

Developing interactive e-module based on realistic mathematics education approach and mathematical literacy ability

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Abstract

Teaching and learning activities are carried out online during the pandemic situation. This condition makes the teaching and learning process in the classroom requires teaching materials that can support the learning process. However, some teachers still use teaching materials commonly used during face-to-face learning, which is irrelevant for offline learning. Therefore, teachers need alternative interactive teaching materials that can facilitate online learning. This study aims to produce teaching materials in an interactive e-module based on the Realistic Mathematics Education (RME) approach with the content of number pattern that is valid, practical, and have potentially affected the eight-grade students' mathematical literacy skills. The research method used is design research with type of development studies which include two main stages, namely the preliminary design and the formative evaluation. The data collection instruments used were content and media expert validation sheets, student response questionnaires, and pretest and posttest questions to measure mathematical literacy skills. This research produces an RME-based e-module on number pattern material that is valid, practical, and potentially affects mathematical literacy skills. The results showed that the e-module was valid in content and media quality with very good criteria. Next, the e-module has also been practical from assessing student responses with good criteria. Finally, the e-module can potentially improve students' mathematical literacy skills, which is indicated by the increase in students' mathematical literacy skills after learning to use the e-module. In addition, the e-module developed in this study contributes as alternative teaching material for teachers in the online learning system.

Keywords: design research; development studies; interactive e-module; mathematical literacy; realistic mathematics education

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Introduction

In industrial revolution 4.0, mathematics learning is guided to hone 21st-century skills—one of the 21st-century skills in mathematical literacy (Wulandari & Azka, 2018; Tanujaya et al., 2021). Mathematical literacy is defined as an individual's ability to formulate, apply, and interpret mathematics in various contexts, including mathematical reasoning, mathematical concepts, procedures, facts, and tools to visualize, explain, and predict phenomena (OECD, 2016). In line with this, mathematical literacy skills can also be interpreted as individual abilities used to formulate and solve mathematics efficiently in everyday life (Sari, 2015). Therefore, students need to have mathematical literacy skills because they can be used in everyday life.

One international standard program that assesses students' mathematical literacy is the Program for International Student Assessment (PISA) (Ridwan et al., 2016). Based on the latest PISA results in 2018, Indonesia ranks 72 out of 78 countries while the average score of students' mathematical literacy ranks 279 of 6 with 379 out of 500 (OECD, 2019). In line with this, some previous studies also said that students' mathematical literacy skills in Indonesia were still relatively low (Edimuslim et al., 2019; Indah et al., 2016; Nursahadah & Salayan, 2020; Putri et al., 2020). Another fact is also proven from an interview with one of the mathematics teachers at SMP Negeri 1 Prambanan, who said that students' experiences were related to students' mathematical literacy skills. This is indicated by the inability of students to communicate information about questions, interpret real problems into mathematical form, represent answers, design strategies in solving problems, determine the right formula or arithmetic operation in solving problems, and reason and convey arguments. Thus, the mathematical literacy ability of students at SMP Negeri 1 Prambanan can be said to be still relatively low.

Given the importance of students' mathematical literacy skills, teachers need to create a learning process that supports and encourages and gives students space to develop their mathematical literacy skills. One of the effective learning models for improving students' mathematical literacy skills is Realistic Mathematics Education (RME) (Babys, 2017). RME is defined as a learning approach that can build mathematical concepts in everyday life (Putri et al., 2020; Rahayu et al., 2021). In addition, mathematics learning will be more meaningful and justified using the RME approach (Heriyadi & Prahmana, 2020). This is because RME always presents and connects all mathematical problems in a real context so that students' learning processes are related to their experiences in everyday life (Hosni et al., 2019; Purwitaningrum & Prahmana, 2021). Previous studies show that RME has a positive impact on improving students' mathematical literacy skills (Hidayah et al., 2019; Heriyadi & Prahmana, 2020; Putri et al., 2020). Thus, learning with the RME approach is considered effective in improving students' mathematical literacy skills.

In addition, another component that supports students' mathematical literacy skills is teaching materials (Putri et al., 2020). Teaching materials are an essential source of material in carrying out the learning process for teachers (Aisyah et al., 2020; Subekti & Prahmana, 2021). In the era of the industrial revolution 4.0, teaching materials are needed that follow the needs in accordance with the times. Teaching materials and independent learning resources that adapt

to the development of science and technology are electronic modules (e-modules) that can make students more enthusiastic in learning and understanding the material provided by the teacher (Zakiyah et al., 2019; Subekti & Prahmana, 2021). In addition, e-modules are teaching materials created by teachers to support teaching and learning, and students can study independently in the era of industrial revolution 4.0.

Several previous studies have developed teaching materials using the RME approach for several topics, especially number pattern and focus on mathematical literacy (Sudarman & Vahlia, 2018; Noviarni et al., 2020; Putri et al., 2020; Saputri et al., 2020) therefore, this research is focused on developing an interactive RME-based e-module to improve the mathematical literacy skills of eighth-grade students on number pattern content.

