DOI: https://doi.org/10.33487/edumaspul.v9i1

EDUMASPUL
JURNAL PENDIDIKAN

Vol 09 No. 02 (2025) page 74-84

p-ISSN 2548-8201 | e-ISSN 236-0469
https://ummaspul.e-journal.id/maspuljr/

Development of a PMRI-Based Module Assisted by GeoGebra for Teaching Geometric Transformations at SMA Negeri 10 Gowa

Ainul Yaqin, Sri Sulasteri, Mardhiah

[1234] Universitas Islam Negeri Makassar
Email : **ainulyaqinb026@gmail.com**

Abstrak

Penelitian ini bertujuan untuk mengetahui proses Pengembangan Modul Berbasis PMRI Berbantuan Aplikasi Geogebra pada Materi Transformasi Geometri valid, praktis dan efektif di kelas XI_B SMA Negeri 10 Gowa. Jenis penelitian yang digunakan adalah *Research and Development* (Penelitian dan Pengembangan) dengan mengacu pada model pengembangan ADDIE yang terdiri dari 5 tahap yaitu Tahap Analisis (*Analysis)*, Tahap Perancangan (*Design)*, Tahap Pengembangan (*Development)*, Tahap Penerapan (*Implementation), dan* Tahap Evaluasi *(Evaluation)*. Produk yang dikembangkan berupa Modul Berbasis PMRI Berbantuan Aplikasi Geogebra pada Materi Transformasi Geometri. Subjek uji coba dalam penelitian ini adalah peserta didik kelas XI_B di SMA Negeri 10 Gowa dengan jumlah 21 peserta didik. Instrumen yang digunakan dalam penelitian ini adalah lembar validasi ahli, angket respons peserta didik, angket respons guru, lembar observasi keterlaksanaan pembelajaran, lembar observasi aktivitas peserta didik dan tes hasil belajar. Berdasarkan hasil ujicoba terbatas yang dilakukan, diperoleh bahwa (1) Hasil validasi bahan ajar dan intrumen adalah 4,3 pada kategori sangat valid karena setiap aspek untuk setiap jenis perangkat berada pada interval $4 \leq M \leq 5$, (2) Praktis karena persentase rata-rata untuk respons peserta didik adalah 90,4% berada pada kategori positif dan persentase rata-rata respons guru adalah 90% dan berada pada kategori positif. (3) Efektif karena telah memenuhi tiga kriteria yaitu rata-rata kemampuan guru dalam keterlaksanaan pembelajaran adalah 4,6 berada pada kategori sangat baik, persentase rata-rata aktivitas peserta didik adalah 76% berada pada kategori baik, dan persentase tes hasil belajar mencapai ketuntasan belajar yaitu 85,8%. Sehingga dapat disimpulkan bahwa pada tahap uji coba terbatas yang dilaksanakan, Pengembangan Modul Berbasis PMRI Berbantuan Aplikasi Geogebra pada Materi Transformasi Geometri di SMA Negeri 10 Gowa telah memenuhi kriteria kevalidan, kepraktisan, dan keefektifan.

Kata Kunci : Geogebra, Modul, Transformasi geometri

Abstract

This study aims to examine the development process of a PMRI-based module supported by the GeoGebra application for teaching geometric transformations, and to determine its validity, practicality, and effectiveness for students of class XIB at SMA Negeri 10 Gowa. The research employed a Research and Development (R&D) design, following the ADDIE development model, which consists of five phases: Analysis, Design, Development, Implementation, and Evaluation. The resulting product is a PMRI-based instructional module integrated with GeoGebra for the topic of geometric transformations.The trial subjects were 21 students from class XIB. The instruments used in this study included expert validation sheets, student response questionnaires, teacher response questionnaires, learning implementation observation sheets, student activity observation sheets, and learning outcome tests. Findings from the limited-trial phase indicated that: (1) the validation scores for both the instructional materials and research instruments reached an average of 4.3, classified as highly valid, as all evaluated components fell within the interval $4 \leq M \leq 5$; (2) the module demonstrated practicality, shown by the average student response rate of 90.4% and the teacher response rate of 90%, both categorized as positive; and (3) the module met the criteria for effectiveness, as evidenced by an average teacher performance score of 4.6 (very good), an average student activity percentage of 76% (good), and student learning outcomes achieving a mastery level of 85.8%. Based on the results of the limited trial, it can be concluded that the development of the

PMRI-Based Module supported by GeoGebra for teaching geometric transformations at SMA Negeri 10 Gowa meets the established criteria for validity, practicality, and effectiveness.
Keywords: *GeoGebra, Module, Geometry Transformation*

Introduction

Education is an essential process in human life because it serves as a foundation for developing knowledge, understanding, physical well-being, and moral character. It is through education that individuals can achieve their goals and aspirations. In the context of national development, education plays a central role in producing intellectually, emotionally, and spiritually competent generations who contribute to the progress of the nation. Education is not merely a formal process but also a lifelong effort that enables individuals to expand their potential and adapt to changing times.

