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Realistic Mathematics Assisted with Learning Management System in Improving Students' Reflective Thinking Ability

Vepi Apiati

Faculty of Teacher Training and Education, Universitas Siliwangi
Jalan Siliwangi No. 24 Kahuripan, Tasikmalaya, West Java, 46115, Indonesia
vepiapiati@unsil.ac.id

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Abstrak

Kemampuan berpikir reflektif merupakan salah satu keterampilan yang perlu dikembangkan dalam pembelajaran matematika di abad ke-21. Salah satu pendekatan yang dinilai mampu mendorong pengembangan kemampuan ini adalah *Realistic Mathematics Education* (RME). Pendekatan ini menekankan pada keterkaitan antara konsep matematika dan konteks aktivitas harian siswa, hal ini memungkinkan siswa untuk tidak hanya menangkap materi secara konseptual, tetapi juga mengevaluasi proses berpikirnya sendiri. Penelitian ini bertujuan untuk mengembangkan modul pembelajaran matematika realistik berbantuan *Learning Management System* (LMS) untuk meningkatkan kemampuan berpikir reflektif siswa dan mengetahui kelayakan dari modul ajar tersebut. Metode yang digunakan dalam penelitian ini adalah *Research and Development* (R&D) dengan model pengembangan yang diadaptasi dari Borg dan Gall. Prosedur pengembangan terdiri atas beberapa tahapan, yakni: pengumpulan data awal, tahap perencanaan, pembuatan prototipe awal, uji coba terbatas, revisi berdasarkan hasil uji coba pertama, uji coba skala luas, revisi lanjutan, uji coba operasional akhir, dan penyempurnaan produk sebagai hasil akhir. Penelitian ini melibatkan siswa kelas XI di SMA Darussalam Tasikmalaya sebagai subjek. Pengumpulan data dilakukan dengan menggunakan instrumen angket kelayakan modul ajar, dan soal kemampuan berpikir reflektif. Analisis data dilakukan dengan penilaian pada hasil tes kemampuan berpikir reflektif dan penskoran pada angket kelayakan modul ajar. Hasil penelitian menunjukkan bahwa modul ajar yang dikembangkan mendapat penilaian layak dari ahli materi dan ahli media. Selain itu, penggunaan modul ajar ini mampu meningkatkan kemampuan berpikir reflektif siswa, sebagaimana tercermin dari peningkatan skor tes kemampuan berpikir reflektif siswa. Temuan ini mengindikasikan bahwa modul ajar matematika realistik berbantuan LMS mampu menciptakan suasana belajar yang kontekstual, menarik, dan efektif dalam mendukung pemahaman matematika yang lebih dalam. Dengan demikian, modul ini dapat dijadikan referensi oleh para pendidik dalam merancang pembelajaran matematika yang bermakna dan sesuai dengan tuntutan pendidikan di era digital.
Kata Kunci: Matematika Realistik; *Learning Management System*; Kemampuan Berpikir Reflektif; Pengembangan Modul Ajar

Abstract

Reflective thinking ability is one of the skills that need to be developed in mathematics learning in the 21st century. One approach that is considered capable of encouraging the development of this ability is Realistic Mathematics Education (RME). This approach emphasizes the relationship between mathematical concepts and the context of students' daily activities, this allows students to not only grasp the material conceptually, but also evaluate their own thinking process. This study aims to develop a realistic mathematics learning module assisted by the Learning Management System (LMS) to improve students' reflective thinking skills and determine the feasibility of the teaching module. The method used in this study is Research and Development (R&D) with a development model adapted from Borg and Gall. The development procedure consists of several stages,

