

The Development of STEM- nuanced Mathematics Teaching Materials to Enhance Students' Mathematical Literacy Ability Through Information and Communication Technology- Assisted Preprospec Learning

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Model

by Nino Adhi



The Development of STEM-nuanced Mathematics Teaching Materials to Enhance Students' Mathematical Literacy Ability Through Information and Communication Technology-Assisted Preprospec Learning Model

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Abstract: The mathematical literacy ability of Indonesian pupils is still relatively low, as indicated by Indonesia's score of 379 for mathematical literacy in PISA 2018. Paying attention to the learning process such as the teaching materials used in learning, is one of ways to increase mathematical literacy skills. To strengthen students' mathematical literacy skills, it is great for building qualified mathematics teaching materials with the nuances of science, technology, engineering, and mathematics (STEM) which are supported by the information and communication technology (ICT)-assisted Preprospec (Prepare, Problem Solving, Presentation and Conclusion) Learning Model. The research method used in this study is research and development (R&D), with the main reference of 4D-model development by Thiagarajan, whose stages are limited to define, design, and develop. The results showed that the feasibility test on teaching materials obtained the total average percentage of validator I to validator V, respectively, 90.19, 95.45, 93.90, 91.95, and 97.95 with very eligible criteria. It is easy to understand by students with a readability score of $\rho = .109 > \alpha = .05$ or Cochran's Q = 13.091, and it can improve students' mathematical literacy skills, as evidenced by the Wilcoxon test and a gain normalization result of 485.

Keywords: *Mathematical literacy, Preprospec learning model, STEM.*

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Introduction

Mathematics is a subject that is learned at all levels of education. Mathematics is a subject that is crucial to human life. This is due to the fact that mathematics is a field of study that teaches not only numeracy skills but also logical, critical, creative, and systematic thinking. According to Julie et al. (2017), one of the things needed to develop 21st-century abilities is mathematical literacy. Mathematical literacy refers to students' abilities to formulate, use, and interpret mathematics in a variety of contexts, including mathematical reasoning which involves the use of mathematical concepts, techniques, facts, and tools to describe, explain, and predict occurrences. Students can use this ability to make sensible and logical decisions and judgments (Syawahid & Putrawangsa, 2017).

As shown in the Program for International Student Assessment (PISA) scores, Indonesian education ranks below the average and even regarded among the lower tiers of the global education rankings. In the 2018 survey, Indonesia achieved a score of 379 for mathematics literacy, with 85 percent of children aged 15 years participating. Indonesia's score falls into the first of six PISA levels. This score also places Indonesia behind neighboring countries such as Singapore, Malaysia, and even Brunei (Organisation of Economic Co-operation and Development, 2019). Indonesia also took part in TIMSS events in 2003, 2007, 2011, and 2015. Indonesia was ranked 44th out of 49 nations in the 2015 TIMSS survey, with a score of 397 out of a global average of 500 (Hadi & Novaliyosi, 2019).

Several studies also show that Indonesian pupils' mathematical literacy is still insufficient. Arvyaty et al. (2018) discovered a lack of mathematical literacy in a junior high school in Kendari, due to students' lack of basic math skills, low learning motivation, and inability to connect mathematical concepts with math problems. Moreover, in one of Lampung public junior high schools, it was found that the students who had low mathematical literacy tended to be passive in the learning process. In addition, the teaching materials did not meet the needs of students in order to improve their mathematical literacy abilities. The phenomena were reasonable since the information provided in the teaching

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materials were dense and straightforward, in which the teaching materials did not train students' mathematical literacy abilities (Sari et al., 2020). As shown by Dewantara (2019) and Suharyono and Rosnawati (2020), the questions in the mathematics textbooks of curriculum 2013 are not ideal for integrating the components of developing students' mathematical literacy skills. The majority of the questions are presented without context, causing students less likely to practice contextual questions and more likely to focus on remembering formulas. In the initial observations conducted by researchers at SMP N 2 Kudus (Public Junior High School 2 Kudus) on 34 students, the average initial score of students was 44.39 with a standard deviation of 28.29, indicating that the mathematical literacy ability of students on SMP N 2 Kudus needs to be improved.

Mathematic literacy skills must be enhanced based on the current facts. Paying attention to the learning provided to students, from the instrument to the learning model utilized, can help to improve mathematical literacy skills. Teaching materials are one component of the learning instrument. The teaching materials are materials that have been carefully and methodically prepared to achieve learning so that students can study independently. Putri et al. (2020) explained that the level of students' literacy skills was influenced by teaching materials in the form of learning modules.