Education plays a crucial role in shaping and improving the quality of a nation and its citizens. As an integral part of a society's sociocultural activities, education strengthens national identity and character, and contributes to the creation of a moral, ethical, cultured, and civilized society grounded in the principles of Pancasila, as outlined in the Long-Term National Development Plan (RPJP) (Novitasari & Wijayanti, 2019:80). These objectives are intended to cultivate an Indonesian society that is devoted to God Almighty, obedient to the law, and capable of maintaining interreligious harmony. Furthermore, education encourages intercultural interaction, the development of social capital, the application of noble cultural values, and a sense of national pride. Ultimately, education serves as a foundation for nurturing both the spiritual and moral dimensions of the nation.

National education aims to develop skills, shape individual character, and strengthen the civilization of the nation in order to enhance the intellectual life of society. Its primary goal is to support learners in realizing their full potential so they may become individuals who are faithful and devoted to God Almighty, intelligent, capable, creative, independent, and responsible democratic citizens. Education, therefore, represents an essential aspect of human life that cannot be separated from one's existence.

Education is not merely a structured and planned process guided by established methods and formal rules within a sociopolitical system. Rather, it has existed as a fundamental part of human life since the beginning of human existence. It may be understood as a consciously designed, organized, and regulated process, grounded in norms and legal frameworks agreed upon through public consensus. As an intentional activity and a purposeful process, education reflects society's growing awareness of the importance of uniting, guiding, and organizing its members.

The objectives of education must be aligned with the expectation of producing high-quality learning outcomes that meet the needs of various stakeholders. Educational management therefore plays a crucial role in ensuring that these goals are realized. The Indonesian people expect an education system that is well-organized and effectively administered, and this can only be achieved when educational managers possess strong professional competence. Among the key managers within the educational environment are teachers. Their responsibilities extend beyond classroom instruction; they also function as educational managers who are expected to design and implement appropriate management strategies. A competent educational manager is someone capable of planning and organizing future educational practices.

In every educational activity, the curriculum occupies a central position, often referred to as "the heart of education" (Beauchamp, 1975). Efforts to enhance the quality of citizens and the nation are manifested through policy formulation, planning, and program implementation. Systematic strategies continue to evolve as responses to ongoing social and national changes. These societal transformations arise from shifts in cultural, political, economic, religious, scientific, and social conditions. Such changes require a careful analysis of the knowledge, skills, values, and attitudes necessary for citizens to address emerging challenges. One of the factors motivating the

development of the 2013 Curriculum as a refinement of the School-Based Curriculum (KTSP) was the need to foster students' creativity and critical thinking through mathematics education.

Based on the observations conducted at SMA Negeri 10 Gowa through an interview with Mrs. Suharni, S.Pd, the mathematics teacher for Grade XI, it was found that the teaching of geometric transformations relied primarily on the textbook *"Perspektif Matematika Kurikulum 2013"* and a cooperative learning model. However, this approach was not sufficiently effective because students were required to solve abstract mathematical problems without the support of learning media. As a result, students' performance on the end-of-semester assessment for the 2021/2022 academic year was low, with an average score of 66.11, which falls below the school's Minimum Mastery Criterion (KKM) of 72. This is consistent with the findings of Fitri Indah Maulani, who reported that students still struggled to apply conceptual understanding when solving geometric transformation problems (Fitri & Zanthy, 2020:25). One proposed solution is the development of more engaging instructional materials or the incorporation of informal contexts into the curriculum by applying principles of Realistic Mathematics Education, in which mathematical ideas are linked to everyday situations or meaningful contexts (Ibda, 2015:29). This approach can help students better grasp abstract mathematical concepts.

