

ARTICLE

(Development of E-Modul Based on Guided Inquiry Learning on the Fundamental Laws of Chemistry Topic for X Grade)

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ABSTRACT

This study aimed to produce an e-module based on guided inquiry learning on the fundamental laws of chemistry topic that is valid and practical for x grade. The type of this research was Research and Development (R&D) with a four-D (4D) development model that consists of four stages; (1) define, (2) design, (3) develop, and (4) disseminate. This research was limited to the validity and practicality test. The validity test was carried out by 8 experts and the practicality test was carried out with a limited trial on teachers and students conducted at MAN 2 Kota Payakumbuh. The research instrument was used in the form of a validity and practicality questionnaire which was analyzed using Aiken's V formula. Data analysis obtained an average validity of content was 0.92 with a valid category, while the average validity of the media was 0.95 with a valid category. Based on the practicality test of teachers and students, the percentages are 0.97 and 0.87, respectively, in the very practical category. Based on the results of the study, it can be said that the e-module based on guided inquiry learning on the fundamental laws of chemistry topic for x grade was valid and practice to use in the learning process.

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1. Introduction

Characteristics of education in the Industrial Revolution Era 4.0 is an activity-based learning model under defined competencies and learning that integrates knowledge skills, attitudes, and abilities to operate existing technology [1]. The role of educators as implementers of educational policies who are tasked with designing, implementing, and evaluating learning systems has not been optimal [2], related to strategies, methods, and teaching materials used during the Covid-19 pandemic, making the learning carried out not following the objectives which have been set.

Based on the results of interviews and questionnaires given to 2 chemistry teachers and 58 students of class XI, it was obtained data that: (a) the application of learning models in the context of independent concept discovery by students was not optimal, (b) teaching materials used by teachers in the fundamental laws of chemistry topic have not made students learn independently, and (c) practicum activities in the context of concept discovery by students cannot be carried out. Therefore, it is necessary to develop

teaching materials in the form of e-modules that can increase the motivation of students to actively participate in learning and find concepts independently.

The 2013 curriculum is a curriculum that in principle uses a student-centered learning pattern. The number of opportunities for students to find concepts independently is carried out using a scientific approach learning model [3]. One of the learning models that can be used to find concepts independently is the guided inquiry learning model. Through 5 stages of learning consist of orientation, exploration, concept formation, application, and closing [4], it provides broad opportunities for students to build deep understanding and create their meanings related to knowledge and experience. The guided inquiry learning model can be applied to students who do not have learning experience using the inquiry method [5,6]. In this learning model, teachers can be involved in learning related to lesson planning and problem formulation on the topics discussed.

The fundamental laws of chemistry topic is one of the chemical materials studied by class X students. This material includes Lavoisier's Law of Conservation of Mass, Proust's Law of Constant Comparison, Dalton's Law, Gay-Lussac's Volume Comparative Law, Avogadro's Hypothesis, the concept of relative molecular mass, chemical equations, the concept of moles, and the content of the substance. In the fundamental laws of chemistry topic, there are concepts, principles, and procedures that must be understood by students before studying advanced material in the form of reaction rates, thermochemistry, and chemical equilibrium. Based on the results of the questionnaires that have been distributed, as many as 74.13% of students stated that the fundamental laws of chemistry topic is a difficult material.

E-Modul based on guided inquiry learning is an electronic teaching material that is compiled based on a certain curriculum, with a series of activities that allow students to find concepts independently using the guided inquiry learning model. The e-module that will be developed is expected to be able to make students participate actively and find concepts independently according to the demands of the 2013 Curriculum, especially during the Covid-19 era. Besides being equipped with interesting materials and pictures, the e-module is also equipped with audio and video practicum. This practicum video is used as a solution if practicum activities cannot be carried out due to limited learning time or lack of school facilities and infrastructure. This e-module will also be equipped with practice questions that can be used as a measuring tool to test students' understanding, especially on the fundamental laws of chemistry topic.

This study aims to develop e-modules that are valid and practical and can be used in the learning process to discover concepts independently by students with the title "Development of e-module based on guided inquiry learning on the fundamental laws of chemistry topic for X grade".

