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DEVELOPMENT OF E-MODULE STEAM-INTEGRATED PROBLEM BASED LEARNING FOR SALT HYDROLYSIS TOPIC

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Abstract: Teaching materials as a support in the learning process in this technological era can be in the form of e-modules. Using e-modules in the learning process is declared effective, with a marked increase in student learning outcomes. This research aims to produce an integrated STEAM Problem-Based Learning E-Module of Salt Hydrolysis and determine its validity and practicality level. The type of research used is research development or Research and Development (R&D). The development model used is the Plomp model, which consists of 3 stages, namely: (1) Preliminary Research, (2) the Development or Prototyping Phase, and (3) Trial and Assessment (assessment phase). This research is limited to the development stage, namely the validity and practicality test. The research instrument used was a validity and practicality questionnaire. Five validators validated the e-module, while the practicality test was carried out by three chemistry teachers and 12 students in class XII MIPA senior high school SMAN 15 Padang. The results of the validation analysis obtained an average content validity test value of 0.87 with a valid category and an average media validity test value of 0.90 with a valid category. At the same time, the practicality tests of teachers and students obtained 91% and 91%, respectively, in the very practical practicality category. In conclusion, the salt hydrolysis e-module based on STEAM integrated Problem-Based Learning for class XI SMA/MA, which has been developed, is valid and practical.

Keywords: *E-module, Problem-Based Learning, STEAM, Salt Hydrolysis, Plomp Model*

INTRODUCTION

Chemistry is a science that deals with the properties and composition of matter and can be interpreted as something that has mass, occupies space; and uses the scientific method in the form of observations made to gather empirical facts [1]. Chemistry is a useful science in life, one of which is in chemistry lessons that discuss salt hydrolysis. Salt hydrolysis is a chemical material studied for class XI even semester, and taught in senior high schools. Teachers are expected to be able to design innovative learning to provide opportunities for students to learn optimally by studying independently or in class to make it easier for students to understand salt hydrolysis material. In the learning process, teaching materials or media that have high appeal and use technology that can improve student learning outcomes are needed. These teaching materials are expected to facilitate learning activities [2]. As a support in the learning process in this technological era, you can use learning media or teaching materials in the form of e-modules which are expected to increase students' interest in learnLearninguse the learning materials presented in e-modules are arranged and designed more attractively so that students can learn independently. by adding animations, videos, or images. Compared to print media, e-modules have several advantages, such as the ability to present animations, videos, and images, making them an interactive medium [3].

Next, namely, information that is easily accessible using electronic devices while in any place, thus enabling students to gain maximum mastery of the material [4]. E-modules can also increase students' learning motivation [5].

The development of this e-module is also based on the demands of education in the Industrial Revolution Era 4.0, where it requires the role of teacher to be able to adapt himself to developments in Information and Communication Technology (ICT), thus requiring teachers to be able to provide encouragement and motivation to students to develop intellectual, moral and emotional intelligence in realizing democratic education for students [6].

One learning model that can be applied is the Problem-Based Learning model, which requires students to work in groups to solve complex problems in realistic situations so that students can hone critical and skilled thinking and problem-solving skills and can acquire essential knowledge and concepts in learning materials [7].

Problem-based learnLearningbe used as a strategy to increase interest in learning in the STEAM field, which has developed from the STEM approach by adding elements of Art to its learnLearningments of Art (Art) is very good for students and teachers through forms of expression, communication, creativity, imagination, perceptual observation, and thoughts to develop cognitive skills such as listening, solving problems, matching forms with functions, and decision-making [8].

Based on the results of giving a questionnaire to 3 chemistry teachers, namely a chemistry teacher at SMAN 9 Padang and a chemistry teacher at SMAN 15 Padang, as well as 95 students in class XII MIPA at the two schools, it was found that: (a) 75% of teachers said they did not carry out practicum on salt hydrolysis

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material due to limited time, tools and materials. (b) 93% of students still use printed teaching materials in the learning process of salt hydrolysis materials which have not been able to provide more attractiveness to students. (c) 100% of teachers say that the STEAM Integrated Problem Based Learning E-module is unavailable. (d) 66.7% of teachers said that the average student learning score was moderate, so students considered it difficult to understand the material because salt hydrolysis material is abstract.