To address these challenges, the researcher proposes the use of the Indonesian Realistic Mathematics Education (PMRI) approach. PMRI helps create a more engaging learning atmosphere by transforming abstract mathematics into practical, reality-based learning experiences. This approach encourages students to imagine, explore, and relate mathematical concepts to everyday contexts (Prihartini et al., 2020:206). According to Zulkadri and Putri in Riyani (2020:46), PMRI emphasizes real-world problems experienced by students and promotes process skills such as "doing mathematics," discussing, collaborating, presenting arguments, exploring concepts, and applying them to problem-solving (Rahayu & Purwoko, 2008:21). Sa'adah (2010:98) also demonstrated that PMRI-based instruction leads to improved student learning outcomes, a finding reinforced by Mustafa and Angga (2022:3), who reported that students enjoyed and actively engaged in PMRI learning, achieving an average score of 93.7 on practice tasks, which falls into the excellent category.

Based on these considerations, the researcher intends to combine PMRI principles with a learning module supported by GeoGebra to enhance students' understanding of geometric transformations. Therefore, the researcher proposes a study entitled: **"**Development of a PMRI-Based Module Assisted by GeoGebra for the Topic of Geometric Transformations for Grade XI Students at SMA Negeri 10 Gowa."

Method

This study employs a Research and Development (R&D) approach, adopting the ADDIE development model, which consists of five sequential phases: Analysis, Design, Development, Implementation, and Evaluation. The product developed in this research is a PMRI-based learning module supported by the GeoGebra application for teaching geometric transformations.

The subjects consisted of 21 students from Class XIB at SMA Negeri 10 Gowa. The instruments used to collect data include expert validation sheets, student response questionnaires, teacher response questionnaires, learning implementation observation sheets, student activity observation sheets, and a learning achievement test.

Result and Discussion

First Validation

The validation process began by submitting the initial draft of the module developed using the Indonesian Realistic Mathematics Education (PMRI) approach to a team of expert validators for review. The instructional materials produced in this study include: (1) a learning module based on the

PMRI framework supported by the GeoGebra application; (2) a Learning Implementation Plan (RPP); (3) a mathematics achievement test; (4) a student response questionnaire; (5) a teacher response questionnaire; (6) a student activity observation sheet; and (7) an observation sheet assessing the teacher's ability to manage instruction.

Second Validation

The second stage of validation was carried out by submitting the revised version of the module amended based on the feedback and recommendations from the initial validation to the validation team for further review.

Based on the second stage of validation, the validation team provided their assessments of the PMRI-based mathematics module through the validation instruments. Overall, the evaluators' judgments covered all instructional components, including the module itself, the lesson plans (RPP), the student activity sheets, the teacher performance observation sheets, the student response questionnaire, the teacher response questionnaire, and the learning achievement test.

Implementation

The students who served as the subjects in this module trial were eleventh-grade students (Class XI-B) of SMA Negeri 10 Gowa during the even semester of the 2022–2023 academic year. A total of 21 students participated, representing diverse academic abilities, including high-, medium-, and low-performing learners.

Evaluation

The module used during the learning process was evaluated by both the teacher and the students. The evaluation involved one teacher and 21 students. Subsequently, the researcher analyzed the evaluation data from the teacher and students, along with the students' learning outcome test results. The module, which had been developed and revised based on input from the two supervisors, was then finalized as a feasible instructional material for use.

Analysis of the Validity, Practicality, and Effectiveness of the Module

Validation Result

After being evaluate, the module underwent a validation process. The experts who validated the module and the research instruments were lecturers from the Faculty of Tarbiyah at UIN Alauddin Makassar.

Expert says The Lesson Plan (RPP), learning achievement test, observation sheets, and teacher and student response questionnaires all demonstrated that the average score across all assessed aspects fell within the 'highly valid' category, as each component of every validation sheet was rated within the interval $4.3 \leq X \leq 5$. In addition, both validators concluded that the developed module is suitable for use with only minor revisions required.

Practicality Data Analysis

The practicality data of the developed instructional materials were obtained from student response questionnaires and teacher response questionnaires. The responses from both groups were analyzed to determine the level of practicality of the module. The results of the data analysis from the student and teacher questionnaires, which were used to assess the practicality of the PMRI-based module, are described as follows:

Student Response Questionnaire

The student response questionnaire was administered to 21 students of class XIb after they had completed the entire learning sequence using the PMRI-based module supported by the GeoGebra application on the topic of Geometric Transformations.

The analysis of student responses to the module during the trial phase showed that 90.4% of the students provided positive feedback on the learning module. These results indicate that, overall, the students responded favorably to the module during its implementation.