In the industrial 4.0 era, science, technology, engineering, and mathematics (STEM) is one of the approaches that can be implemented in students' teaching material which keep supporting the improvement of students' mathematics literacy skills. STEM is an approach that connects science, technology, engineering, and mathematics topics. Although STEM education originated in the United States (US), it has been being adopted in several countries (Permanasari et al., 2021; Sari, 2017). Taiwan, Malaysia, and Australia are examples of countries that have integrated STEM through curriculum reform, teacher training, and the utilization of various learning modalities (Nugroho et al., 2019). STEM can be supported by a variety of learning models due to its integrative character which allows us to use the variety in aiding its implementation (Wulandari et al., 2019). The essence of STEM education is to prepare students to be problem solvers, inventors, pioneers, independent and logical thinkers, and technology experts (Mu'minah & Aripin, 2019). STEM integration patterns are called approaches in STEM learning which include silo, embedded, and integrated approaches (Roberts & Cantu, 2012). In addition, there are types of STEM implementation in Indonesia according to Arlinwibowo et al. (2020). They are divided into three types, namely STEM integration at school scale, STEM integration in building subjects, and STEM integration in a subject.

STEM in this study is used as a nuance of teaching materials by implementing an embedded approach and applying the type of STEM integration in a subject, where mathematics is chosen as the main material supported by science, technology, and engineering. This book is based on real-life problems or situations related to science, technology, engineering, and mathematics. The components of science, technology, engineering, mathematics will be associated with mathematics material, each component will be presented through; (a) the science component is presented with natural phenomena and changes which occur in the surrounding nature; (b) the technology component is presented through existing innovations related to knowledge of technology and information which can be utilized in mathematics learning; (c) the engineering component is presented through a discussion of engineering and construction knowledge related to the material. (d) the mathematics component is related to the fields of geometry, algebra, and calculus which are expressed with numbers and special notation. This is a characteristic of mathematics-teaching materials with STEM nuances that will distinguish them from mathematics-teaching materials in general.

Previous studies have found STEM education to improve student achievement (Becker & Park, 2011). Kelana et al. (2020) discovered that the STEM method had an impact on mathematical literacy skills in their study. Another study by Han et al. (2016) also revealed that students, whose learning activities incorporated with STEM, showed higher scores in geometry, probability, and problem solving than non-STEM students. Research related to the development of STEM-based mathematics teaching materials had been carried out by Haminah et al. (2020) on the material of building space which were tested in both small and large groups. The research shows that the teaching materials are valid, practical, and suitable for use. STEM-based teaching materials, to improve students' mathematical connection skills, have also been studied by Niam and Asikin (2020) by showing positive results, in which the teaching materials are valid, practical, and effective in improving students' mathematical connection skills. Artha et al. (2021) who developed teaching materials in the form of STEM-based student worksheet also showed that these teaching materials could improve students' critical thinking skills.

Based on the initial observations made by researchers, most learning process is still carried out using the teacher-centered method. Although the teachers also applied questions and answers after explaining the material in the lesson, but the students must be given encouragement first to actively ask or answer questions. This is in line with what was revealed by Saihu (2020), that there were still few lessons that could facilitate students to be active in class while there were still many students who were only listening, taking notes, and trying to remember all the materials which were taught by the teachers. This phenomenon causes students to only remember the materials instead of understanding the actual concept. One of the alternative learning models that support student-centered learning is ICT-assisted Preprospec model learning. The ICT-assisted Preprospec is a learning model which is developed specifically for mathematics learning. The Preprospec model was proposed by Dewi (2020). This learning model has five-stage learning model that includes preparation, problem solving, presentation, evaluation, and conclusion. ICT-assisted Preprospec was chosen as a learning methodology because it helps students generate new concepts by applying previously learned

mathematical concepts. Learning will also be more effective and efficient with the use of ICT, this is because mathematics has abstract characteristics, uses many graphs and images, and is widely applied in real life and other disciplines. The use of ICT can also provide opportunities for students to be able to find other learning resources that support learning via the internet without being bound by distance, place and time (Dewi, 2020). In addition, STEM and the ICT-assisted Preprospec learning model have similarities in involving students in meaningful learning, implementing teaching and learning activities which encourage students to be active during class, and training students in collaboration and communication during learning activities (Dewi, 2020; Moore et al., 2016).

Based on the foregoing, it is critical to develop mathematics teaching materials based on the STEM-nuanced through ICT-assisted Preprospec to enhance students' mathematical literacy skills. The topic for this teaching materials development is system of linear equations in two variables. The goal of this study is to understand the process of developing STEM-nuanced teaching materials using an ICT-assisted Preprospec learning model on system of linear equations in two variables materials, to obtain the teaching materials feasibility level, to examine the readability of teaching materials, and to know the increase in students' mathematical literacy skills after using STEM-nuanced teaching materials on the ICT-assisted Preprospec.

