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Research Article

Development of Mathematics Learning e-Modules to Improve Students' Mathematical Communication Skills

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ABSTRACT

E-modules can be used as a self-paced learning process that can help students learn systematically, interestingly, and interactively. The teaching and learning process is also not limited to an information source, this e-module can help students understand concepts better than the material taught by relevant teachers. This research uses research and development (Research and Development) is a research method used to produce certain products and test the effectiveness of products with a 4D model. The subject of this study is grades VII students at MTs. Amin Darussalam. It consists of one class that is randomly selected (random sampling), namely class VII as many as 6 students who are made into a limited field test or a small test group consisting of 20 students and an operational field test or a large test. The feasibility level of the e-module obtained a feasibility level of 81.83%, with a very feasible category. The assessment of the validity level is 81.47% with a category that is quite valid, can be used but needs minor revisions. The assessment of the practicality level is 73.25% with the practical category. The assessment of the effectiveness level of the e-module is 0.84 with the effective category.

Keywords: E-Module; Development; Students' Mathematical Communication

1. INTRODUCTION

Mathematics is a very important subject. This is evidenced by the hours of study at school which get more study hours than other subjects. According to James quoted by Suherman (2003: 16) mathematics is a science that discusses logic related to form, structure and magnitude, as well as concepts integrated in three elements, namely algebra, analysis and geometry. The application of mathematics has quite a lot of coverage, the material can also be said to be complicated and difficult to understand, but it needs to be given to students starting from the elementary school level which aims to provide provision for logical, analytical, systematic, critical and creative thinking skills.

The definition of experts in Prastowo (2015: 16) also says teaching material is a set of materials that are structured, both in written and oral form, so as to create conditions or situations that require students to learn. Meanwhile, according to Lestari (2013: 1) teaching materials are a group of learning tools that contain learning materials, learning methods and ways to evaluate, systematically and interestingly designed to achieve the expected learning objectives and in accordance with basic competencies and achievement indicators. So, that students are not bored when studying a conventional module in the form of a book, a modification is made to electronic media, so it is commonly called an electronic module (e-module). E-modules can be used as an independent learning method that can help students to improve their cognitive knowledge and understanding. It allows students to no longer rely on conventional sources of information. In addition, since it can be used anywhere and anytime, e-modules are easier to carry around.

This is due to the fact that e-modules are a combination of computer and print media that can be accessed by students wherever they are (Rokhmania & Kustijono, 2017). E-modules can be used as an independent learning process that can help students learn systematically, interestingly, and interactively. The teaching and learning process is also not limited to an information source, this module can help students understand concepts better than the material taught by relevant teachers. Epistemologically, the language term communication comes from the Latin word "communicatus", which centres on the word "communis", meaning "to share" or "to belong together", an endeavour that has the same meaning (Ginintasari,

2012). "Communication is the essence of teaching, learning, and one of the accesses in mathematics," says Lindquist (Iskandar, 2012:154). In addition, mathematical problems are related to everyday life, so mathematics can be used to solve various problems faced every day.

Through communication, mathematical concepts can be used from various points of view, students' ways of thinking can be sharpened, their growth in understanding can be measured, their thinking can be organised and consolidated, their mathematical knowledge and problem development can be improved, and mathematical communication can be formed according to the level or level of education, so that the level of mathematical communication skills can vary (Yeni Yuniarti, 2014). The problem that occurs in schools is the use of monotonous teaching materials and media, focusing on the teacher with the lecture method and using textbooks and student worksheets (LKS). Based on the results of temporary observations, the learning atmosphere in the classroom will be more fun and not boring so that students can be motivated and enthusiastic about carrying out mathematics learning if they do not use the lecture method or monotonous media. This makes me interested in conducting research related to teaching materials that are interesting, creative, innovative and apply technology systems to improve students' mathematical communication skills.