namely: initial data collection, planning stage, initial prototype creation, limited trials, revisions based on the results of the first trial, large-scale trials, further revisions, final operational trials, and product refinement as the final result. This study involved grade XI students at SMA Darussalam Tasikmalaya as subjects. Data collection was carried out using a questionnaire instrument for the feasibility of the teaching module, and reflective thinking ability questions. Data analysis was carried out by assessing the results of the reflective thinking ability test and scoring on the module feasibility questionnaire. The results of the study showed that the developed teaching module received a decent assessment from material experts and media experts. In addition, the use of this teaching module was able to improve students' reflective thinking abilities, as reflected in the increase in students' reflective thinking ability test scores. These findings indicate that the LMS-assisted realistic mathematics teaching module is able to create a contextual, interesting, and effective learning atmosphere in supporting a deeper understanding of mathematics. Thus, this module can be used as a reference by educators in designing meaningful mathematics learning that is in accordance with the demands of education in the digital era.

Keywords: Realistic Mathematics; Learning Management System; Reflective Thinking Skills; Development of Teaching Modules

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I. INTRODUCTION

In the 21st century era, it is expected that students can develop higher order thinking skills, including the ability to think reflectively (Ariany, Rosjanuardi, & Juani, 2023). In mathematics learning, reflective thinking plays an important role not only in solving problems, but also in assessing the thinking process and learning outcomes achieved.

However, the ability to think reflectively among students is still low, especially in mathematics (Dwiyanti & Sholihat, 2023). They tend to solve problems mechanically without exploring the meaning behind each step taken. They are also often unable to explain the reasoning behind their answers, have difficulty evaluating the strategies used, and are not accustomed to reviewing their thinking process to identify errors or find alternative solutions.

This problem is reinforced by the results of the TIMSS study in 2011 reported by Mullis et al (2012), showing that the achievements of Indonesian students are still below the international average, especially in the aspects of reasoning and problem solving in mathematics and science. Indonesia's average math score was recorded at 386, placing the country 38th out of 42 countries. For science, the score was 406, placing the country 40th out of 42 participating countries. The data indicates the need to improve reflective thinking skills as the main element in realizing meaningful mathematics learning.

According to Surbeck, Han, and Moyer (1991), reflective thinking is an ability to recognize existing knowledge, use it in different contexts, and adjust understanding based on new information and experiences. This process consists of three main stages:

1. Reacting: Responding to an event, situation or mathematical problem based on personal understanding, emphasizing the main characteristics of the situation.
2. Elaborating (reflection for evaluation): Analyzing and explaining individual experiences and information obtained, with the aim of evaluating beliefs through comparisons between initial responses and other experiences.
3. Contemplating (reflection for critical inquiry): Emphasizes personal deep understanding, highlighting individual involvement in processes such as describing, informing, considering, and reshaping a situation or problem.

Reflective thinking skills are closely related to realistic mathematics, as both emphasize in-depth understanding of concepts through context-based critical thinking processes. In this approach, students are exposed to problems derived from real situations that they experience in their daily activities. This encourages them to explore solutions, design strategies, and reflect on the steps taken during the learning process.

Realistic Mathematics Education (RME) emphasizes that mathematics learning does not only focus on the formal understanding of mathematical concepts, but also how these concepts are directly related to students' real experiences. With this approach, students are invited to think reflectively by linking their mathematical

understanding to familiar real-world situations.

According to Freudenthal (in Gravemeijer, 1994), mathematics should be understood as a human activity close to life, not as a set of formal rules separated from reality. Therefore, mathematics learning should be designed to match students' daily experiences and be contextual in nature. Afsari et al. (2021) also emphasized that the RME approach makes it easier for students to understand mathematical concepts through the presentation of relevant and meaningful problems in their lives.

Learning that connects real-life contexts with mathematical concepts can help students build a deeper understanding and think critically about the material they learn. RME is a solution to students' challenges in understanding abstract concepts, because it is able to present real situations that support reflective and meaningful thinking processes.

Research by Nuriadin (2022) shows that the application of RME supported by concrete media has a positive influence on the mathematics learning process in the classroom. In addition, Dienes (1973) suggested that the structure in mathematics is hierarchical, so that each new concept must be built on the understanding of the previous concept. If this prerequisite has not been met, then the understanding of the next concept will be hampered.