Methodology

Research Design

This research was classified as research and development (R&D). R&D is a research method used to create products and test their effectiveness (Sugiyono, 2016). The final product will be STEM-nuanced mathematics teaching materials that will help students enhance their mathematical literacy skills. The Thiagarajan model's development, known as the 4-D model, was used in this research. The process consists of four stages: define, design, develop, and disseminate (Thiagarajan et al., 1974). This research was limited to the development stage due to a lack of funds, time, and facilities. The research procedure was depicted in Figure 1. In addition, at the development stage, especially for the development of testing stage, this study used a research design in the form of The One-Group Pretest-Posttest Design.

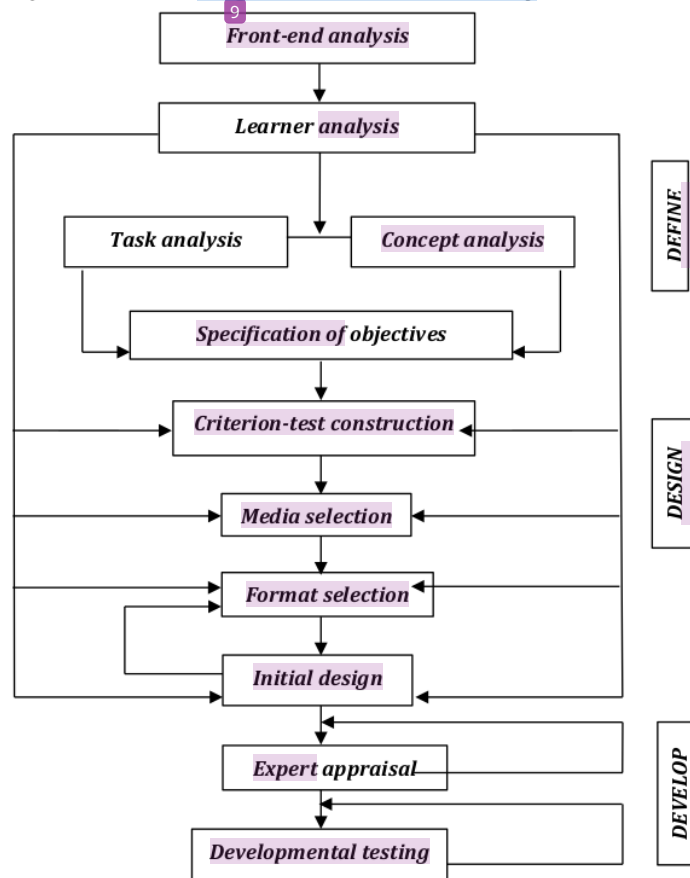


Figure 1. Research Procedure (Al Tabany, 2017; Thiagarajan et al., 1974)

Research Procedure

This designed research consists of three stages, namely the defining, designing, and developing stages. The stages of the research procedure were described as follows. First, the defining stage was where the material requirements and limitations of the teaching materials to be developed are determined. Five sub-stages in this stage must be completed, which were front-end analysis, learner analysis, task analysis, concept analysis, and specifying instructional objectives. Second, the designing stage was where a product prototype was created. Criterion-test construction, media selection, format selection, and initial design were all activities taken in this stage. Lastly, the developing stage was to produce teaching materials that had been revised regarding validator comments and suggestions. Expert appraisal and developmental testing were two activities at this stage. During the expert appraisal activity, the draft 1 was validated by five validators, including three lecturers and two junior-high-school-mathematics teachers. The purpose of validation was to verify the feasibility of the teaching materials. The researchers obtained the level of feasibility of teaching materials as well as comments and suggestions from the validators, which were then amended teaching materials to improve and perfect the flaws that exist in Draft 1. After that, at the developmental testing, teaching materials were put to the test in the classroom. The developmental testing process was divided into four steps: a) preparation, b) pretest, c) learning implementation, and d) posttest. The data from the pretest and posttest were then used to assess whether students' mathematical literacy skills had improved. The tests performed were prerequisite tests and dependent two-sample tests, which were complemented by the normalized gain (N-Gain) test.

Sample, Research Instruments, and Data Collection

This research was undertaken in the academic year 2021/2022. The samples of this research were in Junior High School 2 Kudus (SMPN 2 Kudus) classes VIII H and VIII F. Data were collected utilizing a questionnaire to determine the feasibility and readability of STEM-nuanced mathematics teaching materials, as well as providing students' exams in the form of essays to determine their mathematical literacy abilities before and after using the teaching materials. There were two questionnaires that used in this study, the first one was a validation sheet that was used to obtain data related to assessments from experts in validating teaching materials that had been designed. The results of the assessment by the validator were used as a basis for improving the teaching materials that had been designed. The validation sheet includes summarizing the feasibility aspects of content, language, and presentation. The second one was readability test sheet. The questionnaire on the readability test in this study included language readability, easy reading, attractiveness to the content and choice of language, as well as understanding regarding the material and language used in the teaching materials.

The Analysis of Teaching Materials Development

This study's data was qualitative which were obtained from the validation of the feasibility teaching materials and a questionnaire on the readability of teaching materials sent to pupils. The data has been processed through quantification and descriptive analysis. How to analyze the teaching materials are detailed as follows.