Methods

This study uses a design research method of development studies type which consists of two stages, namely the preliminary and formative evaluation stages, which include self-evaluation, expert review, one-to-one, small group, and field test (Tessmer, 1998; Zulkardi, 2006; Heriyadi & Prahmana, 2020). The following is the e-module development flow which is presented in Figure 1.

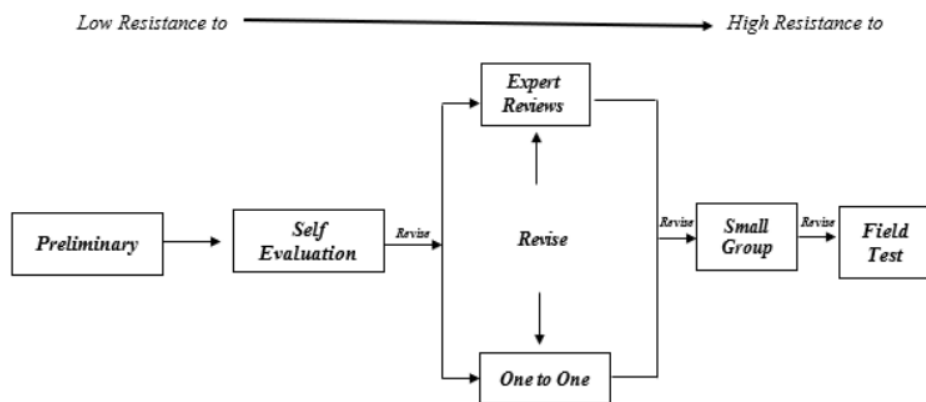


Figure 1. Formative Evaluation Design Flow

(Tessmer, 1998; Zulkardi, 2006; Heriyadi & Prahmana, 2020)

This research was conducted in the odd semester of the 2021/2022 academic year at SMP Negeri 1 Prambanan. The research subjects were students of class VIII C and VIII D of SMP Negeri 1 Prambanan. Class VIII C involved 9 students, with 3 male students and 6 female students. Meanwhile, class VIII D involved 31 students, with 12 male students and 20 female students. This study uses non-test and test data collection techniques. Non-test techniques include interviews, observations, questionnaires, and documentation. The non-test technique was carried out to measure the validity and practicality of the e-module and support research data. At the same time, the test technique includes giving pretest questions and posttest questions. The test technique was carried out to measure the potential effect of using RME-

based e-modules to improve students' mathematical literacy skills. The data collection instruments used were material expert and media expert validation sheets, student response questionnaires, pretest questions, and posttest questions. The material expert and media expert validation sheets were used to collect e-module validity assessment data. Student response questionnaires were used to collect student response assessment data after using the e-module. Meanwhile, pretest and posttest questions were used to obtain data on the potential effects of e-modules in improving students' mathematical literacy skills.

The product quality assessment indicator is valid and practical if the average score obtained at least meets the good criteria (Santi & Santosa, 2016). Meanwhile, to find out the potential effect of the product, it can be seen from the pretest and posttest scores on students' mathematical literacy abilities. Testing the potential effects of e-modules is carried out by processing the pretest and posttest values based on the results of the T-Test and N-Gain Test using IBM SPSS Statistics version 25. The T-Test in this study is the Paired Sample T-Test used to evaluate specific treatment of the same sample in two periods (Pramana & Mawardi, 2012; Susilo & Ernawati, 2017). The e-module indicator is said to have a potential effect if the Paired Sample T-Test table value < 0.05 , then H_0 is rejected. It means that there is a significant difference between the pretest and posttest mean values before after the use of e-modules (Nuryadi et al., 2017). Another indicator is the increase in students' mathematical literacy skills with a minimum N-Gain value of 0.3, meeting the moderate criteria (Falah et al., 2016).

Results

This research has two stages, namely the preliminary stage and the formative evaluation stage. The following is a description of each of the stages.

Preliminary Stage

This stage begins with analysis activities and then continues with product design activities designed based on the results of the needs analysis. In the analysis phase, the researcher carried out several activities such as curriculum analysis, student characteristics analysis, and teaching materials analysis. The analysis was carried out based on the results of interviews between researchers and teachers and filling out student observation sheets.

The results of the needs analysis include: (1) SMP Negeri 1 Prambanan implementing the 2013 curriculum; (2) The Learning Implementation Plan (RPP) that the teacher uses is in accordance with the 2013 curriculum, which in developing learning materials is based on Core Competencies and Basic Competencies well as Competency Achievement Indicators for assessment; (3) students' mathematical literacy skills need to be improved; (4) the teaching materials that teachers use have not yet developed students' mathematical literacy skills; (5) teachers need teaching materials that involve active students in learning activities so that learning is not centered by the teacher and students become more independent in the learning process; and (6) based on student characteristics, students need teaching materials that can

accessed on smartphones and can be studied independently such as e-modules to facilitate the learning process of teachers and students in online learning during the pandemic.

