken Index Range Category Table according to Retnawati [34].

The practicality of the resulting product is tested using a questionnaire response of students and Chemistry teachers. Furthermore, the percentage of student responses is converted with the following criteria (Table 1) [31].

Table 1. Responses Criteria

No.	Value	Criteria
1	80% < x≤ 100%	very good
2	60% < x≤ 80%	good
3	40% < x≤ 60%	fair good
4	20% < x≤ 40%	less good
5	0% < x≤ 20%	not good

RESULTS AND DISCUSSION

Results of "Define" Stage

The "define" stage defines and identifies the stages in determining the subject matter, objectives, and scope to be investigated in the developed product. The "define" stage consists of problem analysis (beginning-late), student analysis, task analysis, concept/material analysis, and specification of learning objectives. Problem analysis is carried out at SMAN 3 Lembar located on the Persada Lendang Garuda highway, East Mareje Village, Sheet District, West Lombok Regency. The problem analysis aims to analyze and determine the basic problems faced by SMAN 3 Sheets in learning chemistry so that PBL-based Chemistry e-module innovation is needed. The results of interviews and observations with teachers stated that the curriculum used at SMAN 3 Lembar is the 2013 Curriculum (K13) and used teaching materials in the form of the K13 module from the Ministry of Education and Culture. In addition, lecture, question-and-answer, and demonstration (practicum) learning methods are applied in the

ISSN 1907-1744 (Print)
ISSN 2460-1500 (Online)

learning process. The observation results show that learning during the pandemic makes it quite difficult for students to understand the learning module without teacher guidance. Furthermore, for the analysis of students, it is conducted by interviews and observations. It is found that students' abilities are different in receiving and responding to the subject matter and affecting the interest and enthusiasm of students in the learning process. In concept analysis, task analysis, and classification of learning objectives, it is found that an analysis of the chemical bond learning material is conducted with three sub-topics: (1) ionic bonds, (2) covalent bonds, and (3) metal bonds. In the specification of learning objectives, an analysis of core competencies and basic competencies is conducted. The selected basic competencies are KD 3.9 and 4.9, which are chemical bonding materials.

Results of "Design" Stage

The design stage aims to determine the selection of suitable media for the purpose, format selection, and initial design. The media used to provide subject matter are e-modules that can be accessed offline and online using electronics (smartphones or laptops). The format of the electronic module (e-module) is developed according to the needs of the analysis at the "define" stage. Thus, for the design of the developed e-module, the modified Prastowo format is used [29]. The format for the developed electronic module (e-module) are as follows.

Table 2. Outline of PBL-based Electronic modules

Beginning Section	Content Section	Final Section
Cover	Material Title	Evaluation
Introduction	Phase 1	Answer key
Table of Contents	Phase 2	Bibliography
Glossary	Phase 3	
Concept maps	Phase 4	
Module Identity	Phase 5	
Basic Competencies		
Brief Description of Material		
Module Instruction Manual		
Introductory Material		

The resulted e-module design is referred to as the initial product. The cover design can be seen in Figure 1.

Figure 1. Design of E-Module Cover

The content section of the e-module consists of a description of the material according to the stages of the PBL learning model and practice questions that are packaged in such a way with the help of animated video displays and images so that students are more active in learning (Figure 2). The final section of the e-module consists of an evaluation and a bibliography (Figure 3).

Figure 2. Design of E-Module Content Section

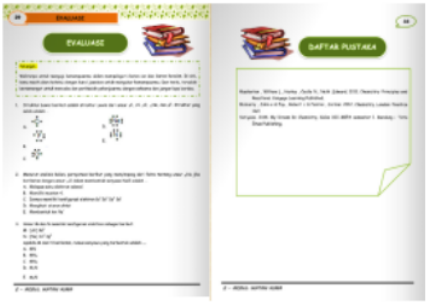

Figure 3. Design E-Module Final Section

Results of "Develop" Stage

The "develop" stage in this study consists of expert validation and limited testing of the product. The product result is in the form of PBL-based Chemical e-modules on chemical bonding materials, which can be accessed at https://online.flipbuilder.com/wndty/cimj/ has been adapted to the modules used in SMAN 3 Lembar, the module from the Ministry of Education and Culture 2013 Curriculum.

In this study, a validation test has been conducted by experts on the developed e-module. Expert validation is by presenting experienced experts in the field of chemistry learning, i.e., 3 expert lecturers, to assess the content of the e-module. The analysis used for the validity test is the Aiken V index, which is to determine the level of validity of the developed PBL-based Chemical e-module. The results of the expert's assessment of the feasibility of the material can be seen in Table 3.

Table 3. Experts Validation Results

Aspects	Value	Category
Cover feasibility	0,92	Very valid
Materials feasibility	0,78	valid
Language	0,87	Very valid
Graphics	0,86	Very valid
Overall Average	0,86	Very valid

Data analysis from material experts obtained an average result of 0.86. Based on the criteria set, it can be explained that the e-module is in the very valid criteria and is suitable to use in the learning process. The expert validation results show that the PBL-based Chemistry e-module developed has good content/material feasibility, easy-to-understand language, and attractive e-module display, and is very helpful for students to understand learning materials independently and optimize their skills [30].

PBL-based Chemical e-modules that have been valid are then tested with limited trials using response analysis. This test was conducted on students of Class X of Science Department at SMAN 3 Lembar and Chemistry teachers. Analysis of student responses consists of 6 aspects: ease of understanding, independent learning, active learning, interest, presentation, and aspects of use. The feasibility of the developed e-module can be seen from the students' responses and the chemistry teachers. The results of the analysis of student responses are presented in graphical form (Figure 4).