2. Research Methodology

The type of research used in this research is Research and Development (R&D). R&D is a research method used to produce certain products and test the effectiveness of these products [7]. The product produced in this study is in the form of teaching materials in the form of an e-module based on guided inquiry learning on the fundamental laws of chemistry topic for X grade. The development model used is the *four-D* (4D) model. The design of educational research in the 4-D model consists of 4 steps, namely: (1) define; (2) design; (3) develop; and (4) disseminate [8].

In the define stage there are 5 activities including: (1) front-end analysis is carried out to obtain information about the learning process according to the current field situation and to find out an overview of the basic problems experienced by teachers as educators which are analyzed through interviews with 2 chemistry teachers; (2) learner analysis is carried out to find out a description of the characteristics and

needs of students related to learning, which is examined from the results of questionnaires distributed to 58 students; (3) task analysis is carried out by analyzing Core Competencies and Basic Competencies on the fundamental laws of chemistry topic in accordance with KEPBALITBANGBUK No.018/H/KR/2020 concerning amendments to Permendikbud no.37 of 2018; (4) concept analysis is carried out by identifying the main concepts in the fundamental laws of chemistry topic which includes concept definitions, types of concepts, attributes (critical and variable), and hierarchical concepts; (5) specifying instructional objectives obtained by reviewing task analysis and concept analysis.

At the design stage, there are 4 activities including: (1) the preparation of test standards is carried out by making and compiling questions to measure the competencies that must be achieved by students in the fundamental laws of chemistry topic; (2) media selection is also adjusted to task analysis, concept analysis, characteristics of educators and students, production resources, and plans for testing teaching materials. The media selected to develop this e-module were *Canva*, *Flip PDF Professional*, *Google Form*, *Microsoft Word Home and Student 2019*, and *VN Video Editor Maker VlogNow*; (3) the selection format is adjusted to the Practical Guidebook for the Preparation of e-Learning Modules by the Directorate of High School Development in 2017; (4) the initial design is carried out to provide an initial description of the e-module on the the fundamental laws of chemistry.

At the development stage, an assessment by experts and development trials are carried out to modify the prototype of the e-module being developed. The assessment by the expert aims to reveal the validity of the created e-module. The validity test was carried out by 3 lecturers and 2 chemistry teachers as material experts and 3 informatics engineering lecturers as media experts. Meanwhile, development trials were carried out to determine the practicality of the e-modules made. Practical tests were conducted on 3 chemistry teachers and 29 students. The dissemination stage cannot be carried out due to time and cost constraints.

The research instrument used was a validity questionnaire and a practicality questionnaire. The data obtained from the validity questionnaire will be analyzed using the Aiken'V formula. Aikens'V Formula[9]:

$$V = \frac{\sum S}{[n(c - 1)]}$$

Information:

V = Aiken's V Index

S = The score determined by the validator (r) minus the lowest score in the assessment category (l_0) or ($r - l_0$)

n = many raters (validators)

c = many categories in the assessment

Tabel 1 Aiken'V scale validity criteria

No	Aiken's V Scale	Category
1	$V \geq 0,80$	Valid
2	$V < 0,80$	Not Valid

While the data obtained from the practicality questionnaire will be analyzed using the 2010 Purwanto formula [10]:

$$\text{Percent Score} = \frac{\text{Skor obtained}}{\text{Max score}} \times 100\%$$

Tabel 2 Practical criteria according to Purwanto (2010)

Percentage	Description
86%-100%	Very Practice
76%-85%	Practice
60%-75%	Sufficient practice
55%-59%	Less practice
≤ 54%	Impractice

3. Results and Discussion

3.1 Define

In the front-end analysis stage, interviews were conducted with 2 chemistry teachers at MAN 1 Kota Payakumbuh and MAN 2 Kota Payakumbuh. Based on the results of interviews that have been conducted, the following data were obtained: (1) the application of the learning model in the context of independent concept discovery by students was not optimal; (2) practicum activities in the laboratory in the context of concept discovery by students cannot be carried out; (3) The teaching materials used by teachers have not made students learn independently and have not been actively involved during the learning process, especially during online learning.