1) The Analysis of Feasibility of Teaching Materials

The feasibility of teaching materials was evaluated by calculating the presentation of the results given by expert validators from the questionnaire with a Likert scale and then translating the qualitative values into quantitative values (Lestari & Yudhanegara, 2018). The criteria for the feasibility level of the teaching materials used in this study according to Akbar (2017) are shown in Table 1.

Table 1. The Criteria for the Feasibility Level of the Teaching Materials

Feasibility Level	Criteria
$1\% \leq P \leq 50\%$	Not Feasible
$50\% \leq P \leq 70\%$	Feasible Enough
$70\% \leq P \leq 85\%$	Feasible
$85\% \leq P \leq 100\%$	Very Feasible

2) The Analysis of Readability of Teaching Materials

This questionnaire used a Guttman scale in the form of "agree or disagree" which was then converted into a quantitative value in the form of 1 or 0. The readability of teaching materials was tested using the Q-Cochran Test. This study's readability hypothesis was as follows.

H_0 : There is no difference of opinion among the 10 related students about their grasp of teaching materials with STEM nuances in the ICT-assisted Preprospec learning model.

H_1 : At least one opinion about students' grasp of teaching materials with STEM nuances in the ICT-assisted Preprospec learning model is different from others' opinions.

The significance level utilized in this study is $\alpha = .05$. The test criteria for this readability test are to accept H_0 if $\rho_{hitung} \geq \alpha = .05$.

The Analysis of Test Instrument

Test instrument was analyzed using validity with Pearson's product moment and reliability with Cronbach's alpha formula. Discriminating power was calculated by subtracting the average score of the upper group students' answers and the average score of the lower group students divided by the Ideal Maximum Score, while the level of difficulty was calculated by dividing the average score of student answers on an item by the Ideal Maximum Score.

The Analysis of Enhancement of Students' Mathematical Literacy Ability

The data of students' mathematical literacy skills were analyzed using normality test (Saphiro-Wilk), two dependent sample test, and N-Gain test.

N-Gain test was used to find out the increase in mathematical literacy skills before and after the use of teaching materials. The average score of N-Gain was the difference between the average posttest score and the average of pretest score divided by the difference between ideal maximum score and the average of pretest score (Hake, 1999). The criteria for the N-Gain level are served in Table 2.

Table 2. N-Gain Scores and The Classification

N-Gain (g)	Criteria
$g > 0.7$	High
$0.3 < g \leq 0.7$	Moderate
$g \leq 0.3$	Low

Findings / Results

The results of research on the development of teaching materials with STEM-nuances to enhance the students' mathematical literacy ability through the ICT-assisted Preprospec learning model are the results of the define, design, and develop stages, which includes the results of the teaching material development process, the results of the appropriateness test of teaching materials by the validator, the results of the readability test by students, and the results of improving students' mathematical literacy skills in the form of pretest and posttest results. The following is a description of the results of this study.

Defining Stage

The information that we got from this stage were; a) at the beginning of the pandemic, learning at SMP N 2 Kudus was carried out online, but started on August 30 2021, was limited face-to-face learning with an allotted time of 2 x 30 minutes for each subject; b) students had difficulty understanding the concept of material provided by the teachers; c) students still had difficulty working on questions whose forms were different from what they had been used to; d) some students still answered questions without using a coherent method; e) some students still had difficulty understanding the questions; f) in classroom learning, the majority of students were still passive, so it was necessary to be given encouragement first to actively ask or answer questions; g) the teachers had never used a learning model in the form of ICT-assisted Preprospec and had never applied STEM nuances in teaching and learning activities; k) the learning resources used by teachers were textbooks from the government and Lembar Kerja Siswa (LKS) or student worksheet from Musyawarah Guru Mata Pelajaran (MGMP) Matematika Kudus or Mathematics Teacher Conference Kudus; l) in learning activity the teacher used lecture method, as well as question and answer sessions; m) the teachers' stated that the students still lack of the ability of mathematical literacy, moreover this was proved by the inaccuracy of students in understanding the information contained in the problems, hence most of the students could not solve the problems correctly; n) the level of education background of the students were on the second year of the junior high school and the socioeconomic status of the students were relatively same i.e. on the middle categories. The results acquired at this stage indicated that students' mathematical literacy abilities needed to be enhanced, as indicated by the findings of a preliminary study for class VIII and an interview with one of the mathematics teachers at SMP N 2 Kudus. To meet these needs, learning innovations that are relevant to students' problems were required, particularly in the area of improving mathematical literacy skills, which can be accomplished through the development of STEM-nuanced teaching materials in the ICT-assisted Preprospec learning model. According to the task analysis, the material used in this study is a system of linear equation in two variables, and the content that students must master is the concept of system of linear equation in two variables (SPLDV), as well as how to solve system of linear equation in two variables using the graph method,

substitution method, elimination method, and combination method. The content of the educational materials will be related to STEM applications in everyday life. The learning objectives are then modified to the ICT-assisted Preprospec learning model based on KI and KD in Curriculum 13.

