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Thematic Teaching Materials Using Science, Technology, Engineering and Mathematics Approaches to Improve Problems Solving Ability of Elementary School Students

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ABSTRAK

Pembelajaran tematik diharapkan menjadi kegiatan pembelajaran yang dapat melibatkan siswa secara aktif dan dalam kegiatan pembelajaran, sehingga siswa mendapatkan pengalaman langsung yang menjadikan kegiatan pembelajaran jauh lebih bermakna. Bahan ajar tematik dengan pendekatan STEM menjadi salah satu alternatif untuk meningkatkan kemampuan pemecahan masalah siswa. Penelitian ini bertujuan untuk menganalisis kevalidan, kemudahan, kemenarikan, kemanfaatan, dan keefektifan bahan ajar tematik dengan pendekatan STEM untuk meningkatkan kemampuan pemecahan masalah siswa di sekolah dasar. Penelitian ini merupakan jenis penelitian Research and Development (R&D), pengembangan dilakukan sesuai dengan teori Borg & Gall. Subyek dalam penelitian ini ditentukan dengan menggunakan teknik purposive sampling dan diperoleh sebanyak 20 siswa. Alat pengumpulan data menggunakan instrumen tes yang valid dan reliabel. Teknik analisis data validitas menunjukkan bahwa bahan ajar tematik dengan pendekatan STEM sangat valid untuk digunakan. Teknik analisis data keefektifan menggunakan N-Gain dengan hasil perhitungan 0,57 dengan signifikansi 0,01<0,05. Berdasarkan penelitian ini dapat disimpulkan bahwa bahan ajar tematik dengan pendekatan STEM yang dikembangkan valid dan efektif untuk meningkatkan kemampuan pemecahan masalah siswa di sekolah dasar.

ABSTRACT

Thematic learning is expected that learning activities can involve students actively and in learning activities, so that students get direct experience which makes learning activities much more meaningful. Thematic teaching materials with the STEM approach are an alternative to improve students' problem-solving abilities. This study aims to analyze the validity, convenience, attractiveness, usefulness, and effectiveness of thematic teaching materials with the STEM approach to improve students' problem solving abilities in elementary schools. This research is a type of Research and Development (R&D) research, the development is carried out according to the theory of Borg & Gall. The subjects in this study were determined using a purposive sampling technique and obtained as many as 20 students. The data collection tool uses valid and reliable test instruments. Validity data analysis techniques show that thematic teaching materials with the STEM approach are very valid to use. Effectiveness data analysis technique uses N-Gain with a calculation result of 0.57 with a significance of 0.01<0.05. Based on this research, it can be concluded that the thematic teaching materials with the STEM approach developed are valid and effective for improving students' problem solving abilities in elementary schools.

1. INTRODUCTION

Thematic learning is defined as learning that is designed based on certain themes (Epita et al., 2021; Salamah, 2017). Thematic learning is learning that combines several subjects in one theme. Thematic learning is expected that learning activities can involve students actively and in learning activities, so that students get direct experience which makes learning activities much more meaningful (Lestariningsih & Suardiman, 2017; Rohmanurmeta & Dewi, 2019). Thematic learning in general aims to develop thinking skills and the growth of students' positive character and behavior. This is in accordance