Teacher Response Questionnaire

The teacher response questionnaire was administered to the teacher after the instructional activities were carried out using the PMRI-based module that had been developed.

The analysis of the teacher's responses during the trial phase shows that the teacher provided a 90% positive rating toward the module. This indicates that the teacher responded positively to the developed learning module.

Considering both practicality components the student response

questionnaire and the teacher response questionnaire the analysis demonstrates consistently positive reactions to the module. Therefore, in accordance with the criteria outlined in Chapter III, the developed module meets the standards of practicality, and no further revisions or modifications are required.

Analysis of Effectiveness Data

As outlined in the research method, the effectiveness of the developed module is assessed through three components: (1) the teacher's ability to manage the learning process, (2) student learning activities, and (3) students' mathematical literacy test results. The description of each effectiveness component is presented as follows:

Observation of the Teacher's Ability to Manage Instruction

The analysis of the teacher's instructional management aims to determine the extent to which the teacher can facilitate mathematics learning using the PMRI-based module in the classroom.

Based on the analysis of the teacher's ability to manage mathematics instruction using the PMRI-based module supported by the GeoGebra application, the trial results show that the teacher obtained an average score of **4.6**, which falls within the interval **$4.5 \leq X < 5$**. This indicates that the teacher's instructional management performance is categorized as *excellent* and has met one of the indicators of module effectiveness.

Observation of Students' Learning Activities

Student activities during the learning process were observed using five activity indicators:

Students read and examined the contextual problems presented in the module. Students formed groups to work on the problems contained in the module. Students discussed their answers to the assigned problems with their group members. Students presented or responded to the results of other groups' discussions. Students formulated conclusions or summaries of the material that had been learned.

Based on the percentage analysis of student learning activities during the trial phase, a score of 76% was obtained, which falls within the interval $60 \leq X < 80$. This indicates that students' engagement in the learning process is categorized as *good*. Therefore, it can be concluded that the level of student activity during the instructional process meets the criteria for effectiveness.

Learning Outcome Test

The analysis of students' learning outcome scores following the implementation of the PMRI-based instructional materials is presented below:

The results indicate that among the 21 students who completed the learning outcome test, 5 students (23.8%) achieved scores categorized as *very high*. A total of 13 students (62%) attained the *high* category, while 3 students (14.2%) fell within the *moderate* category.

Overall, these findings show that the mean score of the learning outcome test lies within the High category.

Based on the mastery criteria, 18 out of 21 students achieved a score of 75 or higher, while three students scored below the minimum mastery threshold. Several factors contributed to these students' incomplete achievement, including low learning motivation and limited participation during instructional activities, which resulted in weaker conceptual understanding compared to their peers.

Referring to the criteria outlined in research method, the students' learning outcome test has met the requirement for classical mastery, with 85.8% of students achieving mastery**.** Thus, the learning outcome test, as one of the indicators of effectiveness, is considered fulfilled.

Considering the three indicators of effectiveness teacher competence in managing instruction, student learning activities, and student learning outcomes it can be concluded that the teacher's instructional management performance falls within the very good category ($4.5 \leq X \leq 5$). Student activity levels also fall within the good category ($60\% \leq P < 80\%$), and the analysis of learning outcome scores indicates a high performance level, meeting the classical mastery requirement of 85.8%.

Therefore, the module developed in this study meets the criteria for effectiveness**.**

Discussion

The findings of this study align with previous research emphasizing the positive role of multimedia and technology-based instruction in improving learning outcomes. The significant increase in students' posttest scores demonstrates that Focusky effectively facilitates comprehension and information retention. This result supports the theory that learning media integrating text, sound, and visual elements can stimulate multiple senses, thereby improving memory and understanding (Hamalik in Tirtiana, 2013). The Focusky application, by combining these elements, succeeded in creating an engaging and meaningful learning experience.

One key reason for the improved outcomes lies in the interactive nature of Focusky. Traditional teaching methods often rely heavily on verbal explanation and printed materials, which can lead to student fatigue and loss of concentration. In contrast, Focusky provided an active learning environment in which students could visualize concepts dynamically. This engagement not only improved focus but also helped bridge the gap between abstract ideas and concrete understanding, consistent with constructivist learning principles.

The effectiveness of Focusky also reflects the role of digital technology in fostering motivation. Motivation is a central component of successful learning, and the integration of multimedia can significantly enhance intrinsic interest. Students in this study expressed greater enthusiasm during lessons using Focusky compared to conventional methods. This finding resonates with Suardi (2019), who noted that visual and auditory media stimulate curiosity and attention, resulting in higher levels of learning engagement.