At the learner analysis stage, it is done by distributing questionnaires to students in MAN 1 Kota Payakumbuh and MAN 2 Kota Payakumbuh. Based on the results of the questionnaire that has been distributed, 74.13% of students stated that the fundamental laws of chemistry topic is a difficult material to understand and 43.11% of students have not been motivated and have not actively participated in the learning process using the available teaching materials. Among the characteristics of teaching materials that are preferred by students are teaching materials that have interesting pictures, have audio and video, can be used anywhere and anytime, and can be used as practice questions as an effort to measure self-efficacy.

At the task analysis stage, an analysis of Core Competence and Basic Competence was carried out on the fundamental laws of chemistry topic following KEPBALITBANGBUK No.018/H/KR/2020 concerning changes to Permendikbud no.37 of 2018[11]. The basic competence analyzed was 3.10 applies the fundamental laws of chemistry, the concept of relative molecular mass, chemical equations,

the concept of moles, and the content of substances to complete chemical calculations and 4.10 analyzes experimental data using the fundamental laws of chemistry quantitative.

At the concept analysis stage, an analysis of the main concepts that will be discussed in the fundamental laws of chemistry is carried out. This analysis is presented in the form of a concept analysis table which contains the definition of concepts, types of concepts, attributes (critical and variable), hierarchical concepts, as well as a series of examples and non-examples on the fundamental laws of chemistry.

In the analysis phase of learning objectives, the learning objectives are obtained namely through guided inquiry learning, students can dig up information from various learning sources, conduct simple investigations and process information, be actively involved during the teaching and learning process, have an inquisitive attitude, are careful in making observations and are responsible, responsible for expressing opinions, answering questions, giving suggestions and criticisms and being able to apply the the fundamental laws of chemistry to complete chemical calculations and analyze experimental data using the the fundamental laws of chemistry quantitative.

3.2 Design

At the design stage, it is done by designing an e-module based on guided inquiry learning on the fundamental laws of chemistry. This e-module was created using several applications such as *Canva*, *Flip PDF Professional*, *Google Form*, *Microsoft Word Home and Student 2019*, and *VN Video Editor Maker VlogNow*. The components that make up the e-module are adapted to the Practical Guidebook for Developing Learning e-Modules by the Directorate of High School Development in 2017, including covers, introductions, instructions for using e-modules, learning competencies, activity sheets, evaluation sheets, and evaluation. In presenting the material in this e-module, it is arranged according to the stages in the guided inquiry learning model.

3.3 Develop

3.3.1 Assesment by Expert

The validity test of the e-module based on guided inquiry learning on the fundamental laws of chemistry topic was assessed by 8 validators, namely 3 chemistry lecturers, 3 informatics engineering lecturers, and 2 chemistry teachers. Where the validity of this e-module is divided into 2 validity, namely content validity and media validity. The content validity was carried out by 3 chemistry lecturers and 2 chemistry teachers as material expert validators, while the media validity was carried out by 3 informatics engineering lecturers. The components assessed by experts (validators) on content validity include four components of the assessment, namely the content feasibility component, the presentation component, the linguistic component, and the graphic component.

The content feasibility component has an average V value of 0.93 with a valid category. Having a valid category means that the content of the e-module developed is following the demands of the basic competencies 3.10 and 4.10 according to changes of Permendikbud no.37/2018, as well as learning indicators that want to be achieved by students is under the basic competencies. In addition, the guided inquiry learning syntax presented and the key questions made can direct students in achieving competency achievement indicators. This is following the function of key questions in guided inquiry learning, namely questions that can guide students in exploring the model. Then the questions given relate to the material being studied, and e-modules can add insight to students' knowledge because of the availability of pictures and videos so that students can answer questions in the e-module.

