Jurnal Pendidikan Matematika
ISSN-p 2086-8235 | ISSN-e 2597-3592
Vol. 16, No. 1, January 2025, Pages: 44-51, Doi: http://dx.doi.org/10.36709/jpm.v16i1.201
Available Online at https://jpm.uho.ac.id/

Development of E-Modules Assisted by Geogebra Software to Improve High School Students' Mathematical Problem Solving Abilities

Betrik Debora Fiera Sihombing [1)] *, Glory Indira D. Purba [1)]
[1]Department of Mathematics Education, Universitas Negeri Medan. Medan, Indonesia

Abstract: This research is motivated by students' low mathematical problem solving abilities in mathematics learning process, which includes four indicators, namely understanding the problem, making a plan, implementation the plan and looking back. The aim of this research is to develop an e-module assisted by geogebra software to improve students' mathematical problem solving abilities. The method used is development research with ADDIE model, analysis, design, development, implementation and evaluation. Data collection techniques used are observation, interviews, questionnaires and tests. The research results show that e-module assisted by geogebra software developed on quadratic function material is suitable use for teaching material that can improve students' mathematical problem solving abilities. This is based on media and material expert validation results of 93% (very valid category), teacher practicality results of 88% and student practicality results of 94% (very practical category), student classical learning completion results of 97% (very effective category) which can achieving complete achievement of learning objectives, the results of student effectiveness questionnaire response to the e-module of 98% (very effective category). It can be concluded that e-module assisted by geogebra software developed on quadratic function material meets the criteria for validity, practicality and effectiveness, so it can be used to improve students' mathematical problem solving abilities.

Keywords: development research; e-module assisted by geogebra software; solving ability problem.

INTRODUCTION

Mathematics is a universal science that plays an important role in various scientific disciplines (Maulyda, 2020). As a universal science, mathematics is one of the subjects that must be studied at every level of education in school. This is because mathematics is able to form logical and rational thought patterns. Beside that, mathematics can also improve the ability to understand and convey information, reason and produce new knowledge (Lusianisita, 2020).

According to NCTM, there are 5 main standards in mathematics learning that need to be improved, one of which is problem solving abilities (Maulyda, 2020). Problem solving is a student's ability to think in solving problems using appropriate methods or strategies, according to the goals to be achieved (Roebyanto & Harmini, 2017). Problem solving abilities play an important role in learning mathematics (Mawardi et al., 2022). This is because problem solving abilities can improve students' abilities in integrating concepts, theorems and increase students' imagination and self-confidence in the mathematics learning process (Ismail, Sinaga, & Sriadhi, 2022). Thus, problem solving abilities must be possessed and improved by every student. In reality, many students are found with low levels of problem solving abilities. This low ability is caused by students not being able to understand the information contained in the questions well (Anggreni et al., 2023). Apart from that, students have not been able to design and implement problem solutions correctly, and have not re-examined the problems they have solved.

The statement above is in accordance with the results of an interview conducted with a mathematics teacher at school, which stated that students' problem solving abilities in the mathematics learning process were relatively low. This is because the mathematics learning process tends to invite students to directly design and implement problem-solving plans,

* Correspondence to Author. E-mail: betrikshbg@mhs.unimed.ac.id Publisher: Department Mathematics Education, Universitas Halu Oleo

rather than understanding the problem first (Maryam et al., 2019). This statement is in accordance with the results of observations through diagnostic tests of students' mathematical problem solving abilities. Based on the results of the diagnostic test, it is known that 26% of students got a score above the KKM and 74% of students got a score below the KKM, with the KKM score limit being 70. In addition, it is known that the lowest problem solving ability is in the "understanding the problem" indicator at 17% and the highest problem solving ability is at the "designing problems" indicator at 29%. According to the analysis of classical learning completeness, it was concluded that students' mathematical problem solving abilities were relatively low, because less than 80% of students did not reach the standard KKM score.

In the interview activity, the teacher also stated that the teaching materials used were still conventional, namely printed books. The teaching materials used are considered not capable enough to improve students' problem solving abilities, because they have not been able to encourage students to understand the information and problems in the questions well, so it is necessary to develop teaching materials that can support the learning process and improve students' mathematical problem solving abilities. This statement is supported by the results of observation questionnaires on the use of teaching materials in mathematics learning. Where 88.2% of students stated that they needed teaching materials that could improve their mathematical problem solving abilities while studying mathematics. Not only that, 97.1% of students stated that they needed technology-based teaching materials

