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# Development of Guided Discovery Learning-Based Atomic Structure E-Module for Class X High School

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*Abstract* — **This study aims to develop an atomic structure e-module based on guided discovery learning for class X SMA/MA and determine the level of validity and practicality. This type of research is Development Studies with the Plomp development model. The Plomp model consists of three stages, namely preliminary research, prototyping stage and assessment phase . The research instrument used in the validity test was in the form of a questionnaire with a sample of three chemistry lecturers at FMIPA UNP, three FT UNP lecturers, one chemistry teacher at MAN 1 Solok Selatan and one chemistry teacher at SMAN 1 Solok Selatan. While the instrument used in the practicality test was in the form of a questionnaire with a sample of two chemistry teachers and 27 students of MAN 1 Solok Selatan. The results of the validation test content for appropriateness of content with syntax aspects of guided discovery learning and aspects of the truth of the content of chemical science shows the average value of the CVR at 0 , 96 and 0.96 with the high category. The results of the validation test constructs matter experts and media experts analyzed by Aiken'V at 0 , 86 and 0.88 with the high category. The results of the practicality test obtained an average value of 0.87 with a high category. Based on the results of data analysis, it shows that the e- module atomic structure based on guided discovery learning for class X high school produced is valid and practical to use in learning.**

***Keywords— Development; E-Module; Atomic Structure; Guided Discovery Learning; Validity; Practicality***

## I. Introduction

The 2013 curriculum is a curriculum that emphasizes the knowledge, skills and attitudes of students. In the learning process, the 2013 curriculum requires active students and teachers to act as facilitators using a scientific approach. The scientific approach helps teachers develop a variety of learning activities so that the potential of students can develop optimally and be able to help improve student learning outcomes[1]. Teachers as facilitators play an important role in increasing the potential of students supported by the application of learning models that are in accordance with the 2013 curriculum and scientific approach. One of the learning models that support the 2013 curriculum is the guided discovery learning model.

*Guided discovery learning* is a learning model that is able to generate motivation and student activity[2]. The application of the guided discovery learning model requires teaching materials, one of which is a module. The use of the module is in accordance with the guided discovery learning model because the module can guide students to learn independently[3]. The use of guided discovery learning-based modules is effective in improving student learning outcomes in the learning process such as acid-base materials[4], redox and electrochemical reactions [5], chemical equilibrium [6].

However, the 2013 curriculum also requires students to be skilled in the use of technology. The use of technology in education can improve the quality of learning and can visualize abstract ideas. In the era of the industrial revolution (ERI) 4.0 which is the era of digitalization, it is an opportunity for teachers to develop teaching materials to make them more interesting. Teaching materials in the form of modules have been previously developed which are still in printed form so that they can be further developed into electronic modules (e-modules).

E-modules are electronic teaching materials that can contain information in the form of videos, animations, diagrams and also text that can improve student understanding.[7]. Use-modules can guide students to find concepts and solve problems independently in chemistry learning, for example atomic structure material. The atomic structure is an odd semester class X material which contains factual, conceptual and procedural knowledge that requires an understanding of concepts.

Several studies of chemistry learning e-modules that have been developed show valid and practical results, including the development of chemical equilibrium e-modules [8], chemical bond [9], sour language [10], buffer solution[11], atomic structure[12] and chemical equilibrium[13]. Research on chemistry learning e-modules has shown that e-modules can effectively improve learning outcomes[14].

Based on the results of a questionnaire analysis of two teachers and 73 students at MAN 1 Solok Selatan and SMAN 1 Solok Selatan regarding the teaching materials used and the model applied to the learning process. According to the results of the questionnaire, it was obtained: (a) 60.3% of students stated that the atomic structure material was difficult to understand, (b) 94.5% of students stated that they were still using printed teaching materials, (c) 80% of students were familiar with e-modules and 83.6% interested in using e-modules in chemistry learning, (d) 100% of teachers still use printed teaching materials in chemistry learning, especially atomic structure, (e) 100% of teachers are familiar with e-modules and 100% of teachers are interested in using e-modules in learning. However, the availability of e-modules is still limited. Then a research was conducted based on the background described, namely " Development of Guided Discovery Learning-Based Atomic Structure E-Module for Class X High School"

## II. Methods

This research belongs to the type of research and development or Development Studies with the Plomp development model. The Plomp development model consists of three stages, namely 1) preliminary research (initial investigation) 2) prototyping stage (prototyping) 3) assessment phase (assessment) [15]. This research was conducted to test the validity and practicality of the developed e-module. The subjects of this study were three chemistry lecturers at FMIPA UNP, three FT UNP lecturers, one teacher at MAN 1 Solok Selatan, one teacher at SMAN 1 Solok Selatan and 27 students at MAN 1 Solok Selatan.