The presentation component has an average V value of 0.9 with a valid category. This means that the e-module based on guided inquiry learning on the fundamental laws of chemistry topic that has been developed as a systematic arrangement, starting from the module usage instructions, student activity sheets, student worksheets, evaluation sheets, worksheet keys, and evaluation sheet keys. The presentation of the e-module is arranged based on the stages of the guided inquiry model. At this stage, there are pictures, videos, and questions related to the material discussed. In addition, the key questions that have been made have been systematic, starting from cognitive, simple, and complex questions. It is intended that students can find concepts independently and are more motivated in learning and increase students understanding of the material.

The linguistic component of the e-module has an average V value of 0.93 with a valid category. This shows that the language used is following the rules of good and correct Indonesian so that it is easy to understand, and the sentences used are clear (no confusion) and easy to understand. In addition, the developed e-module uses a consistent symbol.

The graphic component of the e-module has an average V value of 0.92 with a valid category. This shows that the e-module that has been developed has a clear and attractive layout, images, display design, font size, and typeface. The e-module is also equipped with pictures that support the fundamental laws of chemistry topic. The use of pictures can add to the attractiveness of teaching materials and can reduce student boredom in the learning process. In addition, there are videos and animations that are relevant to the material presented. This serves to improve students' understanding and motivation to learn.

Overall, the e-module based on guided inquiry learning on the fundamental laws of chemistry topic that has been developed has a validity level of 0.92 with a valid category. This means that the e-module that has been developed is valid both in terms of content and terms of constructs. The results of the e-module analysis on the validity test can be seen in Figure 1.

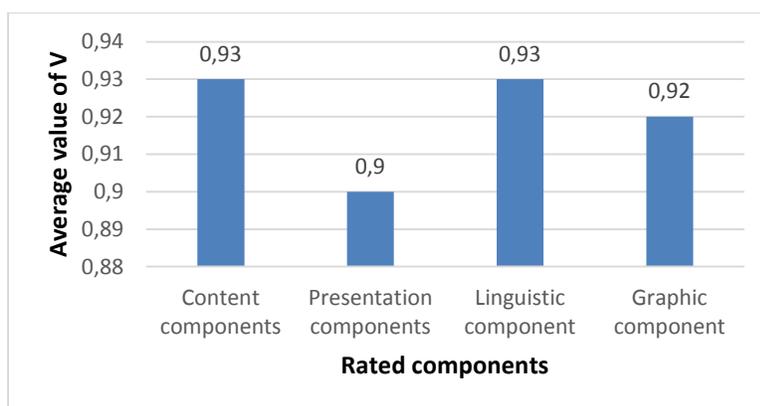


Fig. 1 Content validity test results

The validity of the media includes four components, namely the feasibility of linguistic aspects, aspects of presentation, aspects of the effect of e-modules on learning strategies, and overall appearance. The feasibility component of the e-module linguistic aspect has an average V value of 0.98 with a valid category. The high-value category V means that the developed e-module already has linguistic aspects that are easy to understand, polite, and encourage students' curiosity to learn the material. In addition, the writing of texts that are following the material studied and instructions for using e-modules are conveyed.

The e-module presentation feasibility component has an average V value of 0.94 with a valid category. This means that the developed e-module has been presented coherently and systematically, has attractive and proportional images, and supports students to be involved in learning. The effect component on learning strategies has an average V value of 0.95 with a valid category. The valid category means that the developed e-module is easy to use for learning both in the classroom and outside the classroom, supports students to learn independently, increases students' motivation to learn, increases students' knowledge, and broadens students' horizons, especially on the fundamental laws of chemistry topic.

The overall display component of the developed e-module has an average V value of 0.92 with a valid category. This means that the e-module developed has a regular and consistent design, attractive images, the right type, size of fonts are selected, the video used supports the material in the e-module, the colors chosen are appropriate and attractive, there is a match between the presentation of the images and materials, easy to read text, and easy to operate. Overall, the e-module based on guided inquiry learning on the fundamental laws of chemistry topic that has been developed with a media validity level of 0.92 with a valid category. This means that the developed the fundamental laws of chemistry e-module is valid. The results of the e-module analysis on the validity test can be seen in Figure 2.