Based on the results of observations and coordination with the mathematics teacher, it was determined that class VIII C students were the test subjects in the one-to-one stage and the small group stage. Meanwhile, class VIII D students as test subjects at the field test stage consisted of 32 students with heterogeneous ability levels. Next, the researcher designs a solution to the problems found from the analysis results. Researchers designed an e-module based on RME and oriented it to students' mathematical literacy skills. The developed e-module contains number pattern material for class VIII students. The e-module contains materials, Core Competencies, Basic Competencies, learning objectives, and Competency Achievement Indicators adapted to the 2013 curriculum. In addition, the researchers also designed research instruments such as material expert validation sheets, media expert sheets, student response questionnaires, and pretest questions and posttest questions.

Formative Evaluation

At this stage, the researcher carried out several stages in succession, which included the self-evaluation stage, the expert review stage, the one-to-one stage, the small group stage, and the field test stage.

Self-Evaluation

At this stage, researchers conducted an independent evaluation of the e-modules and research instruments from the aspect of content, construction, language. Based on the self-evaluation results that the researchers did, there were not many changes from before. Improvements were made to the cover design and symbols contained in the e-module. The results of the self-evaluation stage are called prototype 1.

Expert Review

In the expert review stage, the activity begins with the validation of research instruments and continues with product validation on prototype 1. The validated research instruments are in the form of non-test instruments and test instruments. The validated non-test instruments were material expert validation sheets, media expert validation sheets, and student response questionnaires. The non-test instrument reviewer in this study was Anggit Prabowo, M.Pd. as a lecturer in Master of Mathematics Education at Ahmad Dahlan University on May 25, 2021. The validation process for non-test instruments is carried out online via WhatsApp and email. The results of the review of the material expert and media expert validation sheet and student response questionnaires indicate that the instrument is valid from the material, construction, and language or cultural aspects, with the conclusion that the assessment is feasible to use with revision.

Meanwhile, the validated test instruments were in the form of pretest and posttest questions. The pretest and posttest questions each consist of 5 essay questions. The pretest and posttest questions were validated by two validators, namely Dr. Suprpto, M.Si as a lecturer at

the Master of Mathematics Education at Ahmad Dahlan University and Dr. Burhanudin Nurnugroho Arif, M.Sc. as a lecturer at the Master of Mathematics Education at Ahmad Dahlan University on July 6, 2021. The validation process for pretest and posttest questions is carried out online via WhatsApp and email.

The results of the study of the pretest questions by the two validators show that the pretest questions are appropriate to be used with revisions. Meanwhile, the results of the posttest analysis by the two validators showed that the pretest questions were appropriate to be used with revisions. After the pretest and posttest questions were revised according to input from the validator and declared valid, they were tested on 15 students other than the research class on July 15, 2021. The results of the pretest and posttest tests were calculated using IBM SPSS Statistics 25. The results of the validity test of the pretest questions can be seen in Table 1.

Table 1. Validation results of pretest questions

N	r_{table}	r_{count}				
		Question 1	Question 2	Question 3	Question 4	Question 5
15	0.641	0.62	0.662	0.648	0.849	0.758
		Valid	Valid	Valid	Valid	Valid

Table 1 shows that questions numbered 1 to 5 are valid because the value of r_{count} is greater than r_{table} (Nuryadi et al., 2017). While the results of the reliability test of the pretest question obtained the Cronbach alpha value of 0.770. Based on these results, it can be concluded that the pretest question is reliable because the Cronbach alpha value is greater than the minimum standard ($0.770 > 0.7$) (Nuryadi et al., 2017). Meanwhile, the results of the validity test of the posttest were also carried out using IBM SPSS Statistics 25, which can be seen in Table 2.

Table 2. Validation results of posttest questions

N	r_{table}	r_{count}				
		Question 1	Question 2	Question 3	Question 4	Question 5
15	0.641	0.52	0.648	0.735	0.735	0.772
		Valid	Valid	Valid	Valid	Valid

Table 2 shows that questions numbered 1 to 5 are valid because the value of r_{count} is greater than r_{table} (Nuryadi et al., 2017). While the results of the reliability test of the posttest question obtained the Cronbach alpha value of 0.785. Based on these results, it can be concluded that the posttest question is reliable because the Cronbach alpha value is greater than the minimum standard ($0.770 > 0.7$) (Nuryadi et al., 2017).

Meanwhile, the researcher also validated the e-module on prototype 1 that had been produced in the previous stage, then submitted an expert review (validator) to be validated. Material experts and media experts carried out the e-module validity test. The material expert validator in this research is Prof. Dr. Benidiktus Tanujaya, M.Si. as a lecturer in Mathematics Education at the Universitas Papua on 29 June 2021, and Rooselyna Ekawati, Ph.D. as a lecturer in Mathematics Education at the State University of Surabaya, on July 4, 2021. While the media expert validator in this study was Dr. Wahyu Hidayat, M.Pd. as a lecturer in Mathematics Education at the Siliwangi Teacher Training and Education Institute on July 1, 2021, and Dr. Muhammad Irfan, S.Si., M.Pd. as a lecturer in Mathematics Education at Sarjanawiyata

Tamansiswa University on June 28, 2021. The e-module validation process is carried out online via WhatsApp and email. The following are the results of the material expert validation calculations which can be seen in Table 3.

