Design of Mathematics Module Development Based on Guided Discovery Methods to Improve Understanding of Concept of Class X SMA/MA

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Abstract: *Mathematical concepts are very important to be mastered by students. Students who do not understand the concept of mathematics will find it difficult to understand other mathematical concepts because of the interrelated mathematical concepts. Learning with guided discovery can guide students to construct and understand mathematical concepts. One of the teaching materials that can be used to understand the concept of matter is the module. This study aims to produce products in the form of mathematics modules based on guided discovery methods to improve understanding of concepts. This study uses the Design Development type Development Study which consists of initial product design, expert review, small group and field test. Research subjects were teachers and students of class X SMA. Research instruments in the form of interview guidelines, observation guidelines, and questionnaires. Data were analyzed using the Miles Huberman model consisting of data reduction, data display and conclusion drawing. This study concludes that the module is in the practical and valid category. Research can be further developed at the filed test stage.*

Keywords: module, understanding of concepts, guided discovery

INTRODUCTION

Learning mathematics is very necessary because it is related to the planting of concepts in students. These students will later take part in further mathematical development or in applying mathematics in daily life (Cernajeva, 2013) In the learning process, students will find it difficult to go to a higher learning process if they do not understand the mathematical concepts in previous learning, In addition, the concept is the basis for thinking and the basis for further formulating principles (Gilmore, et al 2018). Concept understanding is a skill that is expected to be achieved by students in the process of learning mathematics. So that understanding of the concept becomes one of the abilities that must be possessed and needs to be improved by students in learning mathematics.

Students are said to understand the concept if students are able to define concepts, identify and provide examples, develop mathematical concepts, and understand mathematical ideas (Rittle-Johnson, et al 2008). The higher the students' conceptual understanding of the material being studied, the higher the success rate of learning, the strong understanding of concepts makes students able to develop and understand higher concepts. A concept has a relationship with other concepts, so the initial knowledge plays a role in understanding the next concept. But in fact there are still difficulties for students to understand mathematical concepts (Sajka, 2003).

In connection with one of the most important aspects of mathematics learning, namely learning concepts that are interconnected with one another, then understanding mathematical concepts needs to be built constructively and become the basis for learning mathematics (Domínguez-Rué & Mrotzek, 2013). Cernajeva (2013) revealed that the teacher has the most important influence on student progress in the learning process. In the guided discovery method, The teacher acts as a facilitator who guides students through questions that direct students to connect past knowledge with the knowledge they are acquiring. Students are encouraged to think for themselves, analyze themselves, so they can find concepts, principles, or procedures

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based on the teaching materials provided by the teacher. In other words learning with discovery methods is a way to convey ideas / ideas with the process of finding (Gupta, et al 2012).

Concept understanding is a very important part in the process of learning mathematics. But in reality based on observations at Muhammadiyah 5 Yogyakarta High School and Muhammadiyah 6 Yogyakarta High School seen students slow in receiving math lessons, in this case students find it difficult to repeat the explanation of problems related to mathematical concepts. Based on the results of interviews with math teachers, for users of the mathematics learning device in school, information is obtained that the school does not have textbooks and to support mathematics lessons. Strengthening the results of field observations can also be seen in the results of research from (Domínguez-Rué & Mrotzek 2014) that the process of mathematics learning carried out at this time does not meet the expectations of the teachers as developers of classroom learning strategies. Students experience difficulties in learning mathematics, especially in solving problems that are related to mathematical understanding and communication skills.

According to (Clark , et al 2008) The accuracy of choosing learning methods in each teaching and learning process will determine the learning objectives that have been planned and improvement of students' academic and non-academic abilities, so that it will be followed by an increased understanding of the concepts that are given and the creativity of students in learning. Learning that allows students to construct their knowledge and can develop students' creative (Mahmoud, 2014) which states that Discovery learning emphasizes on understanding the structure or important ideas of a discipline through active involvement of students in learning, and the teacher encourages students to gain experience by carrying out activities that allow students to discover concepts or principles independently.

According to (Zhou, 2014) One of the learning resources that can be used to understand the concept of matter is the module. The module is defined as an independent learning package containing topics or units of learning material that students use to learn independently with minimal assistance from others (teachers).