In the current digital era, the use of Learning Management System (LMS) is a strategic tool in integrating the Realistic Mathematics Education (RME) approach with digital-based learning technology. LMS supports mathematics learning that is interactive, contextual, and more interesting for students. The utilization of this platform provides an opportunity to deliver material systematically, collect assignments, and deliver evaluation results efficiently (Siswono, 2022).

LMS itself is internet-based software designed to support the teaching and learning process both in schools and universities (Amiroh, 2012). Ellis (2009) defines LMS as a digital system that allows the management of learning administration, delivery of materials, and implementation of the learning process online or e-learning. In addition, Pappas (2015) adds that the LMS provides features to automatically monitor student learning progress, analyze evaluation results, and present learning reports that support the provision of appropriate and effective feedback.

In practice, the LMS becomes a supporting medium that strengthens the active involvement of learners. Teachers can design teaching tools creatively, while students get access to more flexible learning, both in terms of time and place. The LMS also provides space for students to explore material, analyze information, and draw conclusions independently. Through the LMS, educators can design syllabi, manage teaching materials, organize learning activities, and organize evaluations, online discussions, quizzes, and attendance tracking.

According to Wiragunawan (2022), LMS is a trusted online learning media due to its complete features compared to similar platforms. Its use, either independently or in combination with other learning

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approaches, is proven to significantly increase student engagement, learning outcomes and motivation.

From the institutional side, the implementation of LMS provides convenience in managing a flexible and quality learning process. Students can learn independently without space and time constraints, while teachers can monitor learning activities in real-time. These advantages make LMS a modern learning solution that supports efficiency as well as effectiveness.

Based on the problems that have been identified, the researcher took the initiative to develop a realistic mathematics teaching module assisted by LMS to encourage students to build concept understanding reflectively and deeply through a contextual approach. The integration of LMS in the development of teaching modules aims to expand access to teaching materials, enrich digital interaction, and provide reflection space for students in the mathematical thinking process.

It is hoped that through this module, students will not only master mathematical material procedurally, but also be able to review their thinking processes, evaluate solution strategies, and make decisions based on logical reasoning. This teaching module is expected to be an innovative alternative in learning mathematics that focuses on developing higher order thinking skills and is relevant to the learning needs of the 21st century.

II. METHOD

This study used a Research and Development (R&D) approach by referring to the model developed by Borg and Gall. The stages in this process include: collecting initial data and information, development planning, making initial product prototypes, preliminary trials in the field, revisions based on trial results, conducting main trials, revising products operationally, trials at the operational stage, until the final stage of product improvement.

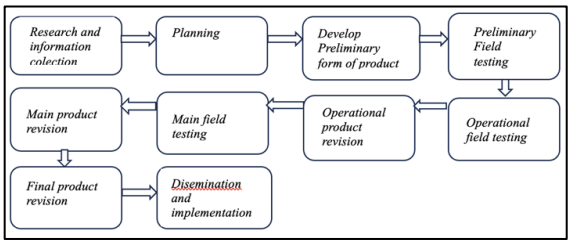

Figure 1. The stages in the development process

The stages in the development process in this study did not reach dissemination and implementation, due to the limited time and costs that researchers have (See Figure 1). The achievement indicators at each stage of product development are described as follows:

1. Research and Information Collection This first stage involves collecting relevant data and information as the basis for designing and developing learning products. This information includes user needs, literature review, and preliminary field study.
2. Planning This phase aims to systematically develop a product development strategy, including the formulation of objectives, preparation of content structure, selection of learning approaches, and determination of methods and media that will be used in the development of teaching modules.