Table 3. Material expert assessment scores

No	Validator	Assessment Score	Criteria
1	Roselyna Ekawati, Ph.D.	79	Good
2	Prof. Dr. Benidiktus Tanujaya, M.Si.	85	Very Good
	Total Score	164	
	Average Score	82	Very Good

Based on the material expert's assessment score in Table 3, the average score of the two validators is 82, so the RME-based e-module developed is included in the very good assessment criteria of the material expert. Thus, the developed RME-based e-module is declared valid. While the results of material expert validation in the form of comments or suggestions can be seen in Table 4.

Table 4. Comments or suggestions from material experts

Comments/Suggestions
Roselyna Ekawati, Ph.D. (Validator 1)
<ul style="list-style-type: none"> For example, in the e-module, instructions for conducting discussions can be added. The use of models has not yet appeared in e-modules. In e-modules, space can be given for students to form models, such as tabulations. Give instructions to interact with others, for example, discussing. Re-check the purpose of intertwinement or linkage is the possible relationship between number patterns with other mathematical objects or other fields of study.
Prof. Dr. Benidiktus Tanujaya, M.Si (Validator 2)
<ul style="list-style-type: none"> The use of marbles as a context may need to be reconsidered. If that means forming a square number. Because the reality of marbles cannot form it. Maybe dice or some other context can be selected.

The following are the results of the media expert validation calculations which can be seen in Table 5.

Table 5. Media expert assessment scores

No	Validator	Assessment Score	Criteria
1	Dr. Wahyu Hidayat, M.Pd.	96	Very Good
2	Dr. Muhammad Irfan, S.Si., M.Pd.	110	Very Good
	Total Score	206	
	Average Score	103	Very Good

Based on the media expert assessment scores in Table 5, the average score of the two validators is 103 with very good criteria. Thus, the developed RME-based e-module is declared valid. While the results of media expert validation in the form of comments or suggestions can be seen in Table 6.

Table 6. Comments or suggestions from media experts

Comments/Suggestions
Dr. Wahyu Hidayat, M.Pd. (Validator 1)
<ul style="list-style-type: none"> It would be better if the table of contents also made a hyperlink to the destination page. In the field/practice section, the provided google form URL cannot be accessed.

Comments/Suggestions

- The quiz section of learning activities would be better if student data could be recorded in the database. There is no music in the e-module content except videos taken from YouTube.
Dr. Muhammad Irfan, S.Si., M.Pd. (Validator 2)
- There needs to be a back cover, as a front cover.
- The font Calibri 12 is too small. It can be replaced with the font type Tahoma.
- The image of marbles is less realistic because it is unlikely that someone will have marbles with the same motif. It can be replaced with glass or bricks.
- Is there music? There are videos.
- You can add interesting pictures because they are for junior high school students.
- It is advisable to add an email confirmation setting to the student proof of having filled out the google form. Make sure that the correct answer choices vary or are spread out in the quiz section. Remove the down arrow symbol on page 31

After validating the product, the researcher made improvements based on material and media experts' comments and suggestions. Some of the improvements that researchers have made can be seen in the following figure. In the learning activity section, improvements were made to the layout, as shown in Figure 2.



Figure 2. Before revision (left) and after revision (right)

In the interactivity section, additional instructions for interacting between students and editors' additions were made, as shown in Figure 3.