Based on these problems, researchers took the initiative to conduct research into the development of E-module teaching materials assisted by Geogebra Software. E-module is an electronic module used to improve students' ability to understand concepts (Putri et al., 2023). Meanwhile, Geogebra Software is a tool used to construct student understanding as well as a demonstration and visualization tool (Priatna & Arsani, 2019). The use of this e-module aims to increase students' understanding of learning material (Santia & Nurmayani, 2023). Not only that, the use of this e-module aims to improve students' mathematical problem solving abilities through understanding concepts with Geogebra software visualization tools (Jehan et al., 2021). In its development, what differentiates the development of this e-module from other e-modules is that the Geogebra software and elements used together are integrated in the e-module, as a tool to help solve problems that hone students' mathematical problem solving abilities. The use of e-modules is considered quite effective, where in previous research there was an increase in mathematical problem solving abilities by 48% (Pramana et al., 2020). Not only that, the use of e-modules can also increase student learning outcomes by 30% (Aspriyani & Suzana, 2020). Thus, it can be concluded that the e-module assisted by Geogebra software is a tool that can be used to improve students' mathematical problem solving abilities through understanding concepts and can contribute to improving student learning outcomes.

METHODS

The research method used is development research with the ADDIE model, analysis, design, development, implementation, evaluation (Okapatrioka, 2023). This research was conducted at Sultan Agung Private High School. The research instruments used include testing the validity of media and material experts, the practicality of teachers and students, as well as effectiveness based on learning test results and student effectiveness responses. The data collection techniques used were observation, interviews, questionnaires and tests (Magdalena et al., 2020). The data analysis technique used is quantitative and qualitative data analysis. Quantitative data analysis includes: (1) validity analysis, (2) practicality analysis, (3) effectiveness analysis which includes individual learning completeness, classical learning completeness, and achievement of learning objectives. Meanwhile, qualitative data analysis

includes input from validators, teachers and students as well as elaboration of descriptions from pictures, tables and graphs contained in the research.

RESULTS AND DISCUSSION

The research carried out is development research, with the resulting product being an e-module assisted by Geogebra software which can improve students' mathematical problem solving abilities. The aim of this research is to describe the validity, practicality and effectiveness of using e-modules assisted by Geogebra software (Purnamasari, 2020). In achieving this goal, previous researchers carried out development using the ADDIE (Analysis, Design, Development, Implementation and Evaluation) model, and obtained development results in the form of an E-module assisted by Geogebra Software.

At the analysis stage, researchers analyzed students' needs, curriculum and initial mathematical problem solving abilities (Wasi, 2022). Based on the results of the needs analysis, the teacher stated that learning requires teaching materials that are active, interesting and can improve students' mathematical problem solving abilities. This is in accordance with the results of needs observations carried out on students, where 88.2% of students stated that they needed teaching materials that could help answer problems and improve mathematical problem solving abilities, and 97.1% of students stated that they needed technology-based teaching materials that could increase learning motivation (Hamidah et al., 2020). Based on the results of the analysis of the school curriculum, the Independent Curriculum is used, but the use of technology-based teaching materials has not been implemented well. Meanwhile, the results of the analysis of students' initial mathematical problem solving abilities (diagnostic tests), it is known that only 24% of students scored above the KKM and 74% of students scored below the KKM.

At the design stage, the researcher selects the media to be used, designs the product design and prepares research instruments consisting of validity, practicality and effectiveness instruments. Next, in the development stage, researchers developed an e-module by integrating Geogebra software and various elements used into the e-module, into an e-module that can improve students' mathematical problem solving abilities. At this stage, researchers also validated aspects of the e-module with several media and materials experts who are competent in their fields. Validity is the main requirement in developing a product before it is tested on students at the implementation stage. Below are presented the results of media and material expert validation.

Table 1. Media and Material Expert Validation Results

Aspects	Validation Results	Category
Design	93%	Very Valid
Content	93%	Very Valid
Learning format	98%	Very Valid
Pretest question	93%	Very Valid
Postest question	97%	Very Valid

Based on table 1, it was found that the design aspects which include design selection, user friendliness, usability and graphics received a score of 93% in the very valid category. The content aspect which includes material content, use of language and presentation method received a score of 93% in the very valid category. Aspects of learning format which include teaching modules, learning tool formats, material organization, activity design, selection of learning media and resources and use of language received a score of 94% with a very valid

category. The pretest question selection aspect received a score of 93%, while the posttest question selection aspect obtained a score of 97%, where the pretest and posttest were in the very valid category. Based on the results of the validity analysis, the average validation results are in the value range 81% < P < 100%, with a very valid category.