On *preliminary research*(preliminary investigation) carried out the identification and analysis needed for research on the development of .-based atomic structure e-modules*guided discovery learning*for class X SMA / MA. This stage includes: (a) needs analysis and curriculum analysis, observing students and teachers, analyzing basic competencies 3.2 and 4.2 which are formulated indicators of competency achievement and learning objectives in accordance with these basic competencies; (b) review of literature, looking for sources and references related to research activities; (c) developing a conceptual framework, identifying and compiling the main concepts studied, namely the atomic structure material.

Stage *prototyping* stage (prototyping) aims to design an e-module based atomic structure*guided discovery learning.* At this stage, four prototypes were formed, namely prototype I, prototype II, prototype III and prototype IV [15]. Each prototype will be evaluated by tessmer's formative evaluation, namely self evaluation; one to one; expert review (e-module validity test) and small group test[16].

Stage *assessment phase* (evaluation) In this case, a field test was carried out on the IV . prototypeto evaluate and reveal the level of practicality of atomic structure-based e-modules *guided discovery learning*.

Instruments used is a check list at the self evaluation stage to evaluate the components that must be in the e-module, a validity questionnaire to assess the validity of the atomic structure e-module at the expert review stage, a practicality questionnaire to determine the practicality level of the atomic structure e-module at the small stage group tests and field tests.

## III. Results And Discussion

### A. *Preliminary research*

1. Needs analysis and curriculum analysis

From the results of the needs analysis, it was found that students had difficulty in understanding the concept of atomic structure material. The level of understanding of students on atomic structure material is only 40.97% while 60.3% of other students stated that atomic structure material is difficult to understand. On the other hand, teachers as facilitators still use printed teaching materials in the application of learning models that can only contain text and images. Therefore, it is necessary to have electronic teaching materials that not only contain text and images but are also able to contain videos, audio and other illustrations that explain chemical concepts so as to make it easier for teachers to apply learning models.

From the results of the needs analysis obtained from the 2013 revised 2018 curriculum of BC 3.2 and 3.4, the IAC and learning objectives for atomic structure material can be seen in Table 1.

**Table 1. BC and IAC on Atomic Structure Material**

| **Basic Competencies of KI-3** | **Basic Competencies of K1-4** |
|---|---|
| 3.2 Analyzing the development of the atomic model from the Dalton, Thomson, Rutherford, Bohr and Wave Mechanics models | 4.2 Explaining natural phenomena or experimental results using the atomic models |
| **Indicator of Achievement Competency** | **Indicator of Achievement Competency** |
| **Supporting IAC**<br>3.2.1 Determine the electron configuration<br>3.2.2 Determine the location of an element in the periodic system of elements<br>**Key IAC**<br>3.2.3 Analyzing the development of Dalton's atomic model<br>3.2.4 Analyzing the development of Thomson's atomic model<br>3.2.5 Analyzing the development of Rutherford's atomic model<br>3.2.6 Analyzing the development of the Bohr . atomic model<br>3.2.7 Determine the difference between atomic number and atomic mass number with the number of atomic constituent particles<br>3.2.8 Analyze the difference between isotopes, isobars and isotones (through the number of protons, electrons and neutrons of an element)<br>3.2.9 Analyzing the development of the wave-mechanical atomic model | 4.2.1 Explain Thomson's atomic model based on natural phenomena or experimental results<br>4.2.2 Explain Rutherford's atomic model based on natural phenomena or experimental results<br>4.2.3 Explain the Borh atomic model based on natural phenomena or experimental results<br>4.2.4 Explaining the wave mechanics atomic model based on natural phenomena or experimental results |

The learning objectives are Through the use of guided discovery learning-based atomic structure e-modules with simple investigations and managing information, it is expected that students are actively involved during the learning process and have thoroughness, curiosity, hard work in making observations and being responsible for expressing opinions, giving suggestions and criticism and answer questions in analyzing the development of atomic models from Dalton, Thomson, Rutherford, Bohr and wave mechanics as well as explaining natural phenomena or experimental results using atomic models.

2. Review of literature

The results obtained based on a review of the literature that has been carried out are -based e-modules *guided discovery learning* has several components, including cover, table of contents, instructions for use, glossary, basic competencies, competency achievement indicators, subject matter, brief descriptions, relevance, concept maps, activity sheets, worksheets, self-assessments, evaluation sheets, worksheet answer keys , answer keys for evaluation sheets and literature.

3. Conceptual framework development

The results obtained are based on the development of the conceptual framework that has been carried out, namely the main concepts studied in the atomic structure material. The main concepts are Dalton's atomic model, Thomson's atomic model, Rutherford's atomic model, Bohr's atomic model, wave mechanics atomic model, atomic constituent particles, atomic number, mass number and isotopes, isobars and isotones. From the analysis of these concepts, it can be seen the relationship of concepts in the form of a concept map that is arranged hierarchically.

*B. Prototyping stage*

1. Prototype I

At this stage, design an e-module based on known components through a review of the literature so that prototype II is produced in the form of an atomic structure-based e-module. *guided discovery learning.*

2. Prototype II

At this stage, a self-evaluation is carried out in the form of a check list of the e-module components and produces a prototype II that is complete without requiring repairs.