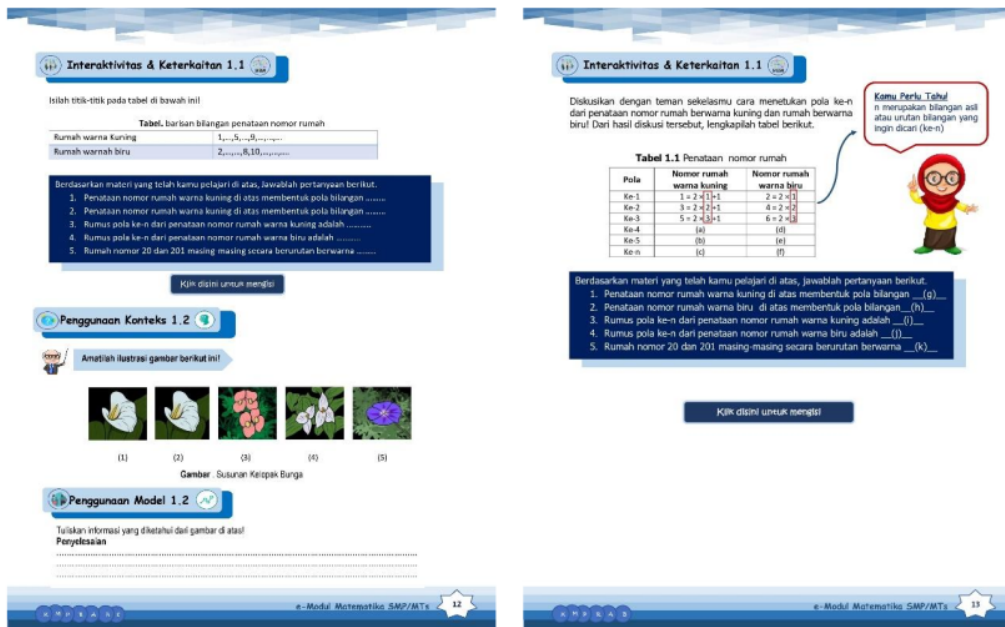


Figure 3. Before revision (left) and after revision (right)

In the quiz section of learning activities, the display is improved to make it more interesting, and the quiz has been set so that students' answers are recorded in the database, as shown in Figure 4.

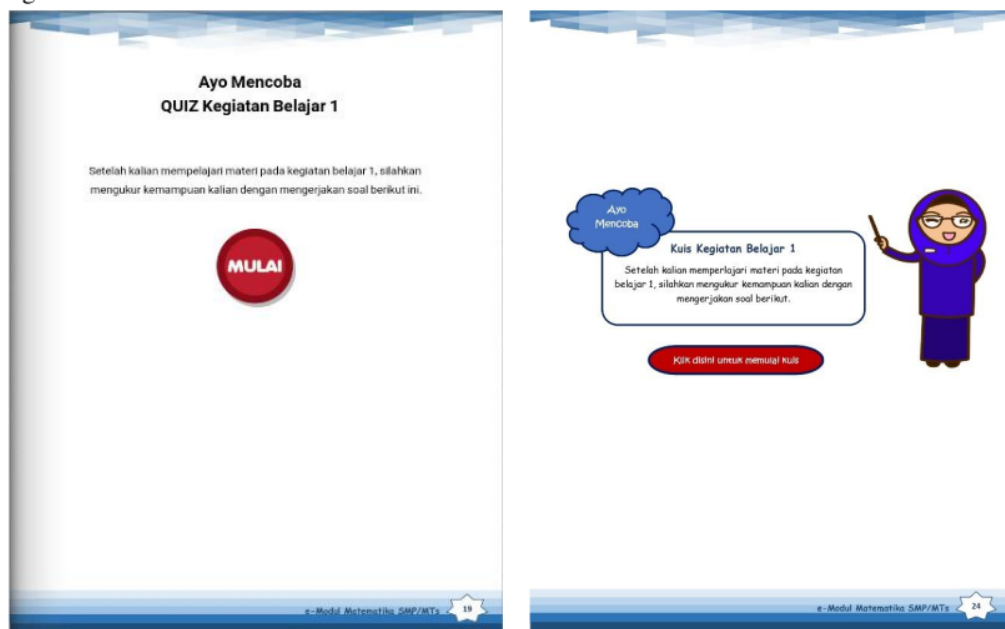


Figure 4. Before revision (left) and after revision (right)

Additional images are added to attract students' attention in the motivation section and the complaint box, as shown in Figure 5.

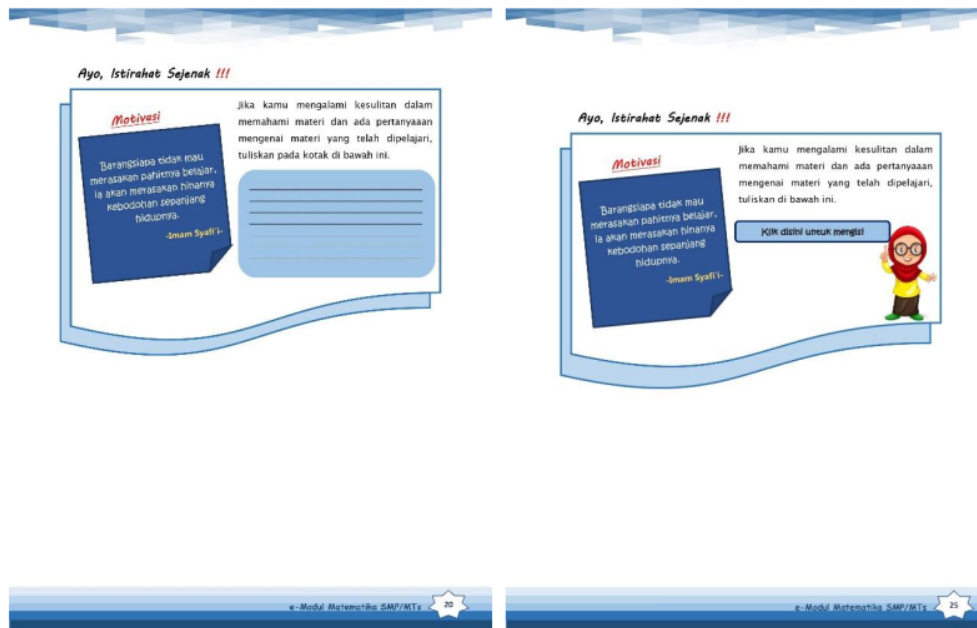


Figure 5. Before revision (left) and after revision (right)

Finally, a rear cover to the e-module, as shown in Figure 6.