In essence, the objectives to be achieved in this study are as follows 1) To analyze the needs in the development of Class X high school mathematics modules. 2) To carry out the design phase of the Class X high school mathematics module based on the analysis of existing needs. This article has 4 parts, namely the introduction of concept understanding and the preparation of modules with guided discovery methods. The second part is the research method used in developing mathematical modules then the results are explained and the discussion in the third part. For the last part contains conclusions and implications of the articles that have been written.

RESEARCH METHODS

The research that will be carried out is development research or development research type development study by Akker (2006). This study developed a mathematics module based on guided discovery models for Class X SMA. Research will be carried out on mathematics learning even semester 2017/2018 school year. The research stage can be seen in Figure 1.

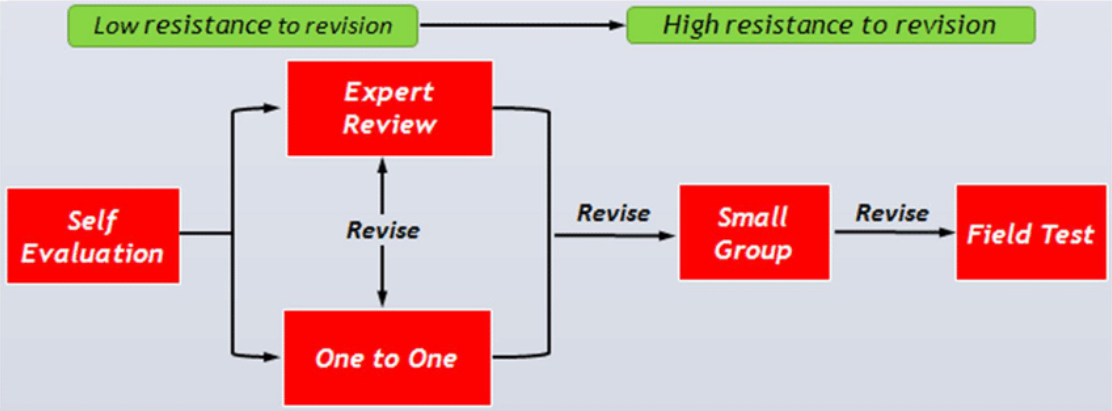

Figure 1. Design flow of formative evaluation (Tessmer, 1993; Zulkardi 2006)

The subjects of the trial were the students of class X SMA Muhammadiyah 5 Yogyakarta, SMA Muhammadiyah 6 Yogyakarta and MA Muhammadiyah 1 Yogyakarta. Data collection techniques and instruments used for each stage in this study are:

Analysis Stage

In the analysis stage, data collection techniques are carried out through interviews and document analysis. Interviews were conducted with teachers at the school where the study was conducted. Document analysis is done by observing the 2013 Curriculum that is appropriate Permendikbud 2016 and literature on the ability to understand concepts.

Evaluation Stage

Self Evaluation, The instrument at this stage is an evaluation sheet document conducted by the researcher himself. The researcher evaluates the product design that has been developed by looking at whether it is appropriate in terms of the construct, content, and language used.

Expert Review, Data collection techniques at this stage are carried out with walk through namely meeting experts directly or through electronic media.

One-to-One, Data collection techniques used in this activity are documents in the form of student comments, worksheets students, and interviews related to the results of the comments and answers of students.

Small Group, The document used at this stage is the student's comment sheet and worksheets that students must do. Supporting data is collected by interviews relating to comments and answers from students.

Field Test, Interviews were conducted on several students in the field test class. Interviews are used to find out what difficulties students experience when using modules and communicate ideas or ideas in writing to resolve trigonometric problems. Tests or practice questions consist of 4 description questions that refer to the indicator of students' ability to understand concepts.

RESULTS AND DISCUSSION

The development of this module uses research methods Design Research, with stages Preliminary Study (includes the analysis and design stages) and Formative Evaluation covers the stage self evaluation, expert review, one to one, small group and field test. In this study research has been

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carried out at this stage Preliminary Study and Formative Evaluation but it hasn't arrived at the field test stage, is the stage to find out the potential effects of the modules. The stages that have been carried out are as follows:

Preliminary Study, includes the analysis and design stages.