The graph in Figure 4 shows the different percentages. The highest percentage is obtained in use, which is 78.64% in the good category. Meanwhile, the lowest percentage is in learning activity which is 60% or good fair category. This aspect of the activity is related to the students' interest in working on the exercises contained in the e-module. The average calculation for the student responses shows a percentage of 72.73% and belongs to the good category [31]. It shows a positive response on the PBL-based Chemical e-modules on chemical bonding materials, which is easy to learn, has an interesting content display and can be used independently. It is support for chemistry learning both outside and inside the classroom.

The analysis of chemistry teacher's response uses 18 statements. Here are the results of the chemistry teacher response data analysis presented in tabular form in Table 4.

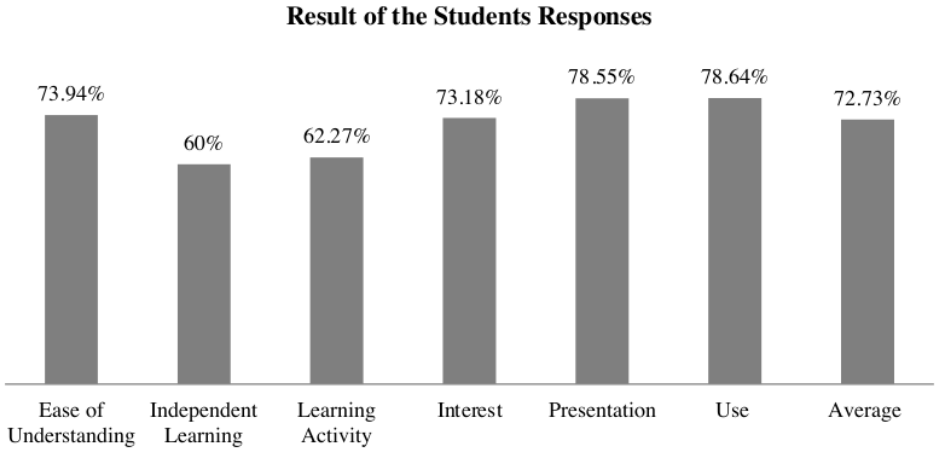

Figure 4. Graph of Student Response Results

Table 4. Results of Chemistry teachers' responses

Statements	Percentages
Learning objectives are clearly explained.	92,50%
The learning objectives are in accordance with the Basic Competencies.	88,75%
There is a relevance between the objectives and the material.	90%
The material in the learning media is given systematically.	87,50%
The material in the learning media is easy to follow.	90%
The content of the material is in accordance with the learning objectives.	90%
The material presented is in accordance with scientific truth.	87,50%
The material presented is according to the latest developments	86,25%
The material presented is in accordance with everyday life.	90%
The use of video is in accordance with the learning objectives.	87,50%
The use of practice questions is in accordance with the learning objectives.	87,50%
The suitability between the level of difficulty with the cognitive development of students.	82,50%
The language used is good.	90%
The language used is easy to understand.	90%
The style of language used is communicative.	87,50%
The language style used is suitable for students.	85%
Language used in learning media is quite clear.	86,25%
The language error rate in the learning media is small.	86,25%
Total	88,06%

The result in Table 4 above shows different percentages obtained. The highest percentage of the responses is the statement of learning objectives clearly explained, i.e., 92.50%, and is included in the very good response category [31]. While, the lowest percentage of the responses is the statement of suitability between the level of difficulty with the cognitive development of students, namely 82.50%, and included in the category of very good response. Meanwhile, the analysis of the average calculation for the chemistry teacher response shows a percentage of 88.06% and is included in the very good category. The percentage shows that the PBL-based chemical E-module on the developed chemical bonding material positively responded to the developed product.

The process of developing a PBL-based Chemical e-module in this study uses this e-module. The steps of *development research* in this study are by Thiagarajan et al, the 4D model, consisting of the stages of *define*, *design*, *develop*, and *disseminate* [28]. However, these e-module development stages are limited to the *develop*ing stage, which is to produce a product in the form of a PBL-based Chemical e-module. In its development, this product is based on data from observations and interviews, including needs analysis and relevant research results used as a theoretical basis.

The development of this PBL-based Chemistry e-module involves using several performance application programs and software such as *Flip PDF Professional*, *Microsoft Office*, and *Portable Document Format (PDF)*. The output of this e-module product is in the form of online access links and digital book files with an *exe* file extension that can be accessed offline. In addition, the PBL-based Chemical e-module development product passed several stages of testing to see the feasibility of the product. Validation tests by experts and limited trials on students of SMAN 3 Lembar and several chemistry teachers. With the PBL-based Chemistry e-module developed by researchers, the use of paper in learning can be reduced. Moreover, its use is practical and easy without being limited by place and time because it can be accessed anywhere and anytime using media access such as smartphones, tablets, and laptops owned by students. In addition, the e-module developed uses a language that is adapted to the abilities of students so that the limitations of teaching materials by teachers in the Chemistry learning process can be helped [10]-[32]-[33].

CONCLUSION

The acquisition of a feasibility test in the form of questionnaires and statements by the expert was in an average value of 0.86 (very valid and feasible). Meanwhile, the results of the analysis of the PBL-based Chemistry e-module on chemical bonding materials according to SMAN 3 Lembar, students gave a good response, and the chemistry

teachers responded very well. It is following the calculation of the average percentage of each questionnaire which is 72 %, 73%, and 88.06%.

THANK-YOU NOTE

Thank you to the Magister of Science Education Study Program at the University of Mataram through the Independent Study course, SMAN 3 Lembar, and other parties who have contributed significantly to this research.

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7