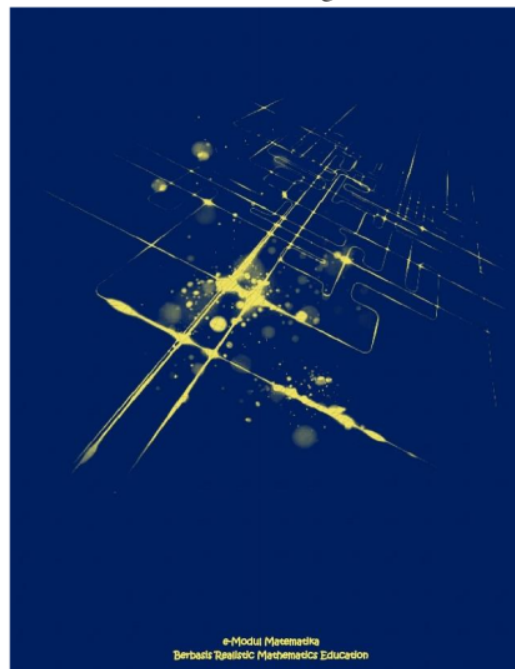


Figure 6. The back cover of the e-module

One-to-One

The product was tested on three grade VIII C students of SMP Negeri 1 Prambanan with heterogeneous ability levels in the one-to-one stage. The one-to-one activity will be held on July 15, 2021. This stage aims to obtain general student responses to the learning activities contained in the e-module. Student comments and suggestions at the one-to-one stage did not experience significant changes. Therefore, the researcher decided to proceed to the small group stage. In the one-to-one stage, student activities are carried out following the researcher's instructions delivered via WhatsApp. The implementation of one-to-one activities can be seen in Figure 7.



Figure 7. Students follow the one-to-one stage

Small-Group

At this stage, prototype 2 was tested on six students from class VIII C of SMP Negeri 1 Prambanan. Activities at the small group stage will be held on July 16, 2021. At this stage, students are asked to use e-modules. The purpose at this stage is to see the student's response to the practicality of the e-module before being tested in a large class. The results of student responses can be seen in Table 7.

Table 7. Scores for the small group stage student response assessment

No	Student	Assessment Score	Criteria
1	S1	103	Good
2	S1	118	Very Good
3	S3	98	Good
4	S4	99	Good
5	S5	89	Good
6	S6	105	Good
	Total Score	612	
	Average Score	102	Good

Based on the student response assessment scores in Table 7, the average student response assessment scores are 102 with good criteria. Thus, the RME-based e-module is declared practical. At this stage, students are asked to provide comments as input for the improvement of prototype 2 before being tested at the field test stage. The following comments and suggestions from students at the small group stage can be seen in Table 8.

Table 8. Student comments and suggestions at stage

No	Comments and Suggestions
1	The story questions given are very interesting and easy to understand
2	Sometimes, the numbers used are too difficult for initial practice
3	I would prefer if the answer collection links were not separated because they were complicated
4	The e-module is very helpful for knowing number pattern material and can train me to learn independently, but for the link in yesterday's e-module there was one that couldn't be pushed, so I had to type the link myself.
5	Positive and easy to understand
6	The module is interesting and easier to understand and find the formula

Several significant improvements were made to prototype 2 based on the comments and suggestions of students at the small group stage, including replacing the use of simpler numbers for the initial exercise, simplifying, and combining the answer filling links in several learning activities, and checking that each link for filling out the answers was correct and worked fine. The results of the improvement of the prototype at this stage are called prototype 3. The next step, prototype 3, is tested at the field test stage to see the potential effects of e-modules on students' mathematical literacy skills. The implementation at the small group stage can be seen in Figure 8.



Figure 8. Students follow the small group stage

Field Test

Prototype 3 e-module was tested in the field test stage on class VIII D students of SMP Negeri 1 Prambanan, who were the research subjects. The learning activities using e-modules in class VIII D were attended by 32 students. At the first meeting, the researcher gave a pretest question to determine the students' mathematical literacy skills before learning to use the e-module. The pretest question consists of 5 essay questions.

Meanwhile, from the second meeting to the sixth meeting, class VIII D students used e-modules to learn number pattern material. Learning activities begin by observing brief material

as an introduction. Then followed by learning activities that start with context, students observe the problems given about number patterns. Then using the model from the problem, students model the problem in mathematical form. Furthermore, using construction, students are given the opportunity to write down the answers to the ideas and solutions. Then interactivity, students are given the opportunity to discuss answers with classmates and teachers if they have difficulty. Finally, linkage, students can relate the material that has been studied. These learning activities are in accordance with the characteristics of RME, which refers to De Lange's theory (Dhoruri, 2010).