Designing Stage

The criterion-test construction was created by creating a test based on indicators of students' mathematical literacy skills and then tested the items on students in class VIII H SMP N 2 Kudus who had received the SPLDV material. STEM-nuanced teaching materials in the ICT-assisted Preprospec learning model, as well as PowerPoint, were chosen as the learning media. The following is the format selection in this teaching material development product: the teaching materials are organized systematically and sequentially; the cover design incorporates images, colors, font sizes, and shapes that are appropriate to make it appeal; and signs or icons are employed. The paper size is A4, the fonts used are Times New Roman, Cambria Math, Lato, Calibri (Body), and Glacial Indifference with a font size of 10 to 14 pt., adjusting the design and empty space on the paper, and the spacing used is 1.5 to make reading teaching materials easier. At the initial designing stage, the supervisors gave some advices on the teaching materials that had been developed, known as the initial draft or Draft 1. The researcher created a feasibility test questionnaire and a readability test during the initial designing stage, which was also discussed with the supervisors. The following are some previews of the initial design of teaching materials shown in Figure 2.



Figure 2. The Initial Design of Teaching Materials

Developing Stage

From the expert appraisal, researchers got the results of the feasibility test assessment by Validator I, Validator II, Validator III, Validator IV, and Validator V were 90.19%, 95.45%, 93.90%, 91.95%, and 97.95%, respectively, with very feasible criteria. The feasibility test is carried out by modifying and customizing the BNSP's aspects and assessment criteria. There are three components of the feasibility test that are evaluated: aspects of content feasibility, aspects of language feasibility, and aspects of presenting feasibility. Table 3 shows the results of the teaching materials feasibility test on each aspect of the teaching materials.

Table 3. The Results of the Teaching Materials Feasibility Test on Each Aspect

The Observed Aspect	P (%)	Criteria
Content Feasibility	94.99	Very Feasible
Language Feasibility	92.65	Very Feasible
Presenting Feasibility	94.05	Very Feasible

The results in the Table 3 show that the STEM-nuanced mathematics teaching materials in the SPLDV material contain aspects of content feasibility, language feasibility, and presenting feasibility with the very feasible criteria. As a result, according to the BSNP, teaching materials that have been adapted to the ICT-assisted Preprospec learning model have met the feasibility requirements. Based on the feasibility test, one of the modifications done by the researchers was to change the contents of the STEM Corner, where in Draft 1, the contents of the STEM Corner were completed with all STEM components, then with various considerations, the contents of the STEM Corner were changed by simply selecting one of the STEM components that are most closely connect [36](#) to the illustration of the problem to be presented. The following are some previews of the Draft 2 of teaching materials shown in Figure 3 and Figure 4.

