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Development of Mathematics E-Module Based on Guided Discovery Learning for Class XI MIA High School Students

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Abstract— The existence of educators and teaching materials greatly affects the level of success of a learning activity which can be seen from the achievement of student learning outcomes. The application of the learning model also greatly affects the usefulness of teaching materials. Based on the conditions in the field at several SMAN Padang city showed that (1) the teaching materials available in specialization mathematics learning had not optimally guided students independently in finding concepts that were in accordance with the demands of the 2013 curriculum, namely the scientific approach, (2) teaching materials for learning online had not been compiled in its entirety, (3) students' mathematical learning outcomes in specialization mathematics were still low. The goal of this study was to produce an e-module of mathematics based on guided discovery learning (GDL) in specialization mathematics learning which was valid, practical and effective material. The Ploomp development model that consist of the preliminary analysis, the development or prototyping, and the assessment phase was used in this research. The research subjects were students of class XI MIA at SMAN 1 Padang. The validity test of the e-module mathematics based on GDL which was developed through the self-evaluation stage and the assessment stage of the experts including mathematicians, language expert and educational technology expert from UNP lecturers. Practicality tests were conducted on students and educators of class XI MIA at SMAN 1 Padang as users of e-modules. Effectiveness tests were conducted on students after using e-modules. The results showed (1) the validity test of the e-module received an assessment of 3.826 with a very valid category, (2) the practicality test of the e-module by students at the small group stage obtained an assessment of 87.69 with a very practical category, the practicality test of the e-module by participants the field test stage was 90.14 with a very practical category and the e-module practicality test by educators obtained an assessment of 89.145 with a very practical category, (3) the effectiveness test of the student learning outcomes test in the field test stage gained 81.25 with an effective category . Thus, it can be concluded that the developed mathematics e-module based on GDL obtained results with valid, practical and effective categories to improve learning outcomes.

Keywords— E-modul, guided discovery learning, Plomp development model.

I. INTRODUCTION

Applying the 2013 curriculum in the mathematics learning process is an effort made by the government to improve the quality of education in Indonesia. This curriculum requires students to be independent in the learning process and expects educators and students to master technology [1]. Mathematics is also a basic science that plays a crucial role in the development of science and technology [2]. Mathematics learning aims to be able to provide good mathematical abilities to students to continue to higher education levels [3].

Base on the importance of learning mathematics, it is important to incrase a quality learning process at all levels of education. However, based on the results of the latest 2015 TIMSS mathematics survey, it was reported that Indonesian students were ranked 44th out of 49 countries [4], meanwhile the results of the 2018 PISA mathematics survey Indonesia placed the lowest 7th rank [5]. This following table I showed the low graded of mid semester assessment of specialization mathematic in class XI MIA at several

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TABLE 1. AVERAGE ASSESSMENT OF MIDDLE SEMESTER MATHEMATICS FOR CLASS XI MIA SMAN, 2021

School name	Specialization Mathematics
SMAN 2 Padang	62.65
SMAN 1 Padang	59.65
SMAN 9 Padang	52.85
SMAN 7 Padang	47.06
SMAN 16 Padang	42.85

The achievement of student learning outcomes above was an indication that the learning objectives had not been reached as expected. The low learning outcomes of students were caused by limited learning resources during the learning process [6]. Therefore, the availability of learning facilities and teaching materials greatly affected the level of learning quality. In line with the information from interviews with educators at SMAN 1 and SMAN 16 Padang, it was found that the main learning source in specialization mathematics is mathematics books from the 2013 curriculum from private publishers. According to educators, the explanation of the material in the specialization mathematics book was difficult for students to understand in independent study, and did not contain steps that were in accordance with scientific approaches such as books on compulsory mathematics. In line with the results of studies which state the lack of availability of learning resources for specialization mathematics and the existing guidebooks did not contain steps in accordance with the scientific approach [7]. Then from the questionnaire given to class XI MIA SMAN 1 Padang students, it was concluded that most students did not like specialization mathematics because they considered that the presentation of material and questions on available learning resources was difficult to understand for independent study and the material was abstract.

Responding to these problems above, it was necessary to innovate in optimizing the learning process of specialization mathematics as an effort to improve student learning outcomes. The Covid-19 pandemic situation has resulted in students accessing learning through smartphones and other devices, and there has been a high level of smartphone use among students as a learning tool. However the problem was the lack using technology in the learning process because of the limited knowledge of educators about using technology in learning [8]. Therefore, today's mathematics learning can be improved through the development of learning resources by utilizing technology. This can be realized in the form of developing electronic-based mathematics teaching materials such as electronic modules (e-modules). The module, which was originally in print form, was transformed into an electronic form which was designed with the help of software.