Analysis stages, at this stage researchers conduct student analysis, curriculum analysis, and content analysis. The results of each analysis are as follows:

Student analysis, based on the analysis conducted obtained information that the subject of research at the stage of one-to-one are 4 student class X SMA Muhammadiyah 6 Yogyakarta. Next, that the subject of research at the stage of small group are 6 student class X SMA Muhammadiyah 6, while field test stage the subject of research are student class X MA Muhammadiyah 1 Yogyakarta as many as 32 students with heterogeneous ability levels, starting from students who have low, medium, to high abilities.

Curriculum Analysis**,** researchers analyze KI and KD trigonometric material in the 2013 Curriculum. From the results of the analysis it was found that trigonometric material consisted of 4 Basic Competencies.

Content Analysis relating to the needs analysis of the modules to be compiled. This analysis is carried out with the aim to find out the needs of students, teachers and schools related to teaching materials. In addition to this, an analysis is carried out to determine students' difficulties in mathematics learning so that it can be improved by developing modules based on appropriate learning methods. To find out the student's response related to the needs analysis, the students responded through interview and questionnaire procedures, the following questions are included in a closed questionnaire.

Table 1 : A series of questionnaire questions aimed for students as respondents

No	Series of Questions
1	Do you have text material/ math teaching /learning materials?
2	Do you think the physical cover of teaching//learning materials are appealing?
3	In your opinion, do you think teaching/learning materials use language that is easily to understand?
4	Do you try to find additional material aside from school materials to assist you understanding the mathematical topics?
5	Do you experience difficulty in learning mathematics from teaching/learning materials?
6	Do you think the teaching/learning materials' instructions are easily to understand?
7	Do you think that the pictures contained in the teaching/learning material are useful to inform the mathematical topic?
8	Do you think the exercise examples given are helpful to comprehend the mathematical topic?
9	Do you think the problem solving practice is beneficial to measure the mathematical topic's mastery?
10	Do you think that evaluation and assessment are helpful to determine someone's ability?
11	Do you think that learning math strategies in the teaching/learning materials' instructions aid you to discover the mathematical concept or mathematical formula?
12	Do you think that math teaching//learning materials needs can be utilized to discover mathematical concept and mathematical formula easier and more interesting?

The results obtained from student responses related to the questionnaire are as follows, in the learning process almost all students already have the mathematics teaching materials used, but half of the student's response is 47.92% students say that the teaching material they use is not interesting in the learning process. In other words, 62.50% of students find it difficult to use the teaching materials so they look for other teaching materials outside of school to help them understand mathematics.

Basically teaching materials that have been used in schools are in good criteria according to student responses, because on average more than 50% of students say positive things related to instructions for using teaching materials that students can understand, images contained in teaching materials also help students, Practice questions and evaluation questions are also complete in the teaching materials used by them at school. With this, students can measure their own abilities related to understanding the concept of the material with the evaluation questions contained in the module.

However, the most significant thing seen in the students' response is 91.67% students need mathematics teaching materials that can be used to find concepts / formulas more easily and interestingly. With this, researchers are looking for solutions to answer the problems found in the field by developing modules that can have potential effects on students' ability to understand concepts. To emphasize understanding concepts, then the guided discovery learning model is expected to help effectively find the mathematical concept. Modules created with Microsoft Office Word 2013 and CorelDRAW X7 Programs.

Design Stage

The teaching material used is a concept understanding module with guided discovery method. The selection of the module development format through the steps of the guided discovery learning model. This initial draft was the first draft draft which was still in the form of a prototype which would later be validated by experts. Characteristics of mathematical modules that have been designed as follows :

Cover Module

The cover of this mathematics module is entitled "Trigonometry Module with Guided Discovery Method". In order for this module to be easily recognizable, the identity is written on the cover such as "SMA / MA Mathematics Module Class X Curriculum 2013 by Sukmana Larasati, S.Pd"

Figure 2. Cover Design of Mathematics Module

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Module Identity Page and Foreword Modules

The module identity page consists of module titles, authors, mentors, and validators. For module specifications also written cover design, software and paper size.

Figure 3. Design Module Information Page and Foreword Module

Module Contents

The table of contents in this module is used to make it easier to find material in this module.