Furthermore, the study demonstrates that technology-supported instruction can strengthen cognitive, affective, and psychomotor aspects of learning. Cognitively, students processed information more efficiently because Focusky's visual structure helped them organize knowledge logically. Affectively, the use of color, motion, and audio elements created emotional involvement, which made the learning experience more memorable. Psychomotorically, operating the application and interacting with the content promoted active participation and digital literacy skills.

Another important point is the pedagogical implication for teachers. The use of Focusky shifted the teacher's role from being a mere transmitter of information to a facilitator who guides students in exploring and understanding material interactively. Teachers reported that the application simplified the explanation of complex linguistic concepts and reduced the reliance on monotonous lecture methods. This transformation aligns with the modern concept of "Merdeka Belajar" (Freedom to Learn), which emphasizes flexibility, creativity, and collaboration in education.

The study's results are consistent with those of Tenriawaru et al. (2023), who found that Focusky significantly improved science learning outcomes among junior high school students. Similarly, Rasyid (2023) reported positive impacts of Focusky on Islamic education learning achievements. These parallel findings indicate that Focusky's effectiveness is not limited to a single subject area but extends across disciplines, reinforcing its potential as a versatile educational tool.

However, despite the positive outcomes, the study also acknowledges certain limitations. The absence of a control group in the research design means that the observed improvement cannot be compared directly with another teaching method. Future research should incorporate control and experimental groups to strengthen the validity of causal inferences. Moreover, factors such as students' individual learning styles, prior digital familiarity, and classroom infrastructure may also influence results and should be explored further in subsequent studies.

the discussion confirms that the use of the Focusky application has a significant and beneficial effect on students' learning outcomes in Indonesian language education. The integration of technology not only enhanced academic performance but also fostered active learning, motivation, and creativity. This study contributes to the growing body of evidence supporting digital

transformation in education, emphasizing that interactive multimedia applications like Focusky can be powerful instruments in achieving effective, enjoyable, and meaningful learning experiences.

The final product generated in this study is an instructional module designed using the Indonesian Realistic Mathematics Education (PMRI) approach and supported by the GeoGebra application for the topic of Geometric Transformations. The development followed the ADDIE model, which includes five stages: Analysis, Design, Development, Implementation, and Evaluation.

The primary activities in the analysis stage involved identifying learning problems related to the existing instructional materials as well as examining learner characteristics in order to determine their needs. The initial analysis revealed that the main material used in the classroom was a standard textbook. The textbook presented definitions and brief explanations using language that students found difficult to understand. As a result, when students encountered unfamiliar problem types, they were unsure how to begin or how to approach the solution process. In addition, the visual design of the textbook was plain, offering limited variation in illustrations or colors, which reduced students' interest in reading the material.

This analysis indicated that both teachers and students required an instructional module that could engage learners actively in the learning process.

The design stage focused on planning the instructional module, lesson plans (RPP), and learning achievement tests (THB). This stage involved creating the initial blueprint for the module and designing the research instruments. The structure of the module was arranged based on the sequence of concepts in the Geometric Transformations topic and was integrated with PMRI steps and the use of GeoGebra. The module design includes a title page, preface, user guidelines, instructions for using GeoGebra, table of contents, core competencies, learning indicators, concept maps, main material, introductory tasks, evaluation activities, summaries, QR codes, and references.

At this stage, the instructional module was produced according to the format and visual design established during the design stage. The module consists of four chapters, each covering a different component of geometric transformations, and integrates the PMRI stages supported by GeoGebra activities. Additional instruments were also developed during this stage, including the lesson plans, student response questionnaires, teacher response questionnaire, student activity observation sheets, teacher classroom management observation sheets, and learning achievement tests.

The implementation was carried out on March 1–3, 2022, involving 21 students from Class XIB at SMA Negeri 10 Gowa. In the first session, the teacher acted as an observer to assess the practicality of the developed module, while the researcher conducted the lessons throughout the entire implementation period.

The goal of the evaluation stage was to examine the practicality and effectiveness of the module. Practicality refers to how easily the module can be used by teachers and students. Based on the results, 90% of the teacher's responses and 90.4% of the students' responses were positive, indicating that the module met the criteria for practicality.