Modules are teaching materials that are designed with systematic steps so that students can learn independently and a good module can trigger students' specialization and motivation in learning [9]. Modules are teaching materials whose constituent components are more complete than other teaching materials. The modules contain important components such as: titles, study instructions, basic competencies, supporting information, exercises, work assignments/steps and assessments [10]. The results of interviews with educators at SMAN 1 Padang stated that there were no teaching materials in the form of modules or e-modules for learning mathematics with specialization at the school. Especially since this pandemic, according to educators, the role of electronic teaching materials was very much needed to facilitate learning activities. The absence of modules or e-modules that have been developed for learning mathematics with specialization was due to the limited time of educators and limited knowledge of educators in using technology. In line with that, the questionnaire distributed in class XI MIA SMAN 1 Padang shows that students hope that there would be teaching materials using language and steps that were easy to understand, interesting, accompanied by pictures and explanations in the form of sound/video for self-study reference and can be accessed using technology media such as smartphones.

Physically, the format for presenting the e-module is different from the print module, but the components of the e-module are the same. E-modules were designed to be accessible via smartphones and other devices. E-modules were equipped with videos,

images, animations and audio to enhance the learning experience and were expected to attract students' interest and motivation to learn and were equipped with tests or exercises that cuold generate immediate automatic feedback [11]. The advantages of e-modules were that they wre efficient to carry, will not wear out over time, and were equipped with images, videos, audio and animation [12,13]. Therefore, the existence of e-modules could trigger students' enthusiasm for learning, facilitate understanding of the material provided by educators for independent learning, made the learning process more interesting, and interactive. In addition, the use of e-modules in learning coud also improve the student learning outcomes [14].

In accordance with the essential of implementing the 2013 curriculum, a good learning process does not present concepts in final form, but students are required to organize themselves in finding concepts. For this reason, in supporting the use of e-modules, one can implement a learning model, which one of that is guided discovery learning (GDL). The selection of appropriate learning models and teaching materials is essentially an effort to optimize student learning outcomes. This guided discovery learning model is able to emphasize the involvement of students in the learning process [15]. The educator designs a series of questions that guide the learning process and guide students to find concepts [16] and the educator as a motivator in solving difficulties in learning [17]. The questions given can stimulate students so as to produce the right perspective on teaching materials [18] so that this model is able to improve student learning outcomes [19,20]. There are 5 steps of the GDL model developed by Yerimadesi (2017) including motivation and problem presentation, data collection, data processing, verification and closure.

Based on the description above, it would develop mathematics e-module based on GDL in specialization mathematics learning and produced valid e-modules from aspects of content, presentation, language, and graphics. Then it was practical in terms of implementation, time, and ease of use and effective in terms of its potential impact on the achievement of student learning outcomes.

II. Research Methods

The development Plomp model was used in this research. Plomp divides the development stage into three phases, namely preliminary research, development or prototyping, and assessment phase [21]. Every series of steps in order to develop a new product or improve an existing product, so that it can be accounted to test the validity, practicality and effectiveness of the product.

The first stage was the preliminary analysis phase that consisting of needs analysis, student analysis, curriculum analysis and concept analysis. The results of the preliminary analysis were then designed or made prototypes in the form of mathematics e-module base on GDL. The following state is a formative evaluation the consisting of prototype 1 to prototype IV. Prototype 1 is self-evaluation and expert reviews. Prototype II is one-to-one evaluation. Prototype III is small group evaluation and prototype IV is field testing. After the product has gone through several prototypes, it will be continued with an assessment phase carried out on class XI MIA SMA 1 students Padang City Senior High Schools for the 2021/2020 academic year. In this case, the e-module was tested on class XI MIA 1 students at SMAN 1 Padang City.

The validity of mathematics e-module base on GDL designed validated by the self-evaluation stage and by experts (mathematics lecturers, language lecturer and educational technology lecturer). One to one evaluation was carried out to see the practicality of the e-module, small group evaluation was also carried out to see its practicality but was already towards effectiveness, and field tests were carried out to see its practicality and effectiveness. The impact of the designed mathematics e-module base on GDL could be seen from the completeness of the learning outcomes achievement.

Data was collected by means of interviews ,documentation , questionnaires, observation, and tests. Data from questionnaires, observations, and tests were analyzed quantitatively, strengthened by the results of the documentation analyzed in a qualitative descriptive manner.