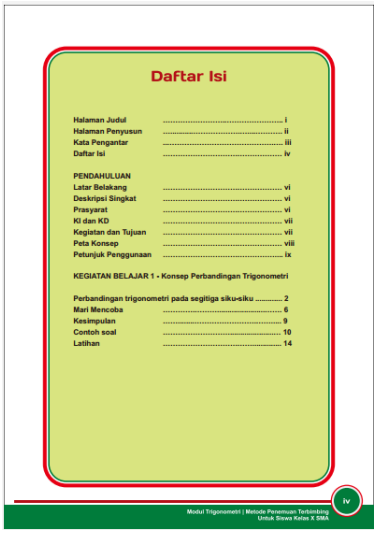

Figure 4. Design of Module Contents

Background, Brief Description and Prerequisites for Modules

The background of the module contains the background of the compilation of trigometry modules with guided discovery methods. For a brief description of the objectives of the preparation of modules relating to student understanding. And the prerequisite is to contain any material that students must understand to study trigonometric modules with guided discovery.

Figure 5. Background Design, Brief Description and Module Prerequisites

KI, KD and Module Learning Objectives

KI and KD are Core Competencies and Basic Competencies for High School Class X trigonometry material and the learning objectives contain activities contained in the module and learning objectives to be achieved in the preparation of the module.

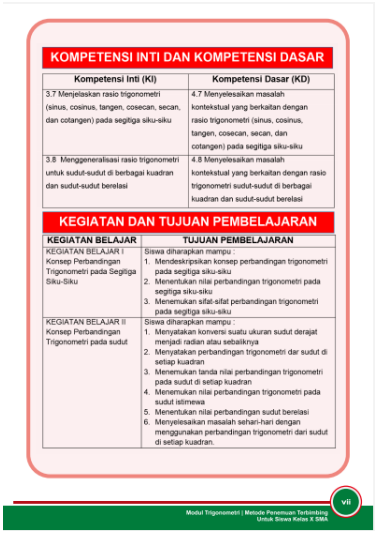

Figure 6. Design of KI, KD and Module Learning Objectives

Module Material

The material in this module is packaged according to the guided discovery model. The steps are, solving problems, formulating problems, arranging conjectures (in the form of questions), formulating problems. In this material is expected to facilitate students to accept the concept and train students to be creative on trigonometric material.

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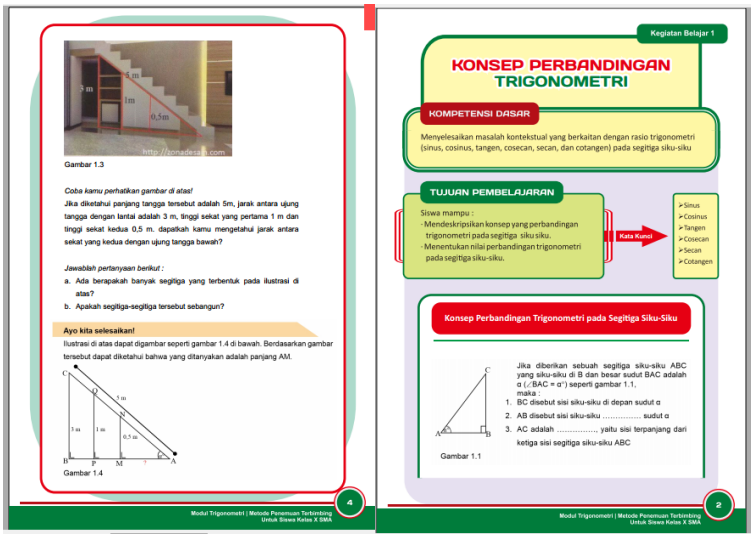

Figure 7. Module Material Design

Examples Questions

Examples of questions serve to facilitate students in learning this module given examples of examples of problems that correspond to trigonometric material.