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with Permendikbud number 21 of 2016 regarding content standards including (1) using thinking and reasoning skills in problem solving, (2) communicating ideas effectively, (3) having attitudes and behaviors that are in accordance with material values and learning , such as obeying principles, being consistent, upholding agreements, respecting differences of opinion, conscientious, tough, creative, and open (Masykur, 2017; Wahyuni & Pratiwi, 2017). Based on this, the thematic learning that is taught must be able to improve students' thinking skills including problem solving abilities, conceptual understanding, reasoning, creative thinking, critical thinking, representation, communication, and connection. One of the higher order thinking skills is problem solving ability. Problem-solving abilities in thematic learning are related to students' skills in making decisions and drawing conclusions about problems based on logical, rational, critical, intelligent, honest, efficient, and effective thinking (Farhurohman, 2017; Jannah & Pahlevi, 2020). Problem solving abilities are useful in developing students' potential knowledge and skills in solving problems encountered in learning. Technological advances are aimed at supporting students' problem-solving abilities in dealing with various difficulties in solving problems in learning material. The ability of students to solve problems needs to be trained so that students are able to solve problems encountered in learning material (Antara et al., 2020; Aristianti et al., 2018). Problem solving ability must be owned by every learner. Because the ability to solve problems is an essential and fundamental ability (Parmiti et al., 2022; Rahayu & Afriansyah, 2015). That is, problem solving ability is a fundamental or very important ability. The possession of problem solving skills helps students think analytically in making decisions in everyday life and helps improve critical thinking skills in dealing with new situations (Ana & Ndole, 2021; Bi et al., 2020).

Problem solving in learning is the core basic ability in the learning process (Hidayat & Sariningsinh, 2018; Ningrum & Leonard, 2015). Therefore, in problem solving it is necessary to develop understanding of the problem, create models, solve problems, and interpret the solutions. Good problem-solving skills can support students in choosing a settlement plan and make it easier to choose the right problem-solving for each problem encountered (Fitriatien et al., 2021; Jehadus et al., 2021). So that through problem-solving skills, students are expected to be able to understand the problem, find the settlement design that is studied and understand how to solve the problem in learning material (Andini et al., 2018; Farhurohman, 2017). Based on some of the opinions above, it can be concluded that problem solving ability is the ability of students to use their thinking processes in solving problems through gathering facts, analyzing information, compiling various alternative solutions, and choosing the most effective problem solving. The results of observations made on September 1 2021 used observation, interview and questionnaire techniques, which discussed the teaching materials used by educators when conducting learning with the target of educators and class III students at SD Negeri 1 Purwosari, indicating that there were still weaknesses in the learning process that carried out in class and not achieved with the maximum learning objectives. These findings are supported by the formative learning outcomes of class III students at SD Negeri 1 Purwosari in Theme 1. The percentage of students' learning completeness at Gugus Imam Bonjol Public Elementary School is 36% while the percentage of students who do not complete is 64%. Based on the results of observations, interviews and questionnaires, it is known that the cause of the students' learning outcomes being less than optimal is that educators make educator books and student books the only source of learning, there are still students who are less active in learning, lack of students' ability to problem solving, the teaching materials used are not maximized to achieve learning indicators, the lack of availability of teaching materials as other learning resources that are adapted to the conditions of students and the surrounding environment.

One of the tools that can be used in the learning process to improve problem-solving skills is the use of teaching materials that have been developed to improve problem-solving abilities in learning materials. Teaching materials can be interpreted as materials or subject matter which are arranged in a complete and systematic manner based on the learning principles used by teachers and students in the learning process. Teaching materials become media or bridges in learning to create meaningful learning with specific goals (Arum & Wahyudi, 2016; Rabbani & Muftianti, 2020). In addition to using teaching materials in thematic learning, the learning approach used is expected to trigger an increase in students' problem-solving abilities. The selection of appropriate learning approaches for thematic learning needs to pay attention to the nature of thematic learning, the nature of elementary school children, and thematic learning theory. The STEM approach is an alternative solution for 21st century learning that can improve students' ability to solve problems with learning materials. The STEM approach is learning that integrates science, technology, engineering, and mathematics in the learning process. The application of STEM in learning activities consists of 4C, namely creativity, critical thinking, collaboration, and communication, so that students can find innovative solutions to real problems and can convey them well (Lestari et al., 2018; Pardede, 2020). The STEM approach is an integrated learning between science, technology, engineering and mathematics to develop students' creativity through the process of solving problems in everyday life