3. Prototype III

*One to one evaluation*. This evaluation is carried out by three students who have different abilities (high, medium and low). Based on this evaluation, it was found that the prototype II produced previously in terms of cover and color selection was considered good and attracted students to read it. The choice of font in the e-module is quite clear and the language used is easy to understand. The content components of the e-module in the form of images, videos and illustrations presented are considered capable of helping students to better understand the lessons contained in the e-module.

*Expert review*. At this stage, the content validity and construct validity were tested. The content validity test was carried out by three chemistry lecturers and two chemistry teachers which resulted in an average CVR score of 0.96 in the high category. The construct validity test of media experts obtained an average Aiken'V value of 0.88 with a high category. While the construct validity test of the material expert obtained the average value of Aiken'V of 0.86 with a high category.

The construct validity component of the material expert is divided into four components, namely the content component, the linguistic component, the presentation component and the graphic component. The results of the material expert construct validity test can be seen in Table 2.

**Table 2. Results of Construct Validity Analysis of E-Module Material Experts**

| Rated aspect | V | Category validity |
|---|---|---|
| A. Content Eligibility | 0.86 | High |
| B. Language Component | 0.88 | High |
| C. Components of Serving | 0.82 | High |
| D. Graphic Components | 0.88 | High |
| Value (V) average | 0.86 | High |

Meanwhile, the validity component of the media expert is divided into three, namely, the display component, the programming component and the utilization component. The results of the media expert construct validity test can be seen in Table 3.

**Table 3. Results of the Construct Validity Analysis of E-Modul Media Experts**

| Rated aspect | V | Category validity |
|---|---|---|
| A. Display Aspect | 0.89 | High |
| B. Programming Aspect | 0.93 | High |
| C. Utilization Aspect | 0.83 | High |
| Value (V) average | 0.88 | High |

Based on the validity results obtained from the suggestions and comments of the validator, improvements were made to the developed atomic structure e-module so as to produce prototype IV.

4. Prototype IV

At this stage, a small group test was conducted on six students which resulted in the practicality value of the e-module. The results of the small group test can be seen in Table 4.

**Table 4. Practical Results of Small Group Test**

| Rated aspect | Aiken'V | Category |
|---|---|---|
| *1.1* ***Ease of Use*** | 0.86 | High |
| *1.2* ***Study Time Efficiency*** | 0.88 | High |
| *1.3* ***Benefit*** | 0.86 | High |
| Average practicality | 0.86 | High |

Based on the results of the analysis of the small group test data, it is stated that in terms of ease of use, the atomic structure e-module has instructions that can be understood, the material is clear and simple, the language is easy to understand by students and practical because it is easy to carry and reproduce. In terms of learning time efficiency, atomic structure e-modules can make learning time more efficient and students can learn at their own pace and ability. In terms of benefits, the atomic structure e-module can help students learn independently because it has pictures, videos and illustrations that make it easier to understand atomic structure concepts. The prototype III that has been produced has an average practicality value of 0.86 with a high category. However, it still needs improvement so that prototype IV is obtained.

### C. *Assessment phase*

At this stage, a field test was conducted to obtain the practical value of e-modules from teachers and students. The practicality test is divided into three aspects of ease of use, time efficiency and benefits. The results of practicality by teachers and students can be seen in Table 5.

**Table 5. Practical Results of the Atomic Structure E-Module in the Field Test**

| Rated aspect | Aiken'V | | Category | |
|---|---|---|---|---|
| | Teacher | Student | Teacher | Student |
| A. Ease of Use | 0.85 | 0.86 | High | High |
| B. Study Time Efficiency | 0.88 | 0.88 | High | High |
| C. Benefits | 0.88 | 0.86 | High | High |
| Average V practicality | 0.87 | 0.87 | High | High |

From the aspect of ease of use of the e-module, the teacher's assessment has a value of 0.85 in the high category and from the student's assessment it has a value of 0.86 in the high category. This shows that the e-module uses language that is easy for students to understand, the writing is quite clear and the e-module can be used easily and can be reproduced without spending a lot of money.

From the aspect of learning time efficiency, the assessment of teachers and students has the same value of 0.88 in the high category. This shows that the use of e-modules makes learning more efficient and students can learn at their own pace and ability.

From the aspect of benefits, the assessments of teachers and students each have a value of 0.88 and 0.86 in the high category. This shows that e-modules are useful in learning because e-module content components such as pictures, videos and illustrations can help students better understand learning and e-modules can support the teacher's role as facilitator.

After the field test was carried out on prototype IV, no further revision was carried out because the prototype produced had a very good practical value so that the final prototype was found in the form of an e-module atomic structure based on guided discovery learning for class X SMA/MA which was valid and practical.

## IV. CONCLUSION

Based on the research that has been done, it can be concluded that the guided discovery learning-based atomic structure e-module for class X SMA/MA produced with the Plomp development model has a high value of validity and practicality. For further researchers, it is hoped that they will be able to test the effectiveness of the e-module atomic structure based on guided discovery learning for class X SMA/MA.

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