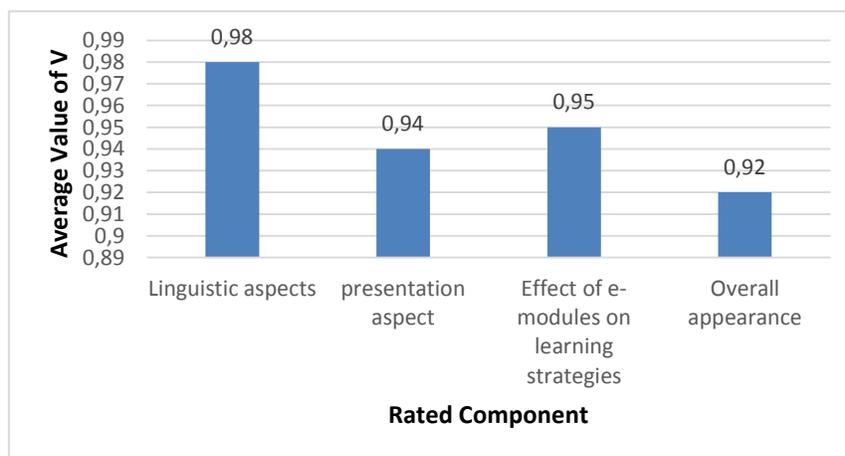


Fig. 2 Media validity test results

3.3.2 Development Test

The practicality of e-modules is carried out on 3 aspects, namely ease of use, the efficiency of learning time, and benefits. In the practical assessment stage of the e-module based on guided inquiry learning on the fundamental laws of chemistry topic by 3 chemistry teachers at MAN 2 Kota Payakumbuh and 29 students in class XI MIA 2. The ease of use aspect of e-modules has an average percentage of 0.96 with a very practical category from the teacher and 0.89 from students in the very practical category. This shows that the e-module developed already has instructions for use that are easy to understand so that teachers know the steps taken in the learning process. The material presented is clear and simple and the overall content of the e-module developed can be understood by teachers and students.

E-module learning time efficiency has an average percentage of 1 with a very practical category from teachers and 0.84 from students with practical category. This shows that e-modules can make students learn at their own pace and make learning time more efficient. Learning using modules can make learning time more efficient and students can learn at their own pace.

The aspect of the benefits of e-modules has an average percentage of 0.96 from teachers in the very practical category and 0.88 from students in the very practical category. The developed e-module can help students learn independently and can understand the material through videos, animations, pictures, or through the questions presented in the e-module so that it can increase students' enthusiasm and pleasure in learning.

Assessment of all aspects of the e-module practicality test obtained practicality values by teachers and students obtained an average percentage of 0.97 and 0.88 with a very practical category. The results of the data processing of the teacher and student practicality questionnaire assessment of the e-module can be seen in Figure 3.

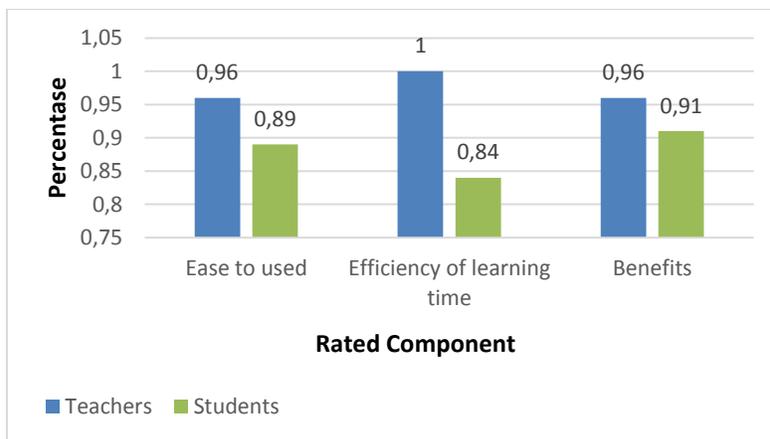


Fig. 3 Practicality test results

4. Conclusion

Based on the research that has been done, it can be concluded that an e-module based on guided inquiry on the fundamental laws of chemistry topic for X grade was produced with a valid and practical by 4D development model. The resulting e-module has a very high level of validity and practicality.

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