In other words, if students cannot communicate well about mathematical problems, they will face problems or cannot solve them well. In addition to being a means to solve, explore, and explore mathematics, mathematical communication also serves as a platform to participate in social activities, such as sharing opinions and discoveries, assessing and sharpening ideas to convince others, and sharing thoughts and discoveries (Baroody 1993, Greenes and Schulman, 1996, Kusumah, 2008 in Heris, et al, 2017). The indicators used in this study are; a) Expressing everyday events into mathematical language or symbols and solving them; b) Connecting real objects, images, and diagrams into mathematical ideas; c) Explaining mathematical ideas, situations and relationships with real objects, images, graphs, and algebra (Fitri, M.F., 2016).

2. RESEARCH METHOD

This study uses research and development (Research & Development) is a research method used to produce certain products and test the effectiveness of these products. This design is used in order to develop a product of learning. According to Trianto (Cahyaningtyas, 2018) the 4D model consists of four stages, the following is a description of the 4 stages: **1) Define**: to establish and define learning needs, the defining stage begins by making initial observations about school conditions. **2) Design**: the purpose of the design stage is to design learning tools that are in accordance with the results of the specification of learning objectives at the definition stage. **3) Develop**: to produce development products, the development stage is carried out through the following steps: a. Expert assessment (practitioner or expert validation), b. Revision I, c. Development testing which is divided into limited and operational field tests. **4) Disseminate**: the dissemination process is the final stage of development. The purpose of this stage is to disseminate the research products that have been produced. The subjects of this study were seventh grade students at MTs. Amin Darussalam. Consists of one class selected randomly (random sampling), namely class VII as many as 6 students made into a limited field test or small test group consisting of 20 students and an operational field test or large test for all students at different times. Based on the description above, then (Sugiyono, 2012: 407) The research design used in this study is the 4D model development research design (4D Models) according to Thiagarajani.

This design was chosen because the researcher assumed that the subjects were not randomly grouped, but the researcher accepted the condition of the subject as it was. In this study there was also a pre-test and post-test. The data used are quantitative and qualitative data. This data is used to describe the validation results of media experts, material experts and linguists to measure the average value of students' mathematical communication skills. The instruments used in this research are in the form of tests and non-tests. Test instruments in the form of mathematical communication skills questions in the form of descriptions in accordance with the indicators of mathematical communication skills. While non-test instruments in the form of interviews and teacher and student response questionnaires with a scale of mathematical communication skills of students using e-modules. Data analysis techniques by conducting validity tests with the data obtained were analysed descriptively. Researchers revised learning devices based on notes from validators. The formula used in the validity test is:

$$V = \frac{Va_1 + Va_2 + Va_3}{3} = \cdots \times 100\%$$

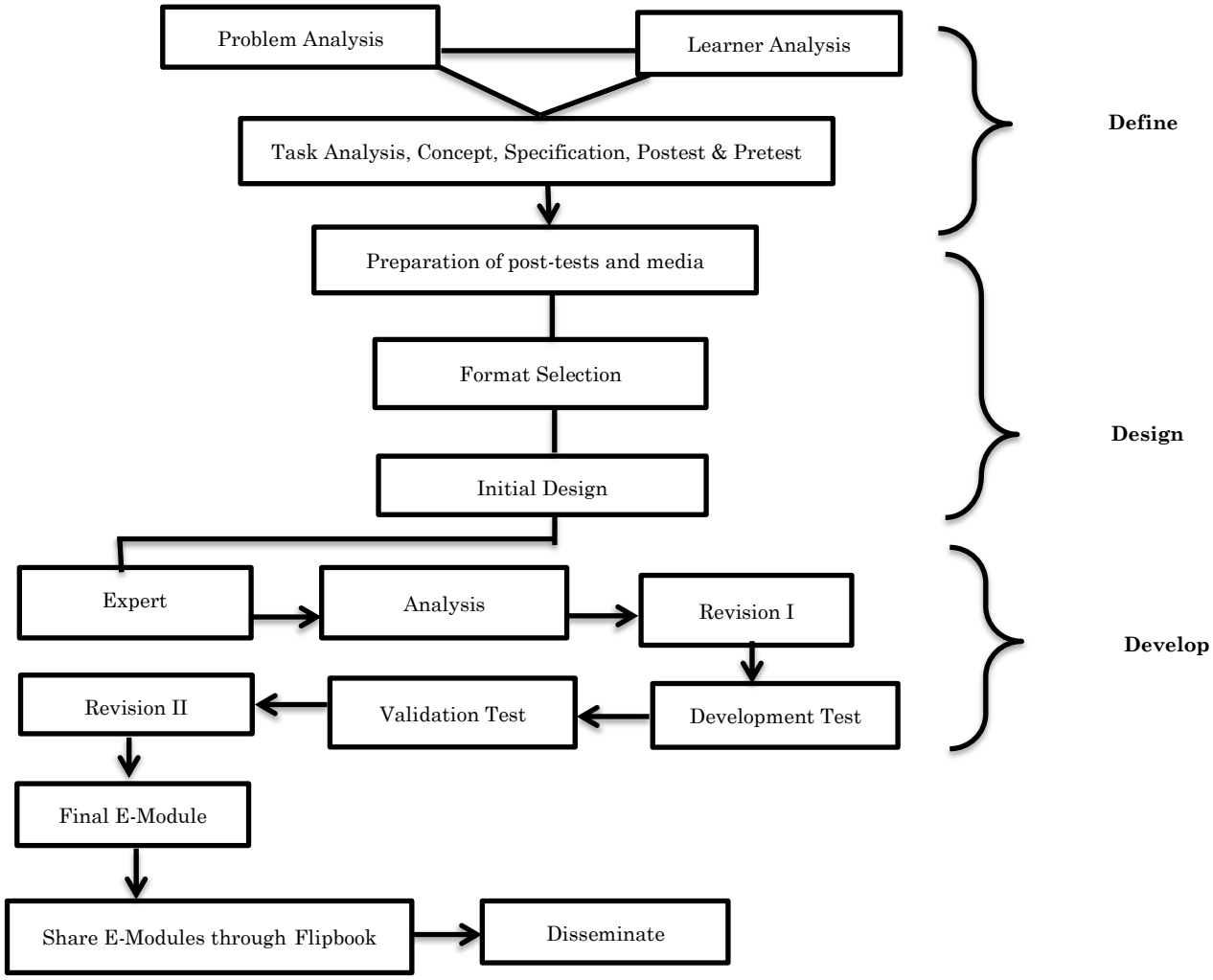

Figure 1. 4D Model Development Procedure

(Source: Adapted from Thiagarajan 1974: 6-9)

Table 1. Criteria for Completion of Validity Level

No.	Validity Criteria	Validity Level
1.	85,01% – 100% (A)	Very valid, can be used without revision
2.	70,01% – 85% (B)	Fairly valid, can be used but needs minor revisions
3.	50,01% – 70% (C)	Less valid, recommended not to be used because it needs major revisions
4.	01,00% – 50% (D)	Invalid, should not be used

The practicality test using the data collected from this study is the teacher's response to the e-module developed by the researcher, the students' response to the e-module developed by the researcher, and the learning implementation questionnaire using the equation:

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

Table 2. Criteria for Completing Practicality Analysis

Score Acquisition	Criteria
0% – 39%	Not practical
40% – 54%	Less practical
55% – 69%	Practical enough
70% – 84%	Practical
85% – 100%	Very practical

The effectiveness of the developed mathematics e-module was analysed using Hake's theory of normalised gain. According to Hake the gain value is formulated:

$$g = \frac{Score\ Posttest - Score\ Pretest}{Score\ Maximal - Score\ Pretest} x\ 100\%$$

Table 3. Gain score criteria (Hake, 1998)