Based on the background that has been submitted and the data from the results of completing the questionnaire that has been done, the authors develop an e-module of salt hydrolysis based on STEAM integrated problem-based learnLearnings e-module is expected to help students through learning salt hydrolysis material and to make students actively involved in the learning process. Per this description, the authors designed and developed teaching materials titled "STEAM Integrated Problem-Based Learning Development of Salt Hydrolysis E-Module For Class XI SMA/MA."

RESEARCH METHODS

The type of research used is Research and Development (R&D). Research and Development (R&D). The development model used in this study is the Plomp (2013) development model, which consists of 3 stages of development: (1) Preliminary Research, (2) Development or Prototyping Phase, and (3) Trial and assessment (assessment phase) [9]. Salt hydrolysis e-module based on STEAM Integrated Problem Based Learning for Class XI SMA/MA will be held at FMIPA Padang State Univesity and SMA Negeri 15 Padang, Academic Year 2022/2023.

The subjects of this study were lecturers in the chemistry department at the Faculty of Mathematics and Natural Sciences, Padang State Univesity, as validators, chemistry teachers, and students at SMA Negeri 15 Padang as validators and practical subjects. While the object of this research is, the STEAM integrated problem-based salt hydrolysis e-module for Class XI SMA/MA. The data used in this study are from validity and practicality questionnaires.

The data used in this study are from validity and practicality questionnaires. Data was collected using data collection instruments in the form of teacher and student questionnaire sheets, validation questionnaire sheets, and practicality questionnaire sheets. The data analysis technique used to analyze the assessment of the validator is by using Aiken's V formula. Meanwhile, practical data is obtained by giving teacher response questionnaires and student response questionnaires.

Aiken's V formula uses the following formula:

$$V = \frac{\Sigma s}{[n(c-1)]}$$

$$s = r - lo$$

Information:
V = validator agreement index
r = score of the validator's choice category
n = number of validators
lo = the lowest validity rating score (lo=1)
c = the highest validity rating score (c=5) [10]

This analysis data was obtained from the provision of teacher response questionnaires and student response questionnaires. Analysis of this practicality sheet uses the following formula [11]:

$$P = \frac{f}{N} \times 100\%$$

Information:
P = product practicality
f = the total value obtained from the questionnaire
N = maximum value on the questionnaire

RESULTS AND DISCUSSION

Based on the research objectives, the salt hydrolysis e-module based on Problem-Based Learning integrated with STEAM for Class XI SMA/MA was produced, as well as knowing the level of validity and practicality of the e-module being developed. This study uses the Plomp development model with the following stages:

Preliminary Research

At this stage, it is carried out to analyze and identify problems to develop salt hydrolysis e-modules based on STEAM integrated Problem-Based Learning. The initial research involved needs analysis and context analysis, literature study, and conceptual framework development. Following are the results obtained from each stage in the initial research:

1. Needs and Context Analysis

   This analysis was carried out to analyze the extent to which the fundamental problems were obtained by teachers and students in chemistry learning activities, especially salt hydrolysis material. This stage is carried out by giving questionnaires to chemistry teachers and students. The results of giving the questionnaire showed that the teacher said he did not carry out a practicum on salt hydrolysis material due to limited time, tools, and materials. Chemistry practicum activities are part of chemistry learning. Practicum can be used so that students better understand the theory and develop basic skills through activities such as practicing with tools, measuring, and observing [12]; students still use printed teaching materials in the salt hydrolysis material learning process, which has not been able to provide more attractiveness to students, teachers, and students are interested in using e-modules in salt hydrolysis material chemistry learning, because the developed e-module has learning videos, pictures and animations, and the teacher says the average student learning value is moderate so that students are considered difficult to understand

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the material because salt hydrolysis material is abstract.