At the implementation stage, researchers assessed the practicality of using e-modules for mathematics teachers. Practicality testing is a test carried out to assess the practicality and ease of use of products developed based on practical aspects. Below are presented the results of the practicality assessment.

Table 2. Results of E-Module Practicality by Teachers

Aspects	Practicality Results	Category
Material Suitability	88%	Very practical
Convenience	86%	Very practical
Time Efficiency	100%	Very practical
Benefit	100%	Very practical

Based on table 2, it was found that the suitability aspect of the material received a score of 88% with the very practical category, the convenience aspect of 86% with the very practical category, the time efficiency aspect and the benefits aspect of 100%, both of which were in the very practical category. Based on the results of the practicality analysis, the average practicality results are in the value range 81% < P < 100%, in the very practical category. So it is concluded that the E-module assisted by Geogebra Software meets the practicality criteria.

At the implementation stage, researchers also assessed the effectiveness of using e-modules in the learning process. Effectiveness testing is a test carried out to assess the success of the e-module being developed. E-modules are said to be effective if they meet the learning completeness values that have been determined. The manifestation of effectiveness in this research is the level of learning completeness, achievement of learning objectives and student effectiveness response questionnaires. Based on the posttest results, it was found that 33 out of 34 students or around 97% of students completed individually with an average test score of 78.00. This figure shows that students also completed classically, where more than 80% of students were able to complete individually. Through this, it can be concluded that e-modules assisted by Geogebra software are effective in improving student learning outcomes.

Based on the results of the analysis of the achievement of learning objectives, it was found that 26 out of 34 students or around 76% were able to achieve at least 65% of the learning objectives. This is proven by the results of the students' KPMM test, where 26 out of 34 students were able to exceed the minimum achievement of learning objectives, namely 75% and were in the range 75% < T < 100%. Thus, it is concluded that for students, e-modules assisted by Geogebra software are effective in improving students' abilities in achieving learning goals. Meanwhile, the results of the analysis of student effectiveness responses refer to the minimum positive response of students to the use of e-modules, which is 80% of the objects studied. Based on the analysis results, it was found that 100% of students stated that they were happy and liked learning using e-modules, 97.06% of students stated that e-modules were interesting, 100% of students stated that e-modules were new teaching materials, and 94.11% of students stated that they were motivated and would actively study using E-modules assisted by Geogebra Software.

The increase in problem solving abilities can be seen through comparing the pretest and posttest results before and after using the e-module assisted by Geogebra software on

quadratic function material. The test results of students' mathematical problem solving abilities are presented in the following table.

Table 3. Results of Students' Mathematical Problem Solving Ability Test (KPMM)

Information	Pretest	Posttest	Enhancement (%)
Highest score	70	85	15
Lowest score	14	65	51
Average	42	75	33

Based on table 3, the average student score at the pretest was 42%, while the average student score at the posttest was 75%. The average increase in pretest to posttest scores was 33%. This shows that there was an increase in students' problem solving abilities after using the e-module assisted by Geogebra software. The increase in KPMM can be seen through the increase in students' KPMM in each indicator. The results of increasing student KPMM in each indicator are presented in the following diagram.

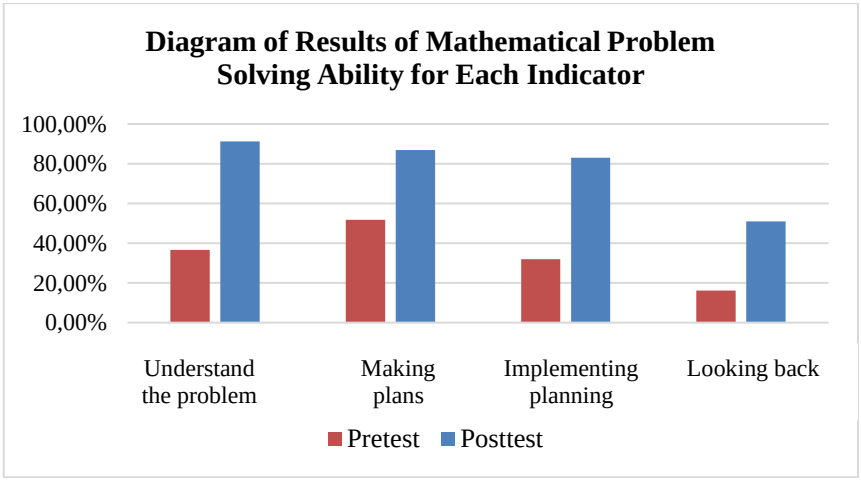

Figure 1. KPMM diagram for each indicator

Based on Figure 1, it can be seen that each KPMM indicator has increased from pretest to posttest. The indicator of understanding the problem increased by 54.56%, the indicator of planning increased by 35.15%, the indicator of carrying out planning increased by 51.18% and the indicator of looking back increased by 34.7%. The increase in KPMM can also be seen through the results of the N-gain analysis, as presented in the following diagram.dari pretest ke posttest.