Gain Value	Criteria
$g \geq 0{,}7$	High (Highly Effective)
$0{,}3 < g < 0{,}7$	Medium (Effective)
$g < 0{,}3$	Low (Less Effective)

3. RESULTS AND DISCUSSION

1. E-Module Design

E-Modules are made based on the analysis at the initial stage, planned in the form of applications made using Adobe Animate from start to finish. The initial draft of teaching materials contains Set material consisting of 5 sub, namely the definition of sets, universe sets, part sets, empty sets and Venn diagrams. The following is an overview of the initial draft of the e-module.

a) Android Type : Min. Android KitKat 4.0

b) Typeface : Poppins Family

c) Format : APK (Application for Android)

d) Subject matter : Sets

e) The E-Module was developed with the 4 phases of the CORE learning model that can develop students' cognitive aspects, namely students' mathematical communication skills. The initial draft of the E-Module was developed in accordance with the learning stages of the CORE learning model and adjusted to the indicators of mathematical communication skills. The 4 phases of CORE in the E-Module are:

1) **Connecting phase**, in this phase students are given questions on student activities to connect their daily experiences with new knowledge or sub-chapter material in the set to be studied.
2) **Organising phase**, in the next phase students are asked to form study groups by being given questions that provoke students to be able to organise all information in the form of mathematical language to better understand the material being studied.
3) **Reflecting phase**, in this phase students will be presented with social artimatics material related to understanding and formulas to review and explore the material and explore additional information.
4) **Extending phase**, in this last phase students will develop their knowledge by working on questions in the formative test in each sub-chapter.

The final product of the e-module for learning mathematics is shown below:

1) Results of E-Module Validity

The results of the validity of the e-module are obtained through validation from material experts, media experts and linguists. Assessment from experts or validity aims to determine the quality of a learning media. The assessment was carried out by 6 experts, consisting of three lecturers majoring in Mathematics Education at the State Islamic University of North Sumatra and 3 teachers of mathematics and Indonesian subjects at Madrasah Tsanawiyah Amin Darussalam. The aspects assessed by material validators are content feasibility, presentation feasibility and language feasibility. The assessment was carried out using a rating scale of one to four on each question. The recapitulation results of the material expert validation were assessed from 3 aspects, namely content feasibility, presentation feasibility and language feasibility with a total average score of 3.3. The recapitulation results of media expert validation were assessed from 2 aspects, namely the appearance of content and characteristics with an average score of 2.6. The results of the recapitulation of linguist validation were assessed from 2 aspects, namely the rules of Indonesian Language and Communicative and Interactive with an average score of 2.2. This is in line with the results of research (Sa'diyah, 2021) showing that digital-based E-modules obtained an average value of 0.91 from the validation results indicating that digital-based E-modules are included in the valid and theoretically feasible category. This is also in line with what Yuliastusi & Soebagyo (2021) stated that teaching materials are said to be valid, if the expert assessment ensures that the teaching materials developed are based on strong theories and there is a connection between the components of the teaching materials developed.

2) E-Module Practicality Results

The purpose of the large-scale trial is to determine the results of students' responses and the practicality of using e-modules in learning. The teacher's response questionnaire to the e-module is divided into 3 aspects of observation, namely the student e-module, the teacher's instruction module and teaching materials in general, which are reviewed from the aspects of practicality and effectiveness. The researcher stated that the E-Module for learning mathematics can be said to be practical because seeing the responses of students and teachers is sufficient to understand. The practicality of a product is very supportive in creating conducive learning and achieving the expected results. Based on the results of the assessment that has been carried out by teachers and students in the development trial, researchers obtained an average total score of (73.25%) for the results of the student response questionnaire and (76.08%) for the results of the teacher response questionnaire. This can be interpreted that the e-module of mathematics learning is in the "practical" category to be used by students as learning media. This is in line with Fatmawati's research (2016: 95) in Canva Apps-based E-Module Development which suggests that a product is said to be practical if the use of the product is easy and can be implemented properly. As stated by Putra & Syarifuddin (2019) that teaching materials are said to be practical if the learning process can provide convenience for teachers and students.