III. Results And Discussion

1. Results of the Preliminary Research Phase

The initial investigation stage begined with needs analysis, curriculum analysis, concept analysis, and student analysis. The results of the description at each stage of the initial investigation are as follows:

a) Results of Needs Analysis

Activities in the needs analysis were collecting information about learning mathematics, especially learning mathematics with specialization at SMAN 1 Padang through interviews with mathematics educators, observing learning activities and teaching materials used by educators in learning mathematics at SMAN 1 Padang. The results obtained was the disruption of the face-to-face learning process since the COVID-19 pandemic, so that in the learning process had being carried out through technological assistance such as smartphones. There was also a lack of student response when participating in interest mathematics lessons when compared to compulsory mathematics. Then the learning resources provided for specialization in mathematics learning were in the form of textbooks and worksheets. However, these teaching materials were not optimal in applying the steps of a scientific approach. Those were less attractive because they contain a lot of verbalism and were not colorful and contained explanations of material that were difficult for students to understand independently. The existence of online learning that occurs made students had to be able to carry out learning activities independently using available teaching materials, while teaching materials for online learning had not been prepared by the school yet. Schools needed electronic teaching materials such as valid, practical and effective electronic modules.

b) Results of Curriculum Analysis

Activities in the analysis of this curriculum was by conducting a study of the 2013 curriculum in mathematics subjects with specialization in class XI MIA SMA in the even semester. Curriculum analysis was carried out to see the suitability of Core Competencies (KI) and Basic Competencies (KD), Competency Achievement Indicators and learning objectives on specialization mathematics materials. Curriculum analysis wa used as a basis in formulating indicators of competency achievement that must be achieved by students in developing mathematics e-module base on GDL for specialization mathematics.

The Ministry of Education and Culture also announced that with the pandemic, learning policy adjustments were made to make it easier for students and educators to carry out learning and teaching activities by implementing an emergency curriculum by simplifying basic competencies. This simplification reduces the basic competencies for each subject and students would only focus on essential competencies and were prerequisites for continuing learning to the next level. Based on the curriculum analysis, information was also obtained that SMAN 1 Padang had also implemented an emergency curriculum in learning mathematics with specialization. The material taught/selected for specialization in mathematics learning in the emergency curriculum of class XI even semester was only limited to KD 3.4 and KD 4.4, namely polynomial material.

c) Results of Concept Analysis

The activity in concept analysis is to determine the content and subject matter needed in the development mathematics e-module based on GDL. Based on the basic competence (KD) 3.4, eleven indicators of competency achievement for knowledge indicators and four indicators of competency achievement for skills indicators are relevant and appropriate. Then a concept map is formulated on the polynomial material as shown below.

d) Results of Student Analysis

Information obtained based on a questionnaire that had been given to all students of class XI MIA at SMAN 1 Padang was analyzed and used as a basis in designing a mathematics e-module based on GDL. It was concluded that 86.9% of students did not like learning specialization mathematics.The use of language and the questions in teaching materials were difficult to understand. Furthermore, 100% of students wanted more interesting learning resources for learning specialization mathematics and they were already using smartphones as a learning resource. Students wanted learning resources accompanied by pictures, explanations in the form of videos/sounds for self-study reference, using language that was easy to understand, teaching materials with material presented briefly, densely and clearly. It can be accessed via smartphones/other devices on learning resources. 93.49% of students liked teaching materials that were colored rather than black and white, and students also choosed the type of writing they like on

the e-module.

The development of mathematics e-module based on GDL expected to be able to invite students to actively construct their knowledge from the beginning to the end of learning. The e-module already contained videos/sounds/images that enrich the learning experience of students and the e-module applied the GDL model. The GDL e-module provided a guidance in the form of problems that can allow students to make these discoveries and to improve learning outcomes for specialization mathematics students.

2. Results of the Development or Prototype Stage

Prototyping was done after the main material, Basic Competence (KD) and Competency Achievement Indicator, have been determined. The results will be described as follows.

a) Design of Mathematics E-modul Base on Guided Discovery Learning

The design of an mathematics e-module based on GDL was carried out after the initial investigation was done. The contents of the e-module were designed using Microsoft Word and then developed using Flip PDF corporate edition software. Through this media, e-modules would be produced in the form of links, then the e-module links would be distributed to educators and students as users. E-modules were designed with varied and bright colors. The developed mathematics e-module GDL is divided into 3 parts, including the initial section, the content section and the closing section.

The initial part of the e-module was a cover page, introduction, author identity, table of contents, list of pictures, list of videos, glossary, instructions for using e-modules, introduction (which contains core competencies (KI), basic competencies (KD), achievement indicators competence and learning objectives, a brief description of the material and a concept map of the polynomial material. The next part was the content section, there were activity title pages, material pages, exercises and self-assessments which were developed into 7 learning activities. In this content section, the activities in the e-module had been designed by applying the syntax of the GDL model. The first syntax was motivation and problem presentation, this stage of the e-module facilitates students to make observations through reading activities / viewing pictures / listening to videos to motivate students to participate in learning activities. And e-modules guide students to make temporary answers to questions that can stimulate them in finding new knowledge in accordance with learning objectives. The second syntax was data collection, students explored and collected information related to the material being studied through reading material descriptions, listened to video explanations related to material and examples of relevant questions and the presence of several pictures. It was hoped that vidio can guide students to understand teaching materials independently or without the help of educators. The third syntax was data processing. Students were asked to re-solve existing problems correctly and precisely after they find the concept. Followed by the fourth verification syntax, through a wordwall application (such as a quiz that immediately has a true/false response), and it is hoped that this activity will be able to guide students to answer correctly based on the knowledge they get at the data collection and processing stage. After going through this stage students were able to draw conclusions correctly. The last syntax was closing, the student's activity is to write conclusions from the material on the activities he has studied, namely by filling in the gap statements available in the e-module. And the last part was a bibliography page and an answer key.