Context analysis is carried out by identifying the subject matter that students need to master in salt hydrolysis material. This analysis is in the form of an analysis of Learning Outcomes (CP) so that Learning Objectives (TP) and Learning Objectives Flow (ATP) can be developed.

2. Review of Literature

The thing to do at this stage is to look for sources and references related to the research process. These supporting sources and references can be in journals, books, and theses regarding salt hydrolysis e-modules based on STEAM integrated Problem-Based Learning. The results obtained from the literature study, namely the e-module components, were referred to from the e-module preparation guidelines issued by the Ministry of Education and Culture on the independent curriculum. The criteria or material contained in the product being developed is referred to from textbooks, while the e-module of salt hydrolysis based on the STEAM integrated Problem-Based Learning is referred to from scientific articles.

3. Development of a Conceptual

At this stage, identifying, describing, and summarizing the main concepts discussed in the hydrolysis material and summarizing them as a concept analysis table to facilitate the making of concept maps on salt hydrolysis material.

Development or Prototyping Phase

At this stage, product development is a salt hydrolysis e-module based on STEAM integrated Problem-Based Learning. The activities carried out are designing formative evaluation and revision to complement the resulting product. The resulting prototype is as follows:

a. Prototype I

On prototype I, a formative evaluation test was carried out in the form of a self-evaluation, using a checklist system for the components that must be present in the salt hydrolysis e-module based on STEAM integrated Problem-Based Learning which has several components such as covers, instructions for use, competencies (CP, TP, and ATP), concept maps, general information, core components, learning activities, assessments and answer keys.

b. Prototype II

Prototype II was produced after a formative evaluation was carried out as a self-evaluation of the previously designed prototype I. Self-evaluation is carried out using a checklist of the components that must be present in the e-module. If you still feel it is lacking, revise it so as to produce prototype II.

c. Prototype III

Prototype III resulted from an expert review (Expert Review) and One to One Evaluation of prototype II with the following results:

1) Expert Review

Assessment by experts is evaluated based on aspects of content and media. This evaluation is carried out to ensure the validity of the product being developed. This assessment uses a validation instrument by filling out a content and media validation questionnaire. The experts' assessment will be revised to produce a more valid prototype. III.

Validation was carried out by five validators for material experts and media experts. The material expert validators consisted of 3 chemistry lecturers at FMIPA Padang State Univesity and two chemistry teachers at SMAN 15 Padang. Meanwhile, media experts consisted of 3 chemistry lecturers from FMIPA Padang State Univesity and two lecturers from the Faculty of Engineering Padang State Univesity. After the data has been processed, it turns out that there are several invalid statements, then the second stage of validation is carried out. For stage II content validation data processing, there are stage II and media validation. Based on the suggestion from the validator, a revision was made to prototype II to produce prototype III. The results of the stage I content validation analysis can be seen in Table 1, the results of the stage I media validation analysis can be seen in Table 2, and the results of the stage II content validation analysis can be seen in Table 3. The results of the stage II media validation analysis can be seen in Table 4.

Table 1. Stage I Content Validation Results

Rated aspect	V	Category
Content Components	0.80	Valid
Language	0.81	Valid
Serving Components	0.80	Valid
Graphical	0.81	Valid
Overall average	0.80	Valid

Table 2. Phase I Media Validation Results

Rated aspect	V	Category
Display aspect	0.81	Valid
programming aspect	0.85	Valid
programming aspect	0.85	Valid
Overall average	0.84	Valid

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Table 3. Results of Phase II Content Validation

Rated aspect	V	Category
Content Components	0.88	Valid
Language	0.90	Valid
Serving Components	0.82	Valid
Graphical	0.88	Valid
Overall average	0.87	Valid

Table 4. Phase II Media Validation Results

Rated aspect	V	Category
Display aspect	0.92	Valid
programming aspect	0.88	Valid
programming aspect	0.92	Valid
Overall average	0.90	Valid