3) E-Module Effectiveness Results

The effectiveness of the use of e-modules can be seen from the results of pretest and posttest scores based on students' mathematical communication indicators consisting of 3 items. Item 1 with indicators of expressing everyday events into mathematical language or symbols and solving them. Item 2 with indicators of connecting real objects, images and diagrams into mathematical ideas. Item 3 with indicators of explaining mathematical ideas, situations and relationships with real objects, images, graphs and algebra. Based on the results of the recapitulation of the effectiveness of the e-module with the average score of the pretest score is 35.25. While the average posttest score is 84.7 with the difference between the two scores being 49.45. So with this the results of the effectiveness of the e-module are worth 0.84 with a very effective category. This research is in line with research from Ahmad Fathoni Rizal, et al (2021) the development of ethnomathematics-based e-modules to foster mathematical communication skills and student interest in learning shows that the existence of e-modules can be declared valid practical and effective by evaluating mathematics-based e-modules that contain practice questions on mathematical communication skills. e-modules are very helpful for students in learning material because e-modules have features that can attract students to learn mathematics. As well as in the research of Danuri, et al (2023) the development of a flipclassroom model mathematics e-module on learning to improve mathematical communication skills. This study concluded that teaching materials in the form of mathematics E-modules are effective for use in the classroom. Therefore, this study demonstrates the ability of mathematics teaching materials in the form of emotions to improve students' mathematical communication this is also shown in the significant difference between pretest and posttest scores. The improvement of learning outcomes was calculated using the formula (N-gain/Normalised-gain). Gain is the difference between pretest and posttest scores (Cahyaningtyas, 2018). The following is the interpretation of the data on the pretest and posttest scores of students in the development trial that has been carried out:

Table 4. Interpretation of Pretest and Posttest Scores

Value Interval	Frequency		Category
	Pretest	Posttest	
0,00 – 0,30	13	0	Low (Less Effective)
0,30 – 0,70	7	4	Medium (Effective)
0,70 – 100	0	16	High (Highly Effective)

The pretest and posttest scores of students will be said to be complete if the results obtained meet the maximum completeness standard (KKM) which is ≥ 70. In the pretest results, it can be seen that all students did not complete the test. Whereas in the posttest results there were 4 students who did not complete and 16 others completed. The pretest and posttest score data were then analysed using the Normality gain test (N-gain score). The following is the acquisition of the N-gain score from the large-scale trial. It was identified that there was an increase in mathematical communication skills of 3 out of 20 students (11.77) in the "high" category, 12 out of 20 students (37.06) in the "medium" category and 5 out of 20 students (6.49) in the "low" category. Overall, the average N-Gain score was (0.84) and included in the "high and very effective" category, this means that the mathematics learning e-module to improve students' mathematical communication skills is effective.

4. CONCLUSION

The mathematics learning e-module has been successfully developed and found to be an appropriate learning media in the seventh-grades mathematics subject of Madrasah Tsanawiyah Amin Darussalam. The mathematics learning e-module was developed with several stages, including: determining the needs of the material contained in the e-module, designing the e-module and developing the module that has been prepared with the consideration of experts. These stages refer to the 4D development model, namely define, design, develop, and disseminate. This is based on the results of the assessment of the feasibility level of e-modules obtaining a feasibility level of 81.83%, with the category very feasible to use. The results of the assessment of the validity level of the e-module obtained a validity level of 81.47% with a fairly valid category, can be used but needs minor revisions. The results of the practicality level assessment conducted through limited and operational trials on students obtained a practicality level of 73.25% with a practical category. The results of the assessment of the effectiveness level of e-modules carried out by students by doing pretests and posttests tailored to students' mathematical communication indicators obtained an effectiveness level of 0.84 in the effective category.

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