b) Prototype I

Prototype I was first phase of designing e-module. The results of prototype I were validated through self evaluation and expert review validation. The following is a description of the validation results on prototype I.

i. Results of Self Evaluation

The first activity carried out after designing a mathematics e-module based on GDL was to be examined by the researcher (self-evaluation) before continuing with consulting and asking for opinions with expert review. In accordance with the Plomp development model where this self-evaluation stage only sees visible errors (abvious errors). In general, the researchers found several typos, errors in using punctuation marks in sentences. There were errors in several buttons leading to the links that had been created, such as the malfunction of the button to the google form link on the e-module. The researcher also reviewed the aspects/components that must exist in the preparation of a mathematics e-module based on GDL. Then it was found that there was no glossary component in the e-module because the glossary is an important part, so the researchers added that component. The results of this revised self-evaluation were then followed by the next step, which was consultation and discussion with expert

reviews and validation.

ii. Results of Expert Review

The next activity was validation of the mathematics e-module based on GDL by experts. Validation was used to appraise the validity of the e-module that has been designed and was able to provide input to improve the e-module that has been designed. E-module were validated by five, they were expert lecturer in the field of mathematics education, languange and educational technology. Validation activities were carried out from December 15, 2021 to December 28, 2021. Validator assessment can be seen from the validation sheet filled out by the validator which was divided into three aspects, namely the material validation sheet, graphics and language.

Validators from mathematicians checked each activity description that has been designed in the mathematics e-module based on GDL and validated the suitability of the material with KD and IPK, the correctness of the presentation of the material, the appropriateness of the content, the suitability of the syntax of the GDL model, and the use of language. Several suggestion and revisions were given by validators. The suggestions were used the term in Indonesian for each syntax/stage of the GDL model in the e-module, prioritized the description of the completion or explanation before presenting a video that helps students understand the material, reduced the number of questions in the exercises available on the e-module. That had more than 10 questions. The e-module can only be accessed using the internet network, so that add a point to the instructions for using the e-module the sentence "The conditions for using this e-module, on some pages you need to have a good internet network". The validator from the language expert provided an assessment of the linguistic aspect of the e-module and the validator from the educational technology expert provided an assessment of the graphic aspect of the e-module. The results of the validation by expert review of the developed mathematics e-module base on GDL are summarized in Table 2 below.

TABLE 2. AVERAGE OF E-MODULE VALIDITY ASSESSMENT BY EXPERT

No.	Rated aspect	Average Score	Category
1.	Test the validity of the e-module by mathematicians (Material Aspect)	3.79	Very Valid
2.	Test the validity of the e-module by language experts (Language Aspect)	4	Very Valid
3.	Test the validity of the e-module by technology expert (Graphic Aspect)	3.69	Very Valid
Average		**3.826**	**Very Valid**

Source: Recap of validation analysis results by Expert review

The table above shows that the results of the validation of the mathematics e-module based on GDL by five validators, namely 3 mathematics education, 1 indonesian language and 1 educational technology expert got an avarage score of 3.826. The score indicated the "very valid" criteria. This means the material, graphic and language aspects of the e-module which were developed with several revisions were very suitable for use in practical trials of e-modules at a later stage.

c) Prototype II

The next activity was to test the practicality. After the e-module based on GDL had been validated by the expert, it produced a prototype 2. Next, the individual evaluation stage (one-to-one evaluation) was done by testing the e-module on three students including one highly capable, one medium ability and one low ability student to comment on the e-module that had been designed. E-modules were given to students of class XI MIA 7 at SMAN 1 Padang which will be held on December 30, 2021 until January 2, 2022. Students read, understand and used e-modules in specialization mathematics learning for polynomial material. E-module had been developed for 7 activities. The activities that the researchers carried out included: observing instructions or parts that were difficult for students to understand in the e-module, noting suggestions, comments or sentences that were difficult for students to understand. At this stage, students also ask questions "Miss, may we use a headset to hear the video sound?" . From these questions, the researcher made a few revisions to the e-module by adding instructions on the e-module usage instructions page in the form of sentences "You may use headset, headphone or other media to help you listen the video in

e-module".