2) One-to-One Evaluation

The one-to-one evaluation was carried out by interviewing three students who had studied the material, namely class XII. This stage aimed to see the students' responses to prototype II that had been produced. Based on the results of interviews conducted on salt-based hydrolysis e-modules. Problem-Based LearnLearninggrated with STEAM found that the appearance of the e-module cover was attractive and appropriate in terms of design, color, font appearance, language, and layout, so it interested students in learning to use the e-module. The use of problems, pictures, and videos as a whole is good and interesting to support learnLearninghelp students in understanding salt hydrolysis material. Overall it is good and interesting, so it can support learnLearninghelp students understand salt hydrolysis material.

4. Prototype IV

At this stage, a formative evaluation is carried out in the form of a valid small-group trial on prototype III. After evaluating Prototype III and revising it according to the results of the small group test, a valid and practical Prototype IV was produced. The small group trial aims to find out the practicality of the salt hydrolysis e-module based on STEAM integrated Problem-Based Learning. Three teachers and 12 students conducted this small group trial. The average value of the practicality of the teacher is 91% in the very practical category, and the average value of the practicality of the students is 91% in the very practical category.

The research aimed at developing a product in the form of an e-module in the form of a salt hydrolysis e-module based on STEAM integrated Problem-Based Learning. E-module has several advantages of ease of use and the ability to present animation, video, and audio, making it an interactive medium [13].

The quality of e-module development results is determined based on the criteria of validity, practicality, and effectiveness. However, this research is only limited to practicality.Validitas E-modul hidrolisis garam berbasis Problem Based Learning terintegrasi STEAM.

A validity test is an assessment of the design of a product. The assessment was carried out using a questionnaire sheet divided into several components, namely the content validation questionnaire consisting of content components, linguistic components, presentation components (constructs), and graphic components. Meanwhile, the media validation questionnaire consists of display, programming, and utilization aspects. The questionnaire sheet was assessed by five material experts with a questionnaire assessment in the form of content validation, as well as questionnaire validation by media experts who five media experts assessed.

The evaluation of the five validators is based on the opinion of Sugiyono (2013: 172) [14], which states that to test the validity, the opinion of experts (judgment experts), a minimum of three people, can be used. The e-module validation assessment sheet data was analyzed using Aiken's V formula.

Based on the stage I content component validation results, which can be seen in Table 1, the average value was obtained at 0.80 so that overall the validation results on the content component were declared valid. Still, several statements were invalid, so stage II validation had to be carried out. Based on Table 3, the second validation stage has increased, with an average value of 0.88 in the valid category. Based on the average value, it shows that the STEAM integrated Problem-Based Learning-based salt hydrolysis e-module is valid in terms of content components, and it can be concluded that the developed e-module is in accordance with the demands of Learning Outcomes (CP), Learning Objectives (TP), and Flow of Learning Objectives (ATP).

In stage I language, which can be seen in Table 1, the average value is 0.81. Different results are obtained in the stage II validation with the average value obtained at 0.90, which can be seen in Table 3, so the e-module is declared valid. It shows that the developed e-module is in accordance with the rules of the Indonesian language, using clear and communicative language so that students can understand the material well. It follows the opinion of Majid (2012: 176) [14] that a good module is presented using good, interesting language and following the rules of the Indonesian language.

Based on the validation results of the presentation components in stage I, which can be seen in Table 1, the average value is 0.80, while the results of the second stage validation are in Table 3. The average value is 0.82, so the e-module is declared valid. So the developed e-module is designed according to the learning objectives that have been formulated. The presentation of the e-module is based on the stages of the Problem-Based Learning model, namely by Hosnan (2014) [15] namely:

a. Orientation of students to the problem
The teacher explains the learning objectives and the logistics needed and motivates students to be involved in the selected problem-solving activity
b. Organizing students to learn
The teacher helps students define and organize learning tasks related to these problems
c. Guide individual or group investigations
The teacher encourages students to collect appropriate information, experiment to get explanations, and solve problems
d. Develop and present the work
The teacher helps students plan and prepare appropriate work, such as reports and videos, and to help with various assignments with their friends.
e. Analyze and evaluate the problem-solving process
The teacher helps students reflect on or evaluate their investigations and the processes they experience.