Effectiveness was assessed through student test results, learner activity observations, and teacher classroom management assessments. The average score on the learning achievement test showed that 85.8% of students achieved mastery, while 14.2% did not. Student activity observations yielded an average of 76%, categorized as good. Additionally, the teacher's classroom management rating achieved an average score of 4.6, categorized as very good. These findings confirm that the module fulfilled the criteria for effectiveness.

Several challenges emerged during the development and trial phases, particularly during the implementation of the PMRI-based module with GeoGebra. Some students did not have access to mobile phones, preventing them from using the application. Internet connectivity issues further limited the learning process. Students were also

hesitant to ask questions or present their work in front of peers, especially during the initial meetings. Consequently, the researcher found it difficult to manage students effectively at the beginning of the intervention, and the preparation stage before learning required more time than planned.

The trial results revealed three main outcomes: the achievement of the research objectives, the extent to which the learning tools fulfilled the criteria of validity, practicality, and effectiveness, and the challenges encountered during implementation.

The module was designed to support students in achieving learning objectives and enhancing their interest in mathematics, particularly in geometric transformations. The validation results showed that the module and research instruments achieved an average score of 4.4, categorized as valid. The validation included assessments of the module, student questionnaires, teacher questionnaires, observation sheets, and learning achievement tests. These results indicate that the module was appropriate for use. This finding aligns with Riyani (2020:27), who reported that a similar module achieved a validity score within the interval of $4.3 \leq X \leq 5$.

Practicality was assessed using student and teacher response questionnaires. The results showed that 90.4% of students and 90% of the teacher responses were positive. These results meet the criteria for practicality and correspond with Hayani (2021:86), who found that a PMRI-based module achieved a practicality level of 77.59%, categorized as practical based on Riduwan's criteria (2011:82).

Effectiveness was analyzed through teacher classroom management, student activity, and test outcomes. The teacher's classroom management score averaged 4.6 (very good), student activity averaged 76% (good), and the learning achievement test indicated that 85.8% of students achieved mastery. These results confirm that the module meets the criteria for effectiveness. This conclusion is consistent with Maulida (2022), who found that PMRI-based instructional modules were effective in improving students' mathematical understanding.

Conclusion

The module was developed using the ADDIE instructional design framework, which consists of five sequential phases: analysis, design, development, implementation, and evaluation. This model guided the creation of a PMRI-based mathematics module supported by the GeoGebra application for the topic of geometric transformations. The resulting product is expected to meet the standards of validity, practicality, and effectiveness.

The developed module satisfied all three criteria. The validity aspect was demonstrated through expert evaluations, which produced an average score of 4.5. Additional indicators of validity were reflected in student response scores (mean 3.4), teacher response scores (mean 3.5), teacher competence in managing instruction (mean 4.4), student activity observations (mean 4.5), the quality of the lesson plans (mean 4.5), and the learning achievement test (mean 4.5). Each of these components fell within the "highly valid" category, confirming that both the learning materials and the associated instruments were appropriate for use.

The practicality of the module was assessed through student and teacher response questionnaires. The data revealed that 90.4% of students gave positive evaluations, while 90% of teachers also expressed favorable responses, indicating that the module is practical and easy to apply in the classroom.

The effectiveness criterion was measured using three indicators: teacher performance during instruction, student learning activities, and student learning outcomes. The average score for teacher performance reached 4.6, classified as "excellent." Student activity reached 76%, which falls within the "good" category. Furthermore, student learning outcomes demonstrated that 85.8% of learners achieved mastery, placing the results within the "high" achievement category. Based on these three

indicators, the module meets the requirements for effectiveness.

The developed module serves as an alternative form of instructional material that can be implemented in classroom learning. However, its use requires adaptation to the specific conditions and characteristics of each class. The module was designed to accommodate learners with diverse ability levels and heterogeneous backgrounds. The module is grounded in the Indonesian Realistic Mathematics Education (PMRI) approach and integrates the GeoGebra application. Since not all students have adequate access to digital devices such as smartphones or laptops, the successful implementation of this module may require additional provision of technological resources.

References

Abi, A. M. (2016). Integrasi Etnomatematika Dalam Kurikulum Matematika Sekolah. *JPMI (Jurnal Pendidikan Matematika Indonesia)*, *1*(1), 1–6. https://doi.org/10.26737/jpmi.v1i1.75

Arsyad, N. (2016). *Model Pembelajaran Menumbuhkembangkan Kemampuan Metakognitif*. pustaka refleksi.