The next activity, the researcher was conducted interviews with students at the one to one evaluation stage. The goal of this was to find out the practicality of using e-modules. Interviews were conducted using a validated interview guide. From the seven activities that have been tested, the conclusions from interviews with students at the this stage include (1) students liked the cover and appearance of the e-module, (2) the type, size of writing, sentences in the e-module were easy to read and understand. (3) the stages of learning to use the math e-module based on GDL were clear and easy to understand, (4) the math e-module base on GDL made students interested in reading and studying it. The use of e-modules was different from the use of printed books that used by everyday educators in schools. Students would be greatly helped if the material made by the educator like this e-module. The learning process since the Covid-19 had been divided into 2 shifts, where half of the students who studied at school and the rest study at home. Videos in e-modules helped them understand the material and improved interest to learning.

Based onobservation results at each meeting and interviews with three students regarding the use of e-modules in the one to one evaluation stage, it shows that the developed mathematics e-module based on GDL developed was easy to understand and worked on, although there were slight improvements. Through interviews, it was also found that the presentation of mathematics e-modules based on GDL could be understood by students to be used as independent learning resources. After the e-module was revised based on one to one evaluation, the next stage was called prototype III, then formative testing was carried out at the next stage, namely a small class trial or small group evaluation.

d) Prototype III

The activity carried out on prototype III was to test the practicality of the mathematics e-module base on GDL through the small group evaluation by selecting 6 students as subjects. The selection of students included two high-ability , two moderately capable and two low-ability students but these students who had not participated in the one-to-one evaluation activity. This small group activity was carried out in class XI MIA 7 SMAN 1 Padang starting on January 3, 2022 until January 9, 2022. Educator who taught in small group activities was researcher. Educator used e-modules based on GDL mathematics that have been revised from the previous stages. Based on the results of the analysis of the answers given by the participants for each stage/syntax of the guided discovery learning (GDL)model that was described in the e-module and has been summarized in Table 3 below.

TABLE 3. ANALYSIS OF E-MODULE WORKING RESULTS AT THE SMALL GROUP EVALUATION STAGE

Activities to	Student Scores in Following Stages					Average
	Motivation and Problem Presentation	Data Collection	Data Processing	Verification	Closure	
1	83.33	83.33	94.44	94.44	88.89	88.89
2	91.67	88.89	100	88.89	88.89	91.67
3	83.33	83.33	88.89	88.89	94.44	87.78
4	83.33	72.22	88.89	88.89	83.33	83.33
5	91.67	100	94.44	88.89	88.89	92.78
6	75	83.33	88.89	83.33	83.33	82.78
7	83.33	83.33	88.89	88.89	77.78	84.44
Average	84.52	84.92	92.06	88.89	86.51	87.38

The researcher also asked for student responses after using the e-module by filling out a practicality questionnaire. Filling the practicality questionnaire aims to determine the extent to which e-modules can be used, ease to use, attractive and efficient to be used as teaching materials in learning activities. This following table is a summary of the results of the practicality questionnaire for the small group evaluation stage by students.

TABLE 4. PRACTICALITY RESULTS BY SMALL GROUP EVALUATION STAGE STUDENTS

Rated aspect	**Average score of each aspect**	**Practical Presentation**	**Category**
Usable	3.47	86.67	Very Practical
easy to us	3.31	82.64	Very Practical
Appealing	3.62	90.48	Very Practical
cost effective	3.63	90.63	Very Practical
Average	3.51	87.69	Very Practical

The table above shows that the average practicality of e-modules was 87.69% with very practical criteria. Furthermore, a summary of the interviews was obtained that students felt the e-modul developed was helpful in specialization mathematics learning . The Covid-19 pandemic made the learning process being carried out onlie, so that students were constrained in participating in learning activities.Using this e-module helped students to learn independently because the e-module contains explanations through videos that help them understand the material. Students also stated that this e-module was interesting to be used as a learning resource because it was colorful and had challenging stages. Based on the average practicality value and the results of the interview, it can be stated that the mathematics e-module based on GDL for polynomial material in small groups was the very practical criteria. Theoretically, a device can be said to be practical if it can be used and understood easily.

This small group stage also aimed to achieve effectiveness. A test of learning outcomes was also carried out with the questions that were the same as the questions in the field test stage later. Mathematical learning outcomes at the small group stage can be seen in the following table.