3. Develop Preliminary Form of Product At this stage, the initial product in the form of a teaching module is prepared based on data from the results of information collection and planning stages. The initial product reflects the initial design that is ready to be tested for feasibility.
4. Preliminary Field Testing The initial product that has been developed is tested on a limited basis to determine the initial response from users, identify weaknesses, and assess its functional feasibility on a small scale.
5. Main Product Revision Based on feedback from the initial trial, the product was improved and refined. This process aims to improve the quality of the teaching module before it is applied in a larger scale trial.
6. Main Field Testing After undergoing revisions, the module was tested again in the actual learning context but with a wider range of subjects. This test is conducted to evaluate the effectiveness and applicability of the product more comprehensively.
7. Operational Product Revision This stage is a further refinement of the product based on the findings from the main field trial. Improvements are made based on quantitative and qualitative data so that the product is ready for operational use in a real context.
8. Operational Field Testing This test is conducted on an operationally revised version of the module. The use of products is carried out in real learning situations, involving teachers or end users directly, and involving more diverse subjects.
9. Final Product Revision This is the final stage in the development cycle. The product is refined based on the results of the operational field trial and produces a final version of the teaching module that is ready to be disseminated for general use in educational institutions.

Data collection techniques in this study include instruments, namely:

1. Questionnaires for media experts and material experts, which are used to assess the feasibility of the product in terms of technical quality. According to Hendryadi (2017), a questionnaire is a data collection method designed to obtain accurate and targeted measurement results.
2. Questionnaires for students, which are intended to determine the feasibility of the product from the aspect of instructional quality, namely the extent to which the product supports the student learning process effectively.
3. Reflective thinking skills questionnaire, which is intended to determine the improvement of students' reflective thinking skills.

According to Sugiyono (2020), research instruments are tools used to measure and collect data, which can be tests, questionnaires, interview guides, teaching materials, or observation guidelines. In this study, the instruments used include questionnaires and reflective thinking ability test questions.

Validity and reliability tests are conducted to ensure that research instruments, such as questionnaires and test questions, have good quality, so that the data obtained are accurate and

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reliable. The validity test in this study used the Pearson Product moment Correlation formula as follows:

$$r_{xy} = \frac{n\sum XY - (\sum X)(\sum Y)}{\sqrt{[n\sum X^2 - (\sum X)^2][n\sum Y^2 - (\sum Y)^2]}}$$

Description:

r_{xy} = correlation coefficient between item and total scores

X = item score

Y = total score

n = number of respondents

Reliability testing in this study was carried out using the Cronbach's Alpha formula as below:

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum \delta_i^2}{\delta_t^2}\right)$$

Description:

α = reliability value

K = number of items

δ_i^2 = variance of each item

δ_t^2 = variance of total score

Data analysis of the feasibility questionnaire after the data is collected is calculated using the following formula to get the percentage of achievement (Shalhi et al, 2024):

$$PC = \frac{SP}{SH} \times 100\%$$

Description:

PC = Percentage of Achievement

SP = Score Obtained

SH = Expected Score

The results of the calculation of the percentage of achievement are classified into five categories based on the criteria according to Arikunto (in Alhadi & Cholik, 2021) as follows:

Table 1.
Criteria for the feasibility of Teaching Modules

Percentage of achievement	Category
<21%	Highly Inappropriate
21% - 40%	Less Feasible
41% - 60%	Feasible Enough
61% - 80%	Feasible
81% - 100%	Very Feasible

III. RESULT AND DISCUSSION

The results of the study explain the teaching module developed using realistic mathematics assisted by LMS and the feasibility of the teaching module. This study also aims to explain how the teaching modules developed can improve students' reflective thinking skills. This research was conducted at Darussalam Integrated High School in Tasikmalaya Regency, using the Borg and Gall development model.