Azka, H. H. AL, Setyawati, R. D., & Albab, irkham U. (2019). Pengembangan Modul Pembelajaran. *Imajiner: Jurnal Matematika Dan Pendidikan Matematika*, *1*(5), 224–236.

Beauchamp, G. A. (1975). *Curriculum Theory* (3rd ed.).

Bou-Fakhreddine, B. (2018). *Modeling, Control and Optimization Of Cascade Hydroelectric-Irrigation Plants : Operation and Planning* [lebanese university]. https://theses.hal.science/tel-02598915

Efuansyah, & Wahyuni, R. (2018). Pengembangan Bahan Ajar Matematika Berbasis PMRI Pada Materi Kubus Dan Balok Kelas VII. *Jurnal Derivat*, *5*(2), 28–41.

Fitri, I. M., & Zanthy, L. S. (2020). Analisis Kesulitan Siswa Dalam Menyelesaikan Soal Materi Transformasi Geometri. *Jurnal Gammath*, *5*(1).

Hariastuti, R. M. (2017). Permainan Tebak-Tebak Buah Manggis: Sebuah Inovasi Pembelajaran Matematika Berbasis Etnomatematika. *Jurnal Matematika Dan Pendidikan Matematika*, *2*(1), 25–36.

Hayani, R. (2021). *Pengembangan Modul Pembelajaran Berbasis Meaningful Intructional Design (MID) Untuk Meningkatkan Kemampuan Pemahaman Konsep Matematis Siswa MTsN 8 Tanah Datar*. Institut Agama Islam Negeri.

Hohenwarter, M., Hohenwarter, J., Kreis, Y., & Lavicza, Z. (2008). Teaching And Calculus With Free Dynamic Mathematics Software SeoGebra. *11th International Congress On Mathematical Education*, 1–9. www.geogebra.org/wiki

Ibda, F. (2015). Perkembangan Kognitif: Teori Jean Piaget. *Jurnal Intelektualika*, *3*(1), 27–38.

Isandhyta, E. (2018). *Pengembangan Lembar Kerja Siswa (LKS) Berbasis PMRI Berbantuan Geogebra Pada Pokok Bahasan Limit Fungsi Untuk Siswa Kelas XI Program IPA*. Universitas Sriwijaya.

Jupri, A. (2018). Peran Teknologi Dalam Pembelajaran Matematika Dengan Pendekatan Matematika Realistik. *Seminar Nasional Matematika Dan Pendidikan Matematika*.

Khoirul, S. M., Sunismi, & Fathani, A. H. (2019). Pengembangan Bahan Ajar Matematika Dengan Pendekatan Pendidikan Matematika Realistik Indonesia

Pada Materi Sistem Persamaan Linier Dua Variabel. *Jurnal Komunikasi Pendidikan*, *3*(1), 33–41.

Maghfiroh, Y., & Hardini, A. T. A. (2021). Pengembangan Modul Pembelajaran Matematika Materi Pecahan Kelas V Sekolah Dasar. *Jurnal Educatio*, *7*(2), 272–281. https://doi.org/10.31949/educatio.v7i2.997

Mahendra, I. W. E. (2017). Project Based Learning Bermuatan Etnomatematika Dalam Pembelajaran Matematika. *Jurnal Pendidikan Indonesia*, *6*(1), 2541–7207.

Maulida, N. (2022). *Pengembangan Modul Pembelajaran Matematika Dengan Model Problem based Learning Pada Materi Limit Tingkat SMA*. Universitas Islam Negeri Syarif Hidayatullah.

Mustafa, P. S., & Angga, P. D. (2022). Strategi Pengembangan Produk Dalam Penelitian Dan Pengembangan Pada Pendidikan Jasmani. *Jurnal Pendidikan : Riset Dan Konseptual*, *6*(3), 413–424. https://doi.org/10.28926/riset_konseptual.v6i3.522

Nababan, N. (2020). Pengembangan Media Pembelajaran Berbasis Geogebra Dengan Model Pengembangan ADDIE di Kelas XI SMAN 3 Medan. *Jurnal Inspiratif*, *6*(1), 38–50.

Nababan, N. (2020). Pengembangan Media Pembelajaran Berbasis Geogebra Dengan Model Pengembangan Addie Di Kelas XI SMAN 3 Medan. *Jurnal Inspiratif*, *6*(1), 37–50.