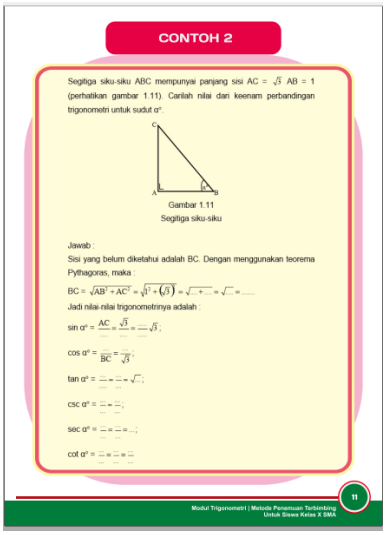

Figure 8. Design Sample Questions on Modules

Practice Questions

Practice questions are arranged to determine students' level of understanding

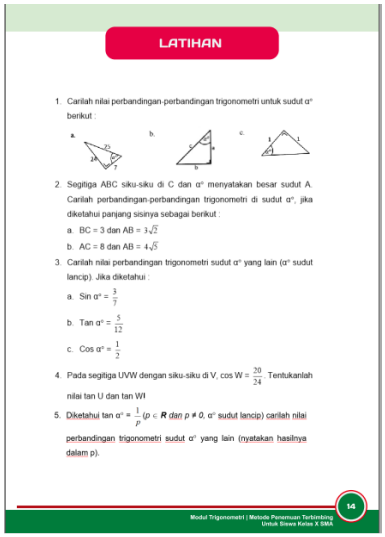

Figure 9. Design of Problem Exercises on Modules

Formative Evaluation Stage was developed by Tessmer (1993), as for the results of each evaluation stage carried out as follows:

Self evaluation

At this stage researchers evaluate the modules that have been designed themselves. Researchers re-evaluate in terms of content, construct, and language, as well as the writing system used in the module. There are several sentences in the module that are repaired and changed. The revised module is then referred to as prototype I.

Expert Reviews

At this expert review stage, researchers consulted Prototype I qualitatively based on content, construct, and language by the thesis supervisor, Sugiarto, M.Sc., Ph.D. In addition, researchers also asked for opinions from several lecturers who were experienced in mathematics education as validators. The validator is Drs. Sunaryo, M.Pd, Dr. Puguh Wahyu P, M.Sc and Anggit Prabowo, M.Pd. The suggestions and comments obtained from the validators on the trigonometric module of the discovery method are guided by prototype I based on the content, construct, and language outlined in table 2.

Table 2 : Validator's suggestions or comments on the mathematics module

Validation indicator	Comments or Suggestions
Content	• There are several materials in the module that the writing rules are not consistent with KD. • There are writing fonts that are not consistent in font type • Images on each question should be original images or clearer images (not blurry) • The image on the question must be clarified to make it easier to understand the problem. • Avoid plagiarism in the development of materials and questions.
Construct	• In the preparation of the module must be in accordance with the steps of the guided discovery learning model. • The formulation of a number of questions needs to be reviewed because there is unclear information and inappropriate use of sentences. • Sentences in questions and questions are more concise so that students are easily understood.

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Language	• Some questions still use non-EYD sentences. • Every use of a foreign language must be italicized.

Table 3 : Validator Comments and Suggestions as well as Revised Decisions

Comments or Suggestions	*Revised Decision*
There are several materials in the module that the writing rules are not consistent with KD.	Improve writing to be more consistent with KD.
Unattractive writing font.	Fix in font selection.
The image on each question should be a clearer picture	Improve the images contained in the module with clearer images
In the preparation of the module must be in accordance with the steps of the guided discovery learning model	Reviewing the steps of the guided discovery learning model.
The formulation of a number of questions needs to be reviewed because there is unclear information and inappropriate use of sentences.	Re-formulate the problem with the appropriate context. Re-editorial of unclear questions then corrected.
Sentences in questions and questions are more concise so that students are easily understood.	Re-formulating the sentence becomes simpler and easier to understand.
Some questions still use sentences that do not match EYD.	EYD in some cases fixed.
Every foreign language usage must be italicized.	The use of foreign languages contained in the problem is fixed.

One-to-one

At this stage, the module developed in prototype I was tested to 4 student class X and mathematics teachers at 6 Muhammadiyah High School Yogyakarta on January 31, 2018 and February 1, 2018. The four students have varying levels of mathematical abilities from high, medium, and low. The four students and teachers were asked to study the guided discovery method trigonometry module, after that stage an interview was then conducted to get opinions, comments and suggestions on the material presented. This is so that researchers can observe the responses and constraints faced by students when studying modules.