The research and information collection stage included a preliminary study conducted through interviews with teachers, vice principal for curriculum, and principal, to obtain information related to the curriculum, syllabus, lesson plans, and learning media used. The information obtained included:

1. Students are less interested in math subjects.
2. Students do not understand the importance of math in everyday life.
3. Students are afraid to take math lessons.
4. Students feel bored with the teaching methods applied in class.
5. Students face obstacles when working on math problems whose presentation is different from the examples that have been given previously.
6. Students cannot learn math independently.

The planning stage is a very important initial phase because it determines the direction and structure of the research. In the planning stage, the researcher makes a design of realistic mathematics-based teaching modules assisted by LMS with an independent curriculum which includes general information, core components, and attachments.

The development stage of the initial product draft (develop preliminary from product) is the development of the initial product draft where the product concept begins to be realized in a more concrete form. The prototype or product produced is a teaching module which will then be presented in the LMS. Previously, the teaching module was validated by material experts and media experts.

Preliminary Field-Testing stage where at this stage the teaching module was tested on Darussalam Integrated High School students in class XI as many as 20 students. Teachers and researchers observed how students used the teaching modules presented in the LMS and how the learning process took place.

In the main product revision stage, researchers identified aspects that needed to be improved, including the appearance of the LMS that was less attractive and questions that were too difficult.

The main field-testing stage involved students at Darussalam Integrated High School class XI as many as 30 students. The researcher acts as a facilitator and observer. At this stage, the researcher also gave a reflective thinking ability test and gave a questionnaire on the feasibility of teaching modules to students.

Media expert assessment was conducted to assess the technical quality of realistic mathematics teaching modules assisted by LMS with the following assessment results:

Table 2.
Feasibility of Teaching Module

No	Aspect	Percentage	Category
1	Readibility Level	75%	Feasible
2	Ease of Use	65%	Feasible
3	Visual design and display	63%	Feasible
4	Efektivitas penanganan jawaban	80%	Feasible
5	Effectiveness of answer handling	80%	Feasible
6	Documentation quality	80%	Feasible
	Total Average	70%	Feasible

Based on the assessment results on the technical quality aspects of the realistic mathematics teaching module supported by the LMS, a feasibility percentage of 70% was obtained. When referring to the assessment category, the percentage is included in the “Feasible” criteria.

In the operational product revision stage, researchers analyzed the results of the student reflective thinking ability test, feasibility questionnaire and interviews, and carried out improvements to the teaching module content and technical in the LMS. The product (teaching module) of realistic mathematics assisted by LMS is considered operational because it has passed the stages of thorough testing and improvement.

The final product stage, producing products that are ready to use and have gone through a thorough validation, revision, and testing process, revisions

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derived from the previous stage are included to improve the teaching modules developed.

Realistic mathematics teaching modules assisted by LMS have great potential in improving students' reflective thinking skills. Learning Management System (LMS) provides a learning environment that supports the implementation of Realistic Mathematucs Education (RME) optimally by providing easy access to real-world contexts relevant to the mathematics being studied.

The material in each meeting is presented in context in Figure 2:

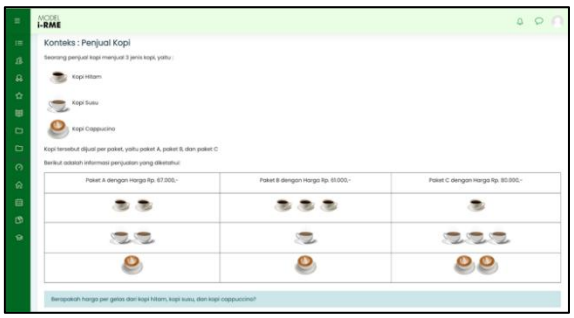

Figure 2. The material of each teaching

The problems given to students should be relevant, meaningful, and connected to their experiences so that learning is more contextualized and not detached from everyday reality.

A concept in the realistic mathematics approach which is a method of teaching mathematics that focuses on using realistic contexts and connecting mathematical concepts with real-life situations to facilitate student understanding is referred to as Intertwine. Students are asked to understand the given realistic situation by using the following work example (see Figure 3).