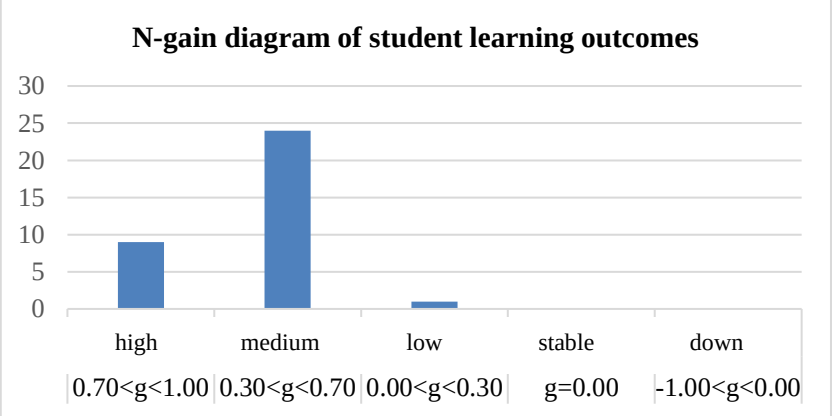

Figure 2. N-gain diagram of student learning outcomes

Based on Figure 2, it can be seen that 9 students obtained an N-gain score in the range $0.70<g<1.00$ or experienced an increase in learning outcomes in the high category, 24 students obtained an N-gain score in the range $0.3<g<7.0$ or experienced an increase in learning outcomes in the medium category, and 1 student obtained an N-gain score in the range $0.00<g<0.30$ or experienced an increase in learning outcomes in the low category.

At the evaluation stage, researchers evaluated the e-modules that had been developed and used in the classroom learning process. At this stage, researchers analyze student improvement before and after using the e-module, as well as carry out revisions or input from teachers and students that do not conflict with the validator entry or the rules for making e-modules.

Based on the results of the analysis of individual and classical student learning completion, achievement of learning objectives, student effectiveness questionnaire responses and improvement in KPMM test results, it can be concluded that E-modules assisted by Geogebra Software can improve students' mathematical problem solving abilities and can attract students' interest in learning activities, so that students will have good mathematical problem solving abilities and will be motivated in learning activities. Thus, it can be concluded overall that the Geogebra Software-assisted E-module developed by researchers on quadratic function material meets the development criteria, which include validity, practicality and effectiveness.

CONCLUSION

The e-module assisted by the Geogebra software developed is said to be of high quality, because it meets 3 development criteria, namely valid, practical and effective. The validity of the e-module assisted by Geogebra software is based on the results of media and material validation by experts, where the design and content aspects each received a score of 93%, the learning format received a score of 98%, the pretest questions received a score of 93%, and the posttest question aspects received a score of 97% with the overall being in the very valid category. Meanwhile, the practicality of the e-module assisted by Geogebra software is based on the teacher's practicality assessment, which received an average score of 88% and was in the practical category. The effectiveness of e-modules assisted by Geogebra software is based on the results of students' classical learning completion through the KPMM test, achievement of learning objectives and students' effective responses. The E-module assisted by GeoGebra software that was developed was able to increase students' KPMM by 97%, with an average test score of 78. The E-module assisted by GeoGebra software was also able to help more than 65% of students achieve at least 75% of the learning objectives. In accordance with students' effective responses, e-modules assisted by Geogebra software can help students solve problems and increase students' KPMM. Thus, it can be concluded that e-modules assisted by Geogebra software can improve students' mathematical problem solving abilities. The advice given by the author is that it is hoped that teachers can use e-modules assisted by Geogebra software optimally in order to achieve maximum learning objectives and increase students' KPMM.

REFERENCES

Anggraeni, V., Yuspriyati, D.N. & Zanthy, L.S. (2023). Kemampuan Pemecahan Masalah Matematis Siswa dalam Menyelesaikan Soal Cerita pada Materi Sistem Persamaan Linear Dua Variabel. *Jurnal Pembelajaran Matematika Inovatif*, *6*(2), 591-598.

Aspriyani, R & Suzana, A. (2020). Pengembangan E-Modul Interaktif Materi Persamaan Lingkaran Berbasis Realistic Mathematics Education Berbantuan Geogebra. *Jurnal Program Studi Pendidikan Matematika, 9*(4), 1099-1111.