Finally, at the seventh meeting, the researcher gave posttest questions to measure students' literacy skills after using e-modules in the learning process. At the seventh meeting, the researcher also asked students to fill out a student response questionnaire to e-modules. Based on the response questionnaire of class VIII D students at the field test stage, the average score of e-module practicality from 32 student responses was 98.03 with good criteria. Thus, the e-module is declared practical.

Furthermore, to determine the potential effect of e-modules on students' mathematical literacy skills. Data analysis of students' pretest and posttest scores was carried out based on the results of the T-Test and N-Gain Test. This study uses a Paired Sample T-Test with a prerequisite for a Normality Test. The data normality test was carried out using the Shapiro Wilk test because fewer samples were than 50 people. The Shapiro Wilk test was performed using IBM SPSS Statistics version 25 with a significance level of 0.05. The normality test results of the pretest and post-test scores of students' mathematical literacy abilities obtained a pretest significance value of 0.639. While the posttest significance value is 0.361. Both data are normally distributed because the significance value is greater than 0.05 (Nuryadi et al., 2017). After the data is declared to be normally distributed, the next step the researcher performs a Paired Sample T-Test using IBM SPSS Statistics version 25. The results of the Paired Sample T-Test test with the pretest and posttest scores of students' mathematical literacy abilities obtained a sig (2-tailed) value of $0.000 < 0.05$, then H_0 is rejected, meaning that there is a significant difference between the average pretest and posttest scores of students' mathematical literacy skills before and after using the e-module.

In addition, based on the N-Gain Test, the average N-gain value of 32 students was 0.32 with moderate criteria. These results indicate an increase of 32% in students' mathematical literacy abilities from the results of the N-Gain Test, pretest scores, and posttest scores. Thus, the RME-based e-module has the potential for students' mathematical literacy skills in number pattern material.

Discussion

The results of the research that have been presented show that the RME-based e-module developed meets the criteria of being valid, practical and has a potential effect on students' mathematical literacy skills. The design of the RME-based e-module development in this study uses a design research type of development studies. Design research of the type of development studies consists of two stages, namely the preliminary stage and the formative evaluation stage (Heriyadi &

Prahmana, 2020). The preliminary stage starts from the analysis activities. The analysis activities include curriculum analysis, student characteristics analysis, and analysis of teaching materials. The data analyzed were obtained from teacher interviews and filling out student observation sheets. Based on the analysis results, it was found that the school had implemented the 2013 curriculum.

In addition, information was also obtained that students had difficulties learning mathematics. The teacher also said that one of the factors that made it difficult for students to learn mathematics was students' low mathematical literacy ability. This can be seen from students having difficulty communicating information about questions, students having difficulty translating real problems into mathematical form, students having difficulty representing answers, students having difficulty designing strategies in solving problems, students having difficulty determining what arithmetic operations to perform. Used in solving problems, students also have difficulty reasoning and conveying arguments. These difficulties are experienced by students when studying number pattern material

Number pattern material is a mathematics subject matter for class eight-grade students. Core Competencies and Basic Competencies for number pattern material are contained in Permendikbud No. 37 of 2018. Meanwhile, from interviews, information was also obtained that teachers need teaching materials to help students become independent and active in the following lessons. One teaching material that students can study independently is e-module (Zakiyah et al., 2019). Meanwhile, one of the mathematical approaches that can activate students is the RME approach. This is because the RME approach is an approach that links human activities with real problems in everyday life, namely RME (Antika et al., 2019; Wardani & Prahmana, 2021). In addition, the RME approach can help students in developing students' mathematical literacy skills (Istiana et al., 2020; Putri et al., 2020). Based on the analysis results, the researcher proceeded to the design stage. Researchers design research instruments and products in the form of e-modules. The product is designed according to the characteristics of the e-module that refers to Riyadi et al. (2017).

The formative evaluation stage begins with the self-evaluation stage. At the self-evaluation stage, the researcher conducted an independent evaluation of the product design in the form of e-modules and the design of research instruments made previously in the introduction. The evaluation results at the initial stage of prototype 1 included an RME-based e-module on number pattern material, material expert validation sheets, media expert validation sheets, student response questionnaires, and pretest and posttest questions. Then, prototype 1 will be validated at the expert review and the one-to-one stages.