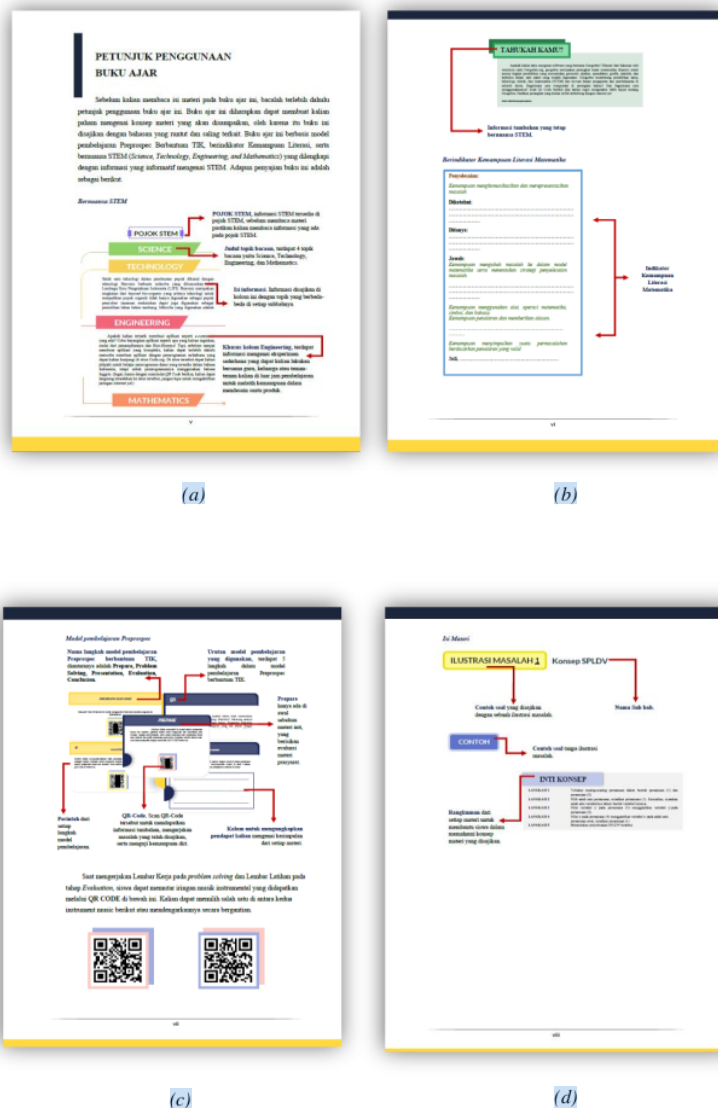
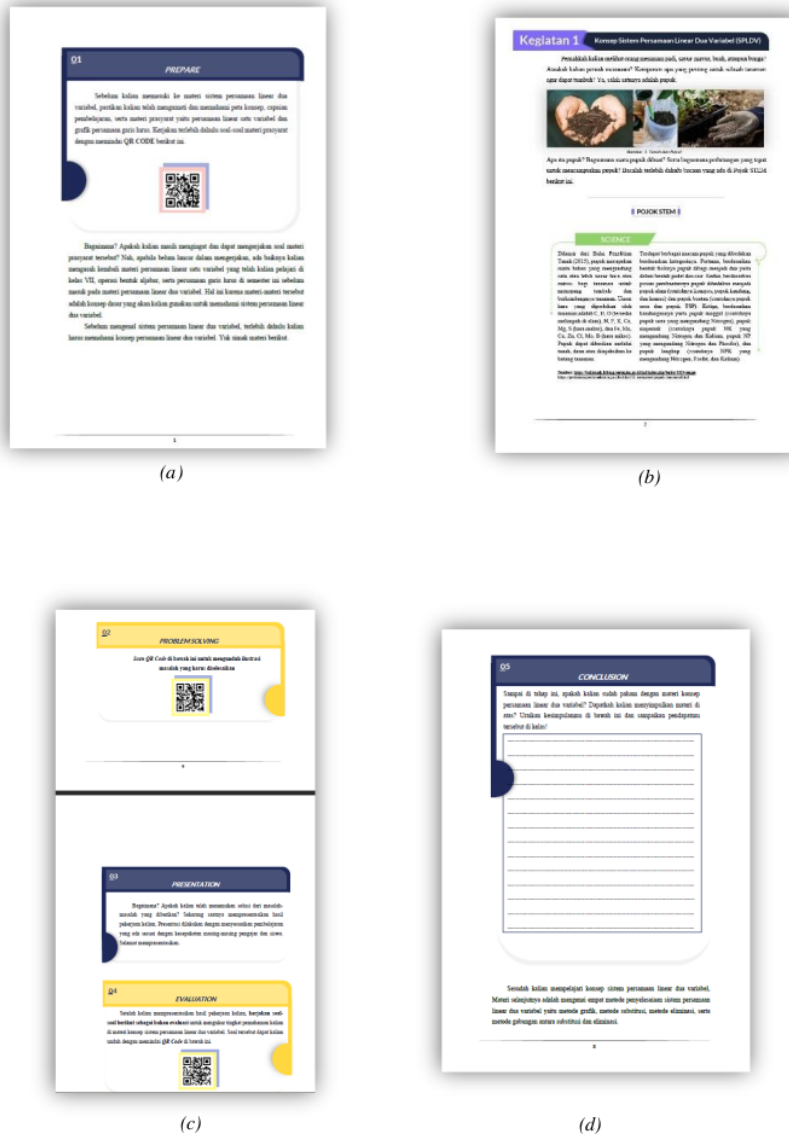


Figure 3. Introductory Part of the Teaching Material



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Figure 4. Parts of the Contents of the Teaching Materials

The readability test of the teaching materials is conducted after the teaching materials have been fixed, which is known as Draft 2. Draft 2 was given to 10 students of SMP N 2 Kudus grade VIII with the objective is to see if all 10 students thought the same thing, namely that they understood STEM-nuanced teaching materials in ICT-assisted Preprospec learning. The Q-Cochran test results are shown in Table 4.

Table 4. The Q-Cochran Test Result

Testing Stage	Cochran's Q	ρ	Null Hypothesis (H_0)	Note
1	46.047	.000	H_0 is rejected	The fourth assessment item was dropped.
2	13.091	.109	H_0 is accepted	Has fulfilled the requirements.

Based on the 4th assessment item, namely rectifying the writing errors which exist in the teaching materials, it can be deduced that the teaching materials need to be improved.

After the experts' appraisal activity completed, then the developmental testing is carried out. The results are detailed as follows.

1) Preparation stage

The preparation stage is the stage where students, who have studied SPLDV material, were given trial questions then the test results were tested for validity, reliability, discriminating power, and level of difficulty. The class that carried out the preparatory stage was class VIII H of SMP N 2 Kudus. The results of the trial analysis can be seen in Table 5.