Okapatrioka. (2023:88). Research and Development (R&D) Penelitian Yang Inovatif Dalam Pendidikan. *Jurnal Pendidikan, Bahasa dan Budaya. 1*(1), 86-100.

Hamidah, N., Afidah, I.N., Setyowati., L.W., Sutini & Junaedi. (2020). Pengaruh Media Pembelajaran *Geogebra* pada Materi Fungsi Kuadrat terhadap Motivasi dan Hasil Belajar Peserta Didik. *Journal of Education and Learning Mathematics Research, 1*(1), 15-24.

Ismail., Sinaga, B. & Sriadhi. (2022). Analisis Kemampuan Pemecahan Masalah Matematis Siswa Melalui Penerapan E-Modul *Flipbook* berbasis Pendekatan Saintifik. *Jurnal Pendidikan Matematika, 6*(3), 3307-3315.

Jehan, A., Octaria. D., Syahbana. A. (2021). Pengembangan E-Modul pada Materi Lingkaran Berbasis CTL bantuan Geogebra. *Jurnal Geogebra Indonesia. 1*(2), 60-67.

Lusianisita, R. & Rahaju, E.B. (2020). Proses Berfikir Siswa SMA dalam Menyelesaikan Soal Matematika Ditinjau dari Adversity Quotient. *Jurnal Penelitian Pendidikan Matematika dan Sains, 4*(2), 93-102.

Magdalena, I., Prabandani, R.O., Rini, E.S., Fitriani, M.A. Putri, A.A. (2020). Analisis Pengembangan Bahan Ajar. *Jurnal Pendidikan dan Ilmu Sosial, 2*(2), 170-187.

Maulyda, M.A. (2020). *Paradigma Pembelajaran Matematika Berbasis NCTM*. Malang: CV IRDH.

Maryam, Masykur. R. & Andriani, S. (2019). Pengembangan E-Modul Matematika Berbasis Open-Ended pada Materi Sistem Persamaan Linear Dua Variabel Kelas VIII. *AKSIOMA:Jurnal Matematika dan Pendidikan Matematika,10*(1), 1-12

Mawardi, K., Arjudin., Turmuzi, M. & Azmi, S. (2022). Analisis Kemampuan Pemecahan Masalah Matematika pada Siswa SMP dalam Menyelesaikan Soal Cerita Ditinjau dari Tahapan Polya. *Griya Journal of Mathematics Education and Application*, *2*(4), 1031-1048.

Pramana, B.W.A., Susanto., Suwito, A., Lestari, N.D.S. & Murtikusuma, R.P. (2022). Pengembangan E-Modul Berbantuan Geogebra pada Materi Transformasi Geometri SMA. *Jurnal Pendidikan Matematika, 5*(2), 1-14.

Priatna, N & Arsani, M. (2019). *Media Pembelajaran Matematika Dengan Geogebra*. Bandung: PT. Remaja Rosdakarya Offset.

Purnamasari, N. L. (2020). Pengembangan Bahan Ajar E-Modul pada Pelajaran TIK Kelas VII SMPN 1 Kauman. *Jurnal Inovasi Pendidikan dan Teknologi Informasi (JIPTI), 1*(2), 70-77. https://doi.org/10.52060/pti.v1i2.404

Putri, L.S., Setiani, Y. & Santosa, C.A.H.F. (2023). E-Modul Matematika Berbasis Problem Based Learning Bermuatan Budaya Lokal untuk Meningkatkan Kemampuan Pemecahan Masalah. *Jurnal Educatio, 9*(2), 880-890.

Roebyanto, G & Harmini, R. (2017). *Pemecahan Masalah Matematika*. Bandung: PT. Remaja Rosdakarya.

Rusdi, M. (2018). *Penelitian Desain dan Pengembangan Kependidikan*. Depok: PT. Raja Grafindo.

Rizqiyani, Y., Anriani, N. & Pamungkas, A.S. (2022). Pengembangan E-Modul Berbantu Kodular pada *Smarthphone* untuk Meningkatkan Kemampuan Literasi Matematis Siswa SMP. *Jurnal Cendekia : Jurnal Pendidikan Matematika, 6*(1), 954-969. https://doi.org/10.31004/cendekia.v6i1.1172

Wasi, K. (2022). Pengembangan Media Pembelajaran Matematika Interaktif Berbantuan Software Geogebra Pada Materi Transformasi Geometri Kelas XI SMA. *Humantech : Jurnal Ilmiah Multidisiplin Indonesia*, *1*(12), 1897–1906. https://doi.org/10.32670/ht.v1i12.2512