Figure 10. Students at the One to One Stage

Small Group

Trial on the small group class using the prototype II module, the revised module based on expert review / validator comments and suggestions. In addition to the suggestions from the validator the revision decision is based on the results in the one-to-one stage, at this stage the module draft gets input from the teacher and students who use the draft module on learning. The trial was carried out on two mathematics lessons, namely on February 15,

2018 and February 16, 2018 at MA Muhammadiyah 1 Yogyakarta, The trial was conducted on 6 students with heterogeneous levels of mathematical ability. In the implementation of small groups, researchers also observe students when working on the questions contained in the module. In contrast to the one-to-one trial, in the trial phase small group intensity students in understanding the material and finding concepts are better.

Figure 11. small group stage

Field Test

The Field Test stage uses the prototype III module, namely the revised module based on the comments and suggestions of the teacher and students at the small group stage. At this stage the expected output is this module has the potential effect of understanding students' mathematical concepts. To get this, a concept comprehension test is carried out, the ability to understand the concept of students is assessed based on indicators of the ability to understand concepts according to Depniknas. The criteria for assessing the ability to understand mathematical concepts can be seen in the following table:

Table 4: Guidelines for scoring concept comprehension skills

Concept Understanding Indicator	Explicative	Score
Re-state a concept	Empty answer	0
	Cannot restate concept	1
	Can re-express the concept but there are still many mistakes	2
	Can re-express the concept but not right	3
	Can re-express the concept correctly	4
Give an example and not an example of a concept	Empty answer	0
	Cannot give examples and not examples	1
	Can give examples and not examples but there are still many mistakes	2
	Can give an example and not an example but not right	3
	Can provide examples and not examples correctly	4
Classifying objects according to certain properties according to the concept	Empty answer	0
	Cannot classify objects according to the concept	1
	Can mention the characteristics according to the concept but there are still many mistakes	2
	Can mention the properties according to	3
	the concept but not yet right	4

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Presenting concepts in the form of mathematical representations	Empty answer	0
	Can present a concept in the form of a mathematical representation (picture) but it is not precise and does not use a ruler	1
	Can present a concept in the form of a mathematical representation (picture) but not yet precise	2
	Can present a concept in the form of a mathematical representation (picture) but not using a ruler	3
	Can present a concept in the form of mathematical representations (pictures) correctly	4
Developing necessary requirements / sufficient conditions for a concept	Empty answer	0
	Cannot use or choose the procedure or operation used	1
	Can use or choose procedures or operations that are used but there are still many errors	2
	Can use or choose procedures or operations that are used but still not appropriate	3
	Can use or choose procedures or operations that are used correctly	4
Use, utilize, and choose certain procedures or operations	Empty answer	0
	Cannot use, use, and	1
	choose procedures or operations	2
	Can use, utilize, and choose procedures or operations but there are still many mistakes	3
	Can use, utilize, and choose procedures or operations but is not appropriate	4
Apply concepts or algorithms in solving problem	Empty answer	0
	Cannot apply the formula accordingly	1
	procedure for solving problem solving	2
	problem	3
	Can apply the formula according to the procedure	4

The score of concept comprehension ability is the number of scores obtained when completing 4 questions. The maximum score is 80 while the minimum score is 0. The way to calculate the percentage value is as follows:

$$Percentage\ value = \frac{acquisition\ score}{maximum\ score} \times 100\%$$

Furthermore, the average value of understanding the concept's ability is interpreted according to the following table:

Table 5. Interpretation of Concept Understanding Ability Value

No	Value	Kriteria
1	85,00 – 100	Very good
2	70,00 – 84,99	Well
3	55,00 – 69,99	Enough
4	40,00 – 54,99	Low

5	0,00 – 39,99	Very low

CONCLUSION

Mathematical modules based on guided discovery learning models developed are categorically qualitatively valid. Valid is drawn from the results of the validator's assessment which contributes in the form of suggestions and comments on improvements to the mathematics module in terms of content, construction, and language. Validator states both based on content (material in accordance with KD and in accordance with guided discovery learning steps), constructive (Developing the ability to understand concepts and learning independence according to class X SMA / MA), and language (according to EYD)

Mathematical modules based on guided discovery learning models developed are categorized as practically qualitatively. Practically illustrated from the observations in the small group test, all students can use the math module well. This shows that the mathematics module is in accordance with the characteristics of students.

For the next stage, it can be continued by doing the field test stage to determine the potential effects of the modules compiled, so that it can be seen the ability to understand the concept of class X SMA / MA students.

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