At this stage, there are pictures, videos, animations, and questions related to the material discussed in the e-module. It is intended that students are more motivated in learnLearningcan to improve their understanding of the material. This e-module is also equipped with worksheet questions and assessment questions. Assessment is an integrated part of the learning process, facilitates learning provides holistic information as feedback for educators, students, and parents so that they can guide them in determining further learning strategies [16].

Based on the results of the validation of the graphical component stage I in Table 1, the average value is 0.81, while the results of the second stage validation are in Table 3, the average value is 0.88, so the e-module is declared valid. It shows that the developed e-module has an attractive appearance regarding the cover, font, font size, images, and videos. E-module makes it easy for users to understand the contents of the e-module. Table 3 shows that the STEAM integrated Problem-Based Learning salt hydrolysis e-module has an average of the four components in content validation of 0.87 with a valid category. It shows that the developed e-module has a good composition.

Based on the results of the validation of the display aspects of stage I, which are in Table 2, the average value is 0.81, but several statements are not valid, so stage II validation is carried out, which can be seen in Table 4, the average value has increased by 0 .92 so that the e-module is declared valid. It shows that the developed e-module has a good display composition. Good layout and color can attract students' interest in learn [17].

Learninged on the results of the validation of the programming aspects of stage I, the average value was 0.88, which can be seen in Table 2, while the validation for stage II obtained the average value of 0.86, which can be seen in Table 4 so that the e-module is declared valid. It shows that the composition of text, images, and videos is balanced, and the use of e-module icons can be understood.

Based on the validation of the utilization aspect of stage I, which can be seen in Table 2, the average value was obtained at 0.85. In contrast, the stage II validation obtained an average value of 0.92 so that the e-module was declared valid. Table 4 shows that the e-module salt hydrolysis based on Problem-Based Learning integrated with STEAM on salt hydrolysis material has an average of the three components in media validation of 0.90 with the valid category.

Based on the results of one-to-one evaluation interviews conducted by 3 class XjII students at SMAN 15 Padang, it can be concluded that the cover of the e-module is attractive, the color design and appearance of the e-module have made students interested in reading it, the fonts on the e-module the module is clearly legible and is following KBBI, existing videos can guide students in finding concepts, presentation of material and language used is easy to understand, problems and pictures presented to make it easier for students to answer questions to find and understand concepts, as well as stages of learning are presented makes it easier for students to carry out the learning process and can train students' thinking skills.

The practicality of E-module salt hydrolysis based on Problem-Based Learning integrated with STEAM

A practicality test was conducted to determine the practicality of the products developed in the field [18-19]. The practicality of the salt hydrolysis e-module based on STEAM integrated Problem-Based Learning is measured by giving practicality questionnaires to teachers and students—assessment based on ease of use, the efficiency of learning time, and benefits.

Data from the practicality of the salt hydrolysis e-module based on STEAM integrated Problem-Based Learning were obtained from small group trials by 12 students at SMAN 15 Padang with different abilities (high, medium, and low) as well as practicality tests from 3 students chemistry teacher at SMAN 15 Padang. The average practicality test results of 3 teachers obtained 91% in the highly practical category, while the practicality test of 12 students obtained 91% in the highly practical practicality category.

Based on data from the practicality of the e-module on the ease of use aspect of the e-module, chemistry teachers have an average practicality of 91% in the very practical practicality category and 90% of students in the very practical practicality category. It shows that STEAM's integrated Problem-Based Learning-based e-module is easy to use. It contains easy-to-understand material, easy-to-understand pictures, and videos and uses clear fonts. Teaching material is said to be practical if the teaching material is easy to use [20-21].