TABLE 5. RECAP OF MATHEMATICS LEARNING TESTS AT SMALL GROUP EVALUATION STAGE

Students	KKM	Test Results	Category
A	80	100	Complete
B	80	100	Complete
C	80	88	Complete
D	80	90	Complete
E	80	81	Complete
F	80	74	Not Complete
Average		88.83	

The average mastery of learning outcomes at the small group stage was 88.83, with a category more than the specified KKM score of 80. This shows that the six students had given good answers when taking the learning outcomes test. It can be stated that learning using an e-module based on GDL had an effect on students' mathematical learning outcomes and the e-module was said to be effective. The mathematics e-module based on GDL given to the small group evaluation has met the requirements for practicality and effectiveness. The result of the e-module after the small group activity would be treated through prototype IV. For this reason, based on the Plomp development model used, prototype IV needed to be tested again at the field trial stage.

e) Prototype IV

The results of the revision at the one-on-one evaluation stage and small group evaluation were then continued with field trials (prototype IV). The e-module was tested on 40 students of class XI MIA 1 at SMA Negeri 1 Padang City. The field test was

carried out in 7 meetings. The implementation of specialization mathematics learning using e-modules in this field test is carried out directly by educators in the field of specialization mathematics in class XI MIA 1, while researcher was assisted by colleagues as observers during learning activities on . Research wa done during the Covid-19 pandemic. The Padang city government policy limited the attendance of the students number in the class. Students are divided into 2 shifts with the number of students in each shift is half of the total students in normal classes. Half of the students carry out learning activities in the classroom and the other half carried out learning activities through online (in the network). Before the field test was carried out, the researcher had submitted the link of the mathematics e-module based on GDL to the educator , so that it could be studied. Then the educator shared the link on the WhatsApp math group belonging to class XI MIA 1 which was made accessible online using students' internet data.

The field test stage was also seen how the assessment of the implementation of the stages/syntax of GDL model that had been developed in the e-module. The assessment for the motivation and problem presentation stages as well as data collection could be seen with a qualitative assessment or description of the student's activities, while for the data processing, verification and closing stages, an assessment can be given using a number quantitatively at each stage. Analysis of the assessment of all learning activities with the stages/syntax of the GDL model presented in the e-module have been summarized in the following table.

TABLE 6. RESULTS OF E-MODULE WORKING ANALYSIS IN THE FIELD TEST STAGE

Activities to	Student Scores in Following Stages			Excercise	Average
	Data Processing	Verification	Closure		
1	83.7	93.54	91.5	85.66	88.60
2	94.17	92.86	92.5	89.99	92.38
3	85	93.93	89	82	87.48
4	80	94.72	91.25	85	87.74
5	92.92	96.98	90.83	94.3	93.76
6	91.67	95.83	90	88.93	91.61
7	88.33	97.79	81.88	85.85	88.46
Average	87.97	95.09	89.57	87.39	90.00

Referring to the table above, it appears that the high average value of each stage of the GDL model and the final average obtained by students is 90.00. It can be concluded that field test students with different abilities have been guided to find concepts with the existence of an e-module of mathematics based on GDL in the mathematics learning process with specialization in polynomial material.

The practical assessment of the mathematics e-module based on GDL at this stage could be seen from the practicality sheet in the form of a questionnaire filled out by students and educators who acted as e-module users. Beside using the questionnaire, practicality could also be seen from the observation sheet on the learning process while using the e-module and the interviews conducted. The effectiveness of e-modules can also be seen from the results of students' mathematics learning tests after learning using e-modules.

i. E-Module Practicality Questionnaire Results by Students

This questionnaire showed the easy to use of the developed e-module, time efficiency, easy to understanding and the attractiveness and benefits of the e-module by students. The following tabke summarized the results of the student response questionnaire at the field test stage to see the practicality of the mathematics e-modul based on GDL that has been developed.

TABLE 7. RESULTS OF DATA ANALYSIS OF E-MODULE PRACTICALITY QUESTIONNAIRE BY FIELD TEST STAGE STUDENTS

No	Rated aspect	Average Score of Each Aspect	Average Paracticity Value (%)	Category
1	*Usable*	3.58	89.5	Very Practical
2	*Easy to use*	3.59	89.5	Very Practical
3	*Appealing*	3.65	91.25	Very Practical
4	*Cost effective*	3.605	90.13	Very Practical
Percentage of practicality			90.14	Very Practical

Based on Table 7, the average practicality percentage is 90.14%, It means that mathematics e-module based on GDL had the very practical category.

ii. E-Module Practicality Questionnaire Results by Educators and Educator Interviews

The researchers also asked for responses from educators after carrying out the specialization mathematics learning process using a mathematics e-module based on GDL that had developed. The practicality questionnaire was used to see the aspects of the ease of use of the developed e-module, time efficiency, ease of understanding and the attractiveness and benefits of e-module by educators. The following table is results of the practicality questionnaire analysis on e-modules by educators.

TABLE 8. RESULTS OF DATA ANALYSIS OF E-MODULE PRACTICALITY QUESTIONNAIRE BY FIELD TEST STAGE EDUCATORS

No	Rated aspect	Average Score of Each Aspect	Average Paracticity Value (%)	Category
1	*Usable*	3.6	90	Very Practical
2	*Easy to use*	3.58	89.5	Very Practical
3	*Appealing*	3.75	93.75	Very Practical
4	*Cost effective*	3.33	83.33	Very Practical
Percentage of practicality			89.14	Very Practical

The table above showed that the e-modules based on GDL for each aspect were considered to be in the very practical category, and the percentage of practicality of e-modules is 89.14% in the very practical category. It can be stated that the mathematics e-module based on GDL was practical.