(Susanti, E. & Kurniawan, 2020; Wakabayashi & Ishikawa, 2011). Learning with a STEM approach is teaching in a more connected way, especially in the context of real world problems, can make STEM subjects more relevant to students and educators so as to increase motivation to learn and increase students' interest, achievement, and persistence in learning. It is believed that STEM, which integrates the four disciplines, will also increase the number of students considering careers in STEM-related fields (Gog et al., 2020; Nathan, 2014). Development in this research STEM is integrated into the form of teaching materials, namely science, technology, engineering, and mathematics. The development of learning is based on an awareness of the importance of quality teaching materials for students. Enhanced printed teaching materials which can also be combined with various learning approaches, one of which is the STEM approach (Isatunada & Haryani, 2021; P. K. Sari & Sutihat, 2022). STEM-based teaching materials as learning resources in elementary schools to motivate student learning and improve students' ability to solve problems so as to create more effective and efficient learning activities (Oktaviani et al., 2020; Thuneberg et al., 2018). Through STEM-based teaching materials, students are expected to be able to think more broadly, have freedom and safety in expressing ideas, feel comfortable doing learning activities while doing them, determine their own learning, be able to collaborate or be collaborative. The STEM approach in the thematic learning process will strengthen an important component, namely the ability of students in problem solving (Han et al., 2016; Lumbantobing & Azzahra, 2020).

The use of the STEM approach is intended so that students can have an understanding of the four STEM aspects that are interrelated to one subject and can help students solve problems and draw conclusions from previous learning by applying them through science, technology, engineering and mathematics (Bashooir & Supahar, 2018; Puspitasari et al., 2020). The STEM approach is very suitable for use in thematic learning in Elementary Schools because it can integrate several interrelated subjects in one theme that is appropriate to the real life of students. Based on the description above, a study is needed to develop teaching materials in the form of thematic textbooks with a STEM approach to improve problem solving skills. In order to obtain teaching materials in the form of teaching materials that are valid, interesting, easy and useful, and effective for thematic learning of class III SD Negeri 1 Purwosari. Thematic learning using teaching materials in the form of textbooks with the STEM approach is expected to improve students' ability to solve problems in learning.

2. METHOD

This research is a type of research and development research that refers to the development steps of Borg & Gall (Hermawan, 2019). The teaching materials developed are thematic teaching materials with a STEM approach for third grade elementary school students. Data collection begins with analyzing reference sources, class observations, identification of problems found, and determining the right solution to overcome these problems. At this stage the researcher conducted a questionnaire on the needs of public elementary schools in the Gugus Imam Bonjol, Padang Ratu District, Central Lampung Regency, Lampung. Based on the results of the questionnaire it is known that the learning problems experienced by students are low student learning outcomes. At planning stage the researcher conducted a curriculum analysis to determine basic competency planning, learning indicators, learning objectives, and material coverage, as well as compiling instrument grids. After completion, then proceed with designing the framework of the textbook and determining the contents of the parts of the textbook that will be developed. After planning the material to be developed according to learning needs, the next step is to develop the initial product. Initial product development in this study includes determining the elements of teaching materials, collecting material according to the selected material, designing teaching materials, compiling teaching materials according to the design to be made, editing to produce products, finishing the initial product in the form of teaching-based materials the STEM approach to improve problem solving abilities Development of initial forms in the form of product drafts of thematic teaching materials with a STEM approach for third grade elementary school students.