Figure 3. The given realistic situation

In the LMS-assisted realistic mathematics teaching module, in addition to being invited to find concepts based on the context provided, students are also given assessments to train their reflective thinking skills. The assessment in the LMS is presented in Figure 4:

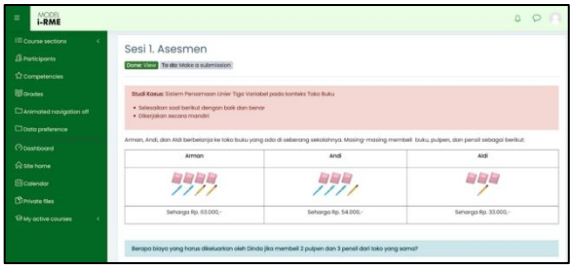

Figure 4. The assesment in the LMS

Everything presented is based on problems/contexts that are close to students' daily lives.

The test results of each indicator in answering reflective thinking questions are presented in the following Table 3.

Table 3.
Descriptive Statistics Results

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
eksperimen	30	25	100	80.50	19.138
kontrol	27	20	100	46.15	21.253
Valid N (listwise)	27				

Descriptive results show that the experimental average of 80.15 is greater than the control class average of 46.15. Indicates that the LMS-assisted realistic mathematics teaching module can improve students' reflective thinking skills.

Realistic Mathematics Education is an approach that focuses on the connection between mathematical materials and real-life contexts that are close to students' experiences. Through this approach, students are invited to construct their own understanding of mathematical concepts through meaningful and contextual problem solving.

In the learning process, students are trained to review their way of thinking, compare various solution strategies, and draw general conclusions from the real situation at hand. This activity indirectly develops reflective thinking skills. As stated by Gravemeijer and Doorman (1999), the RME approach allows students to reflect on the solutions they use to find more efficient strategies and generalize the mathematical ideas obtained.

This approach prioritizes the use of meaningful context to facilitate conceptual understanding. Students are encouraged to explore, gradually build understanding and reflect on the solution steps used. RME not only deepens students' understanding of mathematical concepts, but also contributes positively to the improvement of reflective thinking skills. This is in line with the findings of Sari et al. (2019), who stated that the RME approach significantly improved students' reflective thinking skills, because this approach utilizes the context of everyday life and encourages in-depth exploration in the process of learning mathematics.

In practice, RME involves students in group discussions, comparison of solutions, evaluation of strategies, and generalization processes. These activities are the main components of reflective thinking. Therefore, the RME approach is considered effective in developing reflective thinking skills, because it provides opportunities for students to think critically, understand their own thinking processes, and be responsible for the strategies chosen in solving a problem. Similar findings were also presented by Hakim et al. (2024), who showed that through discussion activities and exploration of relevant contexts, students can compare solutions and evaluate strategies as part of strengthening reflective thinking skills.

IV. CONCLUSION

The use of teaching modules based on the realistic mathematics approach integrated with the Learning Management System (LMS) showed significant results. Students in the experimental class obtained an average score of 80.15, while the control class only reached an average of 46.15. This difference in scores shows a considerable increase in the group using the RME teaching module assisted by LMS. This means that a learning approach that involves real contexts and interactive digital media can have a positive impact on student learning outcomes, especially in developing reflective thinking skills.

Furthermore, the LMS-based realistic mathematics teaching module has also gone through a feasibility test process with a result of 70%, which according to the classification standard is classified in the “Appropriate” category for use in learning activities.

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AUTHOR'S BIOGRAPHY

Vepi Apiati, M.Pd.

Born in Ciamis on April 27, 1975. Completed his undergraduate studies at the Department of Mathematics Education, FKIP Siliwangi University, Tasikmalaya, and graduated in 1998. Continued his master's degree in Mathematics Education at the Indonesian Education University (UPI), Bandung, and graduated in 2012.