Noviandi, A. (2019). Integrasi Nilai Pendidikan Iman Dan Ilmu Pengetahuan Dalam Tafsir Al-Misbah (Kajian Surat Al-Mujadilah 58:11). *Andragogi: Jurnal Pendidikan Islam Dan Manajemen Pendidikan Islam*, *1*(3), 418–440. https://doi.org/10.36671/andragogi.v1i3.66

Novitasari, R. D., & Wijayanti, A. (2019). Analisis Penerapan Penguatan Pendidikan Karakter Sebagai Implementasi Kurikulum 2013. *Indonesian Values and Character Education Journal*, *2*(2), 79–86.

Nur, M. (2008). *Guru Yang Berhasil dan Model Pengajaran Langsung*. Depdiknas.

Prihartini, N., Sari, P., & Hadi, I. (2020). Design Research: Mengembangkan Pembelajaran Konsep Peluang Dengan Pendekatan Pendidikan Matematika Realistik Indonesia pada Siswa Kelas IX di SMPN 220 Jakarta. *Jurnal Riset Pembelajaran Matematika Sekolah*, *4*.

Rahayu, T., & Purwoko. (2008). Pengembangan Instrumen Penilaian Dalam Pendidikan Matematika Realistik Indonesia (PMRI) Di SMPN 17 Palembang. *JURNAL PENDIDIKAN MATEMATIKA*, *2*(2), 17–33.

RI, D. A. (2015). *Al-Quran Terjemahan*. CV Darus Sunnah.

Riduwan. (2011a). *Belajar Mudah Penelitian* (B. Alma, Ed.). Alfabeta.

Riduwan. (2011). *Belajar Mudah Penelitian* (B. Alma, Ed.). Alfabeta.

Riliyanti, B. T., & Noviyana, H. (2020). Pengembangan Lembar Kerja Peserta Didik (LKPD) Pada Materi Segitiga Dan Segiempat Dengan Pendekatan Matematika Realistik Indonesia (PMRI). *Epsilon*, *2*(1), 2715–6028.

Riyani, W. (2020a). *Pengembangan Modul Berbasis STEM Pada Materi Perubahan Lingkungan Untuk Siswa SMA*. Universitas Negeri Semarang.

Riyani, W. (2020b). *Pengembangan Modul Berbasis STEM Pada Materi Perubahan Lingkungan*

Untuk Siswa SMA. Universitas Negeri Semarang.

Sa'adah, W. N. (2010). *Peningkatan Kemampuan Penalaran Matematis Siswa Kelas VIII SMP Negeri 3 Banguntapan Dalam Pembelajaran Matematika Melalui Pendekatan Pendidikan Matematika Realistik Indonesia (PMRI)*.

Simanulang, J. (2013). Pengembangan Bahan Ajar Materi Himpunan Konteks Laskar Pelangi Dengan Pendekatan Pendidikan Matematika Realistik Indonesia (PMRI) Kelas VII Sekolah Menengah Pertama. *Jurnal Pendidikan Matematika* , *7*(2), 27–35.

Sudjana, N. (2010). *Penilaian Hasil Proses Belajar Mengajar* (15th ed.). PT Remaja Rosdakarya.

Sugiyono. (2020). *Cara Mudah Menyusun Skripsi, Tesis, dan Disertasi*. Alfabeta.

Syafri, F. S. (2018). *Pengembangan Modul Pembelajaran Aljabar Elementer Di Program Studi Tadris Matematika IAIN Bengkulu* (D. Isran & A. Sunarto, Eds.). CV. Zigie Utama.

Trianto. (2017). *Mendesain Model Pembelajaran Inovatif, Progresif dan Konstektual* (3rd ed.). Kencana.

Widoyoko, E. E. P. (2010). *Evaluasi Program Pembelajaran : Panduan Praktis dan Calon Pendidik*. Pustaka Pelajar.

Widoyoko, E. E. P. (2010). *Evaluasi Program Pembelajaran : Panduan Praktis dan Calon Pendidik*. Pustaka Pelajar.

Yuana, R. A. (2020). *Perspektif Matematika 2* (Suwardi, Ed.). PT. Tiga Serangkai Pustaka Mandiri.

Yuanita, & Kurnia, F. (2019). Pengembangan Bahan Ajar Berbasis STEM (Science, Technology, Engineering, And Mathematics) Materi Kelistrikan Untuk Sekolah Dasar. *Profesi Pendidikan Dasar*, *1*(2). https://doi.org/10.23917/ppd.v1i2.9046