Supporting the results of the questionnaire above, interviews with educators were also carried out after carrying out the learning process using e-modules in class XI MIA 1 at SMAN 1 Padang. Based on these interviews, it was concluded that educators like to use e-modules as teaching materials, e-modules are easy to use, attract the attention of students, and e-modules can overcome problems that occur during the mathematics learning process. This is because since the Covid-19 pandemic the learning process has been carried out in two shifts, including online shifts and offline shifts. The e-module helped educators present the material and it was equipped with an explanation of learning videos to answer students' confusion. Beside reading the material, students can hear directly on the vidio the listed explanations . The e-module also contains complete material that has been summarized in one complete learning activity. After showing the process of making this e-module, the educator stated not too difficult to use te module, and helped the learning process during the COVID-19 pandemic. Educators were interested in trying to make an e-module. Thus, it can be concluded that the e-module used is practically used in mathematics learning in class XI SMA.

iii. Effectiveness Results

The effectiveness of using mathematics e-module base on GDL on polynomial material that has been developed aims to see the extent to which the e-module can help acquire the learning mathematics objectives. The results of the effectiveness of this e-module can be seen from the analysis of students' mathematical learning outcomes after carrying out learning activities using the e-module. This test was given to all students (40 people) in class XI MIA 1 SMAN 1 Padang. The effectiveness test was carried out on Monday, February 7, 2020. The test questions given to test the effectiveness of the e-module at the field test stage were the same as the small group stage. These questions had been validated and tested on SMAN 10 Padang students to see the acceptance criteria for the test questions (distinguishing power, index of difficulty, reliability of questions). E-module was said to be effective if the results of the calculation of the average mastery learning outcomes of students are in the effective category. The test is not carried out in the e-module, but the test is carried out directly by distributing questions and answer sheets to students. The assessment to test the effectiveness of using the e-module used a validated learning outcomes test answer key. The following tabe is the results of the analysis of students' mathematical learning outcomes in the field test stage.

TABLE 9. RESULTS OF COMPLETENESS ANALYSIS OF MATHEMATICS LEARNING OUTCOMES FOR FIELD TEST STAGE STUDENTS

	Complete	Not Complete
Number of Students	29	11
Percentage of Students	72.5%	27.5%
The average value of students	84.55	63.45
Final Average	81.25	

In the table, it can be seen that the students who completed were 29 out of 40 students, it also shows that the percentage of students who completed was 72.5%. The students who were incomplete is due to the fact that during the learning process students may not focused and may not serious about working on each stage of the GDL and the practice questions given in the e-module. These caused students not to be able to answer the test questions properly. The overall average value of 40 students at this field test was 81,25 that was higher than the KKM that had been determined wth complete criteria. By matching the percentage of students who complete the criteria for mastery learning outcomes in Table 9, the effectiveness test is in the "effective" criteria. So it can be concluded that mathematics e-module base on GDL have been effective in improving student learning outcomes. The matematics e-module based on GDL allow students to acquire an expirience to construct a mathematic concept by themselves. This is agree with that mathematics should enable students to acquire a variety of expiriences thought various sources and activities to increase learning prosess [22].

IV. CONCLUSION

The mathematics e-modules based on GDL for polynomial material to improve student learning outcomes in specialization mathematics learning has been developed by using the plomp development model. The developed e-module has been in

accordance with the subject syllabus and curriculum content, could direct students to construct their knowedge, and ease to use learnng. The developed module was valid, practical and effective for polynomial material at high school mathematics learning. Module developed had very valid criteria that had 3.82 by experts judgment. E-module practicality was very practice criteria that had 90.14 by students and 89.145 by educators. E-module effectiveness was effective criteria that indicated by average grade of small group students learning outcome was 88.83, and that of fied test was 81.25. This e- module was recomended to use in a real meaning of polynomial material in specalization mathematics learning.

REFERENCES

[1] Rusdi., Arnawa, I.M., Fauzan,A., & Lufri. (2018). The need analysis development of mathematics learning model based realistic mathematical education and literacy in junior high school. Proceeding ICESST 2018 International Conferences on Education, Social Sciences and Technology.

[2] Reski, A., Nikat R., & Sari, D. K. (2019). Analysis of The Lecture's Teaching Skills Using Structural Equation Modeling Method. IOP Conference Series: Earth and Environmental Science, 343(1), 1-6.

[3] Fauzan, A., & Yerizon. (2013). Pengaruh Pendekatan RME dan Kemandirian Belajar Terhadap Kemamampuan Matematis Siswa. Prosiding Semirata FMIPA Universitas Lampung.