Table 5. The Trial Analysis

Number of Indicators	Items	Validity	Discriminating Power	Level of Difficulty	Note
1	1	Valid	Bad	Hard	Not used
	2	Valid	Bad	Hard	Used with improvements
2	3	Valid	Bad	Hard	Used with improvements
	4	Valid	Bad	Hard	Not used
3	5	Valid	Bad	Hard	Not used
	6	Valid	Bad	Hard	Used with improvements
4	7	Valid	Bad	Hard	Used with improvements
	8	Valid	Bad	Hard	Not used
5	9	Valid	Bad	Hard	Used with improvements
	10	Valid	Bad	Hard	Not used

The value of the reliability correlation coefficient obtained in the test is 0.944 with a very high category. Based on the validity, reliability, discriminating power, and level of difficulty tests in Table 5, it can be seen that there are questions which are not used with improvements. The selection of items is based on the values obtained from the validity, reliability, discriminating power, and level of difficulty tests while were still considering the results of each student's work. The questions used with further improvements will be used as pretest and posttest questions to find out the increase in students' mathematical literacy abilities.

2) Prerequisite Tests

In this study, the Shapiro-Wilk test was applied to analyze normality. The results of the normality test in Table 6 are shown as follows.

Table 6. The Normality Test Result

Data	Mean	Median	Std. Deviation	Sig.	Null Hypothesis (H ₀)	Note
Pretest	14.56	13.46	12.03	.004	H ₀ is rejected	Not normally distributed
Posttest	55.50	64.81	21.66	.055	H ₀ is accepted	Normally distributed

The pretest data, as seen in the Table 6, is not normally distributed. Because one of the data sets is not normally distributed, the pretest and posttest data are analyzed using non-parametric statistics, specifically the Wilcoxon test.

3) Wilcoxon Test

This research used the Wilcoxon test to measure whether there was a difference in the mean values of the two sample groups that were mutually dependent. Table 7 shows the Wilcoxon test findings.

Table 7. The Normality Test Result

Data	Z	Sig. (2-tailed)
Pretest- Posttest	-5.160	.000

If the Wilcoxon test results indicate sig. (2-tailed) = .000 < α = .05, then H₀ is rejected. This implies that the pretest and posttest results are on average difference.

4) N-Gain Test

The N-gain test was used to determine the increase in students' mathematical literacy skills by using pretest and posttest data. The results of the N-gain test calculation are shown in Table 8.

Table 8. The N-Gain Test Result

Class	Average Score		N-gain	Criteria
	Pretest	Posttest		
VIII F	13.57	55.50	0.485	Moderate

The N-gain value of 0.485 obtained from the table above indicates that there is a 0.485 increase in mathematical literacy ability in the moderate level. This shows how using STEM-nuanced teaching materials in the ICT-assisted Preprospec learning model can assist students in improving their mathematical literacy abilities. Each indicator of students' mathematical literacy abilities was also evaluated to the N-gain test. The increase in the value of four indicators is in the moderate level, while one indicator is in the low category, according to the test results. The results of the N-gain test on each indicator of students' mathematical literacy ability are shown in Table 9.

Table 9. The N-Gain Test Result

Indicator	Test Score		N-gain	Criteria
	Pretest	Posttest		
1	27.57	72.71	0.623	Moderate
2	2.60	56.10	0.549	Moderate
3	10.91	53.25	0.475	Moderate
4	0.82	29.39	0.288	Low
5	0.57	37.14	0.368	Moderate

Note:

- Indicator 1 : The ability to communicate and represent problems.
- Indicator 2 : The capacity to translate problems into mathematical models and design problem-solving strategies.
- Indicator 3 : The ability to use tools, mathematical operations, symbols, and language.
- Indicator 4 : The reasoning ability and providing reasons.
- Indicator 5 : The ability to conclude a problem based on valid reasoning.