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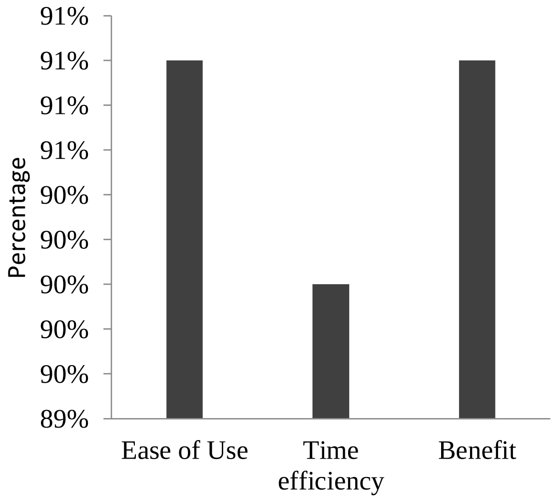
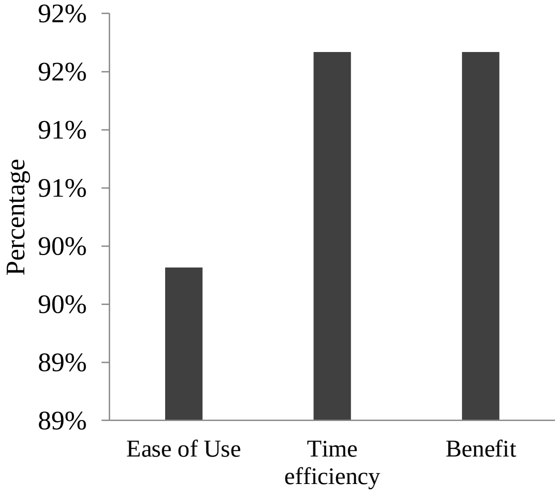
The aspect of efficiency of learning time was obtained from the teacher's response of 90% in the very practical category. In comparison, the student response results were obtained by 92% in the very practical category. This shows that the STEAM-integrated Problem-Based Learning-based salt hydrolysis e-module developed is efficient in terms of time to be used in the learning process.

Then on the benefit aspect, a value of 91% was obtained in the very practical practicality category from the results of the teacher's response. From the results of the student's responses, a value of 92% was obtained in the very practical practicality category. It shows that the developed e-module can help students learn independently and understand the material through animations, pictures, videos, and questions contained in the e-module. It is in accordance with the Ministry of Education and Culture, that e-module is one of the teaching materials presented in electronic form that students can use to study independently [5]. The e-module also helps the teacher's role as a facilitator. It is because the steps presented in the e-module are systematically arranged and easily understood by students.



Picture 1. Results of Teacher Response Practicality



Picture 2. Results of Student Response Practicality

Analysis of Salt Hydrolysis E-module Based on STEAM Integrated Problem-Based Learning

The hydrolysis e-module developed uses the Problem-Based Learning syntax, which consists of five stages: student orientation to problems, organizing students to learn, guiding individual/group experiences, developing and presenting work, and analyzing and evaluating problem-solving processes [22].

Based on the results of data processing analysis of students' answers on the learning activity sheet, it can be seen that students can answer questions at each stage of the learning model with an average percentage of 87% in learning activity 1, 86% in learning activity 2, 88% in learning activity 3, and 87% in worksheets 1, 2, & 3, and 87% in formative assessment.

Based on the results of the student's answers, the resulting STEAM integrated Problem-Based Learning salt hydrolysis e-module can increase students' interest in learning independently and make it easier to find concepts.

CONCLUSION

Based on the results of the development and small group tests that have been carried out, the researcher can conclude that the salt hydrolysis e-module based on STEAM integrated Problem-Based Learning has been produced. The resulting STEAM-integrated Problem-Based Learning salt hydrolysis E-module has a content validity level of 0.85. A media validity level is 0.88, and a teacher's practicality level is 91%. The student's practicality level is 91%.

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