[4] International Association for the Evaluation of Educational Achievement. (2016). TIMSS 2015. Assessment Framework

[5] OECD. (2019). PISA 2018 Assessment and Analytical Framework: Mathematics, Reading, Science, Problem Solving and Financial Literacy. Paris: OECD

[6] Rahmawati. (2019). Deskripsi Kesulitan Belajar Matematika Siswa Ditinjau dari Segi Kemampuan Koneksi Matematika Siswa. *Thesis, Universitas Negeri Makasar*.

[7] Magdalena, M., Zagoto., & Dakhi, O. (2018). Pengembanagan Perangkat Pembelajaran Matematika Peminatan Berbasis Pendekatan Saintifik Untuk siswa Kelas XI SMA. Jurnal ReviewPendidikan dan Pengajaran. Volume 1 Nomor 1. http://journal.universitaspahlawan.ac.id/index.php/jrpp

[8] Zulkarnain., & Jatmikowati. (2018). Pengembangan Media Pembelajaran Berbantuan Adobe Flash CS6 Berbasis Android Pokok Bahasan Segitiga. *Jurnal Gammath*, 3(1), 49-57. p-ISSN: 2503-4723, e-ISSN: 2541-2612.

[9] Bayharti, Yerimadesi, Jannah, S. M., Lufri, Festiyed, & Kiram, Y. (2018). Validity and Practitality of Acid-Base Module Based on Guided Discovery Learning for Senior High School. *IOP Conference Series: Materials Science and Engineering*, 335, 1-11. https://doi.org/10.21831/cp.v3i3.7340

[10] Depdiknas. (2008). *Panduan Pengembangan Bahan Ajar*. Jakarta: Tim Penyusun Depdiknas.

[11] Direktorat Pembinaan Sekolah Menengah Atas. (2017). *Panduan Praktis Penyusunan E-Module*. Jakarta: Kementerian Pendidikan dan Kebudayaan.

[12] Sugihartini, N., & Jayanta, N. L. (2017). E-Modul Strategi Pembelajaran Berbasis Cai Dengan Project Based Learning (Kajian Respon Pengguna Sistem). *Seminar Nasional Riset Inovatif*, 5, 831–838.

[13] Ummah, R., Suarsini, E., & Lestari, S. R. (2018). Analisis Kebutuhan Pengembangan E-Modul Berbasis penelitian Uji Antimikroba pada Matakuliah Mikrobiologi. *Seminar Nasional Pendidikan IP*.

[14] Safitri,I. (2015). Pengembangan E-modul dengan Pendekatan Pembelajaran Matematika Realistik Berbantuan Flipbook Maker Pada Materi Bangun Ruang Sisi Datar Kels VIII SMP. *Jurnal Matematika dan Pendidikan Matematika*. DOI: https://doi.org/10.26877/aks.v6i2.1397

[15] Yerimadesi, Kiram, Y., Lufri, & Festiyed. (2017). *Buku Model Guided Discovery Learning untuk Pembelajaran Kimia (GDL-PK) SMA*. Pasca Sarjana Universitas Negeri Padang. https://doi.org/10.31219/osf.io/gkmt6

[16] Martin, A. J. (2015). Teaching Academically At-Risk Students in Middle School: The Roles of Explicit Instruction and Guided Discovery Learning Middle. 207–223.

[17] Yerimadesi. (2018). Pengaruh Model Guided Discovery Learning (GDL) untuk meningkatkan keterampilan berfikir kristis pada pembelajaran kimia di SMA. Disertasi. Universitas Negeri Padang

[18] Smitha. (2012). Inquiry Training Model and Guided Discovery Learning. Kozhikode: Vilavath Publication.

[19] Khasanah, V. N., Usodo, B., & Subanti, S. (2018). Guided Discovery Learning in Geometry Learning. *Journal International Conference on Mathematics, Science and Education.*

[20] Yuliana, T., & Wijayanti, S. (2017). The Effectivennes of Guided Discovery Learning to Teach Integral Calculus for the Mathematics Students of Mathematics Education. *Infinity Journal of Mathematic Education*. Volume 6, No. 1, February 2017.p–ISSN 2089-6867.

[21] Plomp, T. (2013). Educational Design Research: an Introduction. Dalam Tjeerd Plomp dan Nienke Nieveen (Ed.). An Introduction to Educational Design Research. Enschede: SLO•Netherlands Institute for Curriculum Development.

[22] Syarifuddin, H., & Atweh, B. (2022). The Use of Activity, Classroom Discussion, and Exercise (ACE) Theaching Cycle for Improving Students Engagement in Learning Elementary Linear Algebra. *European Journal of Science and Mathematics Education.* Vol. 10. No. 1. 2022.