At the expert review stage, prototype 1 was validated by validators of material experts and media experts. Meanwhile, in the one-to-one stage, the e-module in prototype 1 will be tested for readability to three students who have different ability levels. The expert review stage begins with a review of research instruments, including non-test and test instruments. The non-test instrument was a material expert validation sheet, a media expert validation sheet, and a student response questionnaire. While the test instruments include pretest and posttest questions. Based on the study results conducted by the validator on non-test instruments and test instruments, it shows that the instrument is suitable for use with revisions. After that, the pretest and posttest questions were tested on students other than the research subjects to determine the validity and reliability of the questions. Based on what has been explained in the research results, the validity of the pretest and posttest

questions using SPSS 25.0 obtained the results that the pretest and posttest questions have met the valid and reliable criteria. The question is valid if r arithmetic is greater than r table (Nuryadi et al., 2017). While the question is said to be reliable if the Cronbach alpha value is greater than the minimum standard of 0.7 (Nuryadi et al., 2017).

Meanwhile the researcher also validated the e-module on prototype 1 to material and media expert validators. Based on the validation results of the e-module in terms of material and media, it obtained an assessment with very good criteria. The e-module product is declared valid, referring to Santi and Santosa (2016), which says the product is valid if the average validation value in terms of material and media has a minimum of good criteria. Meanwhile, the student's assessment of the e-module was not very significant. Then the researchers made improvements to the e-module on prototype 1 according to comments and suggestions. The results of the improvement of prototype 1 at the expert review stage and the one-to-one stage that have been said to be valid are called prototype 2. Next, prototype 2 is tested for practicality at the small group stage.

In the small group stage, the e-module in prototype 2 was tested for practicality to six students from class VIII C of SMP Negeri 1 Prambanan. Practicality criteria were assessed from filling out student response questionnaires. Aspects assessed include language feasibility, content feasibility, RME characteristics, presentation feasibility, graphics, and usefulness. At this stage students carry out learning activities contained in e-modules. After that, students filled out student response questionnaires. The results of filling out the student response questionnaire to the e-module obtained an assessment of the practicality of the e-module with good criteria. The e-module product is declared practical, referring to Santi and Santosa (2016), which says the product is practical if the average practicality value is at least good criteria. Then the researchers made improvements from the comments and suggestions of students at the small group stage. The result of improving the e-module on prototype 2 is called prototype 3. e-module on prototype 3 has been declared valid and practical.

The e-Module in prototype 3 was tested at the field test stage. The e-module field test stage was tested on class VIII D students of SMP Negeri 1 Prambanan with 32 students. At the field test stage, students participate in learning mathematics using e-modules. At the meeting's beginning and end, students were asked to work on pretest and posttest questions and fill out student response questionnaires after learning to use e-modules. Then, the data on the students' pretest and posttest scores were obtained to determine the potential effect of the e-module on students' mathematical literacy skills. Researchers conducted the Paired Sample T-Test and N-Gain Test on the data of students' pretest and posttest scores to determine the potential effect of e-modules on students' mathematical literacy skills. Based on the Paired Sample T-Test, the pretest significance value was 0.639. While the posttest significance value is 0.361. The two significance values indicate that the pretest and posttest values are normally distributed because the significance value is greater than 0.05 (Nuryadi et al., 2017). In line with the normal distribution of the pretest and posttest values, the researcher tested the hypothesis using the paired sample t-test with a significance value of 0.05. Based on the Paired Sample T-Test, the pretest value of Sig. (2-tailed) of 0.000 is smaller than 0.05, so it can be said that there is a difference between the pretest and posttest scores. This can also be seen from the average posttest score (mean=69.17), which is more than the average pretest score (mean=54.81).

Furthermore, based on the N-Gain Test, the N-gain value of 32 students was 0.31 with moderate criteria. This is in line with some researchers investigating increasing students' mathematical literacy skills by applying RME-based learning (Fahmy et al., 2018; Fitria Herliani & Wardono, 2019; Putri et al., 2020). The results of this study support empirical evidence that the application of the RME approach has the potential to improve students' mathematical literacy skills. In addition, the product developed in this study also adds alternative teaching materials in the form of RME-based e-modules to grow students' mathematical literacy skills. In addition, it also supports previous researchers who stated that the development of e-modules can help students learn number pattern material (Ula & Fadila, 2018).

Conclusion

The RME-based e-module with number pattern material for eight-grade students is proven to be valid, practical, and potentially affects students' mathematical literacy skills. The results showed that the e-module developed was valid from the assessments of media and material experts and student comments at the expert review and one-to-one stages with very good criteria. Furthermore, the e-module developed has been practical from assessing student responses at the small group stage and the field test stage with good criteria. Finally, the potential effect of the e-module obtained at the field test stage shows a significant difference in students' mathematical literacy skills after using the e-module based on the average pretest and posttest scores. Furthermore, students' mathematical literacy skills have increased by 32% with moderate criteria. Thus, the RME-based e-module on number pattern material is proven to improve students' mathematical literacy skills. In addition, other researchers are advised to manage time well when implementing RME-based e-modules. This is because the implementation of this e-module takes longer than other approaches. In addition, this research can be used as a reference for other researchers interested in developing RME-based e-modules to improve the abilities of other students.

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Conflicts of Interest

The authors declare that no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely by the authors.

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