Discussion

Based on the Wilcoxon test, which indicates that there is an average difference between the pretest and posttest scores, and the N-gain test, which shows that there is an average difference between the pretest and posttest scores, it was determined that STEM-nuanced teaching materials in the ICT-assisted Preprospec learning model can improve students' mathematical literacy skills. Research related to the effect of STEM on mathematical literacy skills was studied by Mujib et al. (2020) at the university level by testing a number of questions on students in STEM classes and non-STEM classes, showing that mathematical literacy skills in STEM classes are better than non-STEM classes. According to him, this is due to learning by applying STEM can increase sensitivity to real-world problems so that students can provide various solutions with justification for various phenomena contained in the daily life environment related to the concept of mathematical literacy. The N-gain value is 0.485 in the moderate category. The similarity of this study with other studies, one of which is research from Niam and Asikin (2020) is that both develop STEM-related teaching materials and get N-gain results in the moderate category. While the difference is that in this study the ability tested in the study is the improvement of students' mathematical literacy skills. Several factors influence students' mathematical literacy skills: (a) teaching materials are developed based on indicators of students' mathematical literacy abilities, so it can help students improve their mathematical literacy skills; (b) STEM components are provided in teaching materials which are customized to the learning material, ensuring that the content in the teaching materials is not monotonous; (c) teaching materials provide ICT-assisted Preprospec learning models, which allow students to participate in learning experiences that entail their active participation. The increase in pupils' mathematical literacy skills, on the other hand, is moderate, due to the following factors: (a) each student has a varied mathematical literacy ability, as indicated by the pretest and posttest scores, resulting in an increase in the moderate category when these scores are averaged; (b) because students are unfamiliar with the learning model used, some students struggle with activities that need active participation, such as arguing and discussing activities in classroom learning. This can have an impact on students' mathematical literacy skills; (c) the limited study time, particularly six sessions with details of 2 JP × 30 minutes, has hampered the development of students' mathematical literacy abilities. The researchers have been unable to discuss the material in more depth to build students' mathematical literacy skills. In line with a study by Widayoko et al. (2018) who found that STEM-integrated teaching materials result in better learning results for scientific literacy competency than conventional teaching resources. Additionally, according to research by Utami et al. (2020), the implementation of STEM-based modules enhances students' mathematical literacy abilities because the activities in the module require them to use math in context.

On each of the indicators of the student's mathematical literacy, the N-gain test was also conducted. According to the test results, four indicators' value increases fall into the moderate group, while one indicator falls into the low category. Table 8 shows the results of the N-gain test on each indicator of students' mathematical literacy ability. The explanation is as

follows, based on the table. Indicator 1, which measures the ability to communicate and represent problems, has a moderate N-gain of 0.623. On this indicator, many students do not write down what they know or are asked in the questions, which has an impact on their scores. Indicator 2, which evaluates the capacity to translate problems into mathematical models and design problem-solving strategies, get 0.549 in the moderate level. In the second indicator, several students failed to write down the definition of the variable to be used, leading the score to being affected. Indicator 3, which measures the ability to use tools, mathematical operations, symbols, and language, falls into the moderate level with N-gain of 0.475. In this indicator, some students make multiple errors in the use of mathematical operations and symbols and affecting their score. Indicator 4 which is the reasoning ability and provides reasons, obtain N-gain of 0.288 in the low category. Indicator 4 is the reasoning ability, and it explains why an N-gain of 0.288 in the low group was obtained. Most students do not write down the value of each variable mathematically (e.g., $x = 15$ and $y = 30$) before converting the mathematical statement into a statement, significantly affecting the scoring. Indicator 5 which is the ability to conclude a problem based on valid reasoning get N-gain of 0.368 in the moderate category, indicating that the majority of students did not conclude a problem, thus affecting the scoring.

50 Conclusion

Based on the findings of research and discussions, the following conclusions can be drawn: (a) the development of STEM-nuanced teaching materials in the ICT-assisted Preprospec learning model has gone through stages such as defining, designing, and developing; b) the teaching materials which were developed are eligible for use in learning, with the total average percentage achieved from Validator I to Validator V, respectively, 90.19%, 95.45%, 93.90%, 91.95%, and 97.95% with very feasible criteria. Content feasibility, language feasibility, and presentation feasibility are also addressed in the teaching materials. The average scores are 94.99%, 92.65%, and 94.05%, respectively, with very feasible criteria; c) the developed teaching materials were easily understood by pupils, with a value of $p = .109 > \alpha = .05$ and a value of Cochran's $Q = 13.091$; and d) the developed teaching materials can help students enhance their mathematical literacy skills. The Wilcoxon test findings show that there is an average difference between the pretest and posttest scores. It also has an N-gain test result of 0.485 in the moderate category and each indicator of mathematical literacy ability has improved.

Recommendations

As a result, this teaching material can be used as a supplement to classroom learning to develop students' mathematical literacy skills. For future research, we can inform that there were some students who still struggled with working on mathematical literacy indicator questions, thus more exercises with mathematical literacy indicators and more extensive explanations were required. Future researchers also could investigate the enhancement of another ability such as critical thinking, mathematical connection, creativity, etc. on the development of STEM-nuanced teaching materials in the ICT-assisted Preprospec learning model. Lastly, the material arranged in the development of teaching materials is supposed to be more matched to the level of knowledge and/or understanding of students.

70 Limitations

This research is limited to improving students' mathematical literacy skills and restricted to the material of system of linear equations in two variables. 56

Authorship Contribution Statement

Dewi: Conceptualization, development of Preprospec learning models, making learning instrument, editing/reviewing, critical revision of manuscript, final approval. Maulida: Conceptualization, design, collecting data, data analysis, making learning instrument, drafting manuscript.

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