After the initial product design is completed, the next step is to validate the product design. This stage consists of product validation tests by experts. Product validation tests were carried out to validate teaching materials by subject experts targeting material experts, media experts, and linguists. Make revisions to the main product, based on input and suggestions from experts. Based on the results of the teaching material validation, with the advice of experts, the main product revision was carried out. Revisions to the initial form of this product produce the main form of the device which is ready for further series of tests. Initial product trials were carried out to test the feasibility of the product being developed, namely in the form of thematic teaching materials based on the STEM approach to improve problem solving abilities in elementary schools. At this stage, a small group trial was conducted on 8 students III of SD Negeri 1 Purwosari to determine the level of attractiveness, usefulness, and readability of the teaching

materials being developed. Assessment of the attractiveness, usefulness, and readability of student teaching materials by filling out student response questionnaires, then data is collected and analyzed. After the initial product design is carried out to find out whether there are still discrepancies or errors in the product design so that it is corrected and as a product improvement that will be developed. At this stage the researcher then improves or revises the teaching materials that have been validated based on suggestions for improvement and design validation. Revisions to the initial form of this product produce the main form of the device which is ready for further series of tests.

3. RESULT AND DISCUSSION

Result

The Validity of Thematic Teaching Materials with STEM Approach

Material expert validation based on aspects of the suitability of teaching materials with the STEM approach. The product revision suggested by the material expert is to adjust the KD mapping in the teacher's book on theme 6 sub-theme 3, use language according to the child's education level, for example the word “sunday” is changed to the word “weekend”, check again for writing typos in the script, and teaching material products are developed it is feasible but needs to make improvements related to images, written substance and others. The results of the validation test for teaching material products obtained a value of 87.9 which was included in the very valid category. In media expert validation, the assessment is based on the description of the contents of the teaching materials and the suitability of the teaching materials with technical requirements. Product revision based on media expert advice viz The color of the cover has been changed to make it more attractive.The results of the validation test by media experts score of 85 is included in the very category valid. Based on the analysis of media expert validation data, the teaching materials developed can be said to be valid and can be implemented, although there are still things that need to be revised according to expert advice. The linguist validation assessment includes straightforward, communicative, writing, suitability for the level of development of students, and the use of terms, symbols or pictures. The results of the linguist validation test amounted to 86 is included in the very category valid.The recapitulation of expert validation results is presented in Table 1.

Table 1. Recapitulation of Validation Results

Validation Aspects	Mark	Information
Material	87.9	Very Valid
Media	85	Very Valid
Media	86	Very Valid

The Effectiveness of Thematic Teaching Materials with the STEM Approach to Improve Problem Solving Ability

The effectiveness test was carried out to determine the effectiveness of thematic teaching materials with the STEM approach in the learning process that has been implemented. The effectiveness test was carried out on 20 class III students of SD Negeri 1 Purwosari. The results of the test analysis of problem solving ability tests are presented in Table 2.

Table 2. Analysis of Problem Solving Ability Tests

Data	Class	$\bar{X} \pm SD$	Normality test	Homogeneity Test	Independent Sample t-Test	Note
Pre-test	E	47.5 ± 13.7	Sig. 0.140 > 0.05	Sig. 0.71 >0.05	Sig. 0.00 < 0.05	There is a difference
	K	25 ± 8.27	Sig. 0.100 > 0.05			
Post-test	E	77 ± 16.25	Sig. 0.233 > 0.05			
	K	39.5 ± 7.59	Sig. 0.124 > 0.05			
N-gain	E	0.57 ± 25.6	0.717 > 0.05	Sig. 0.332 > 0.05	Sig. 0.01 < 0.05	Significantly Different
	K	0.18 ± 30	0.148 > .05			

From the results of the interpretation of the table above, it is known that the increase in students' problem solving abilities can be seen from the pre-test, post-test and N-gain scores. The normality test shows that the pre-test and post-test in the experimental and control classes are normally distributed with a value (Sig.)> 0.05 according to the test criteria, it can be stated that the study is normally

distributed. The variance of the experimental class post-test data and the control class post-test data is the same or homogeneous (Sig. 0.71> 0.05). Independent test results sample t test post-test experimental group and control group in table 24 shows that the average value of students between the experimental group and the control group (Sig. 0.00 <0.05). Furthermore, the N-gain test was carried out by calculating the difference between the pre-test and post-test values, it can be stated that there was a significant increase from the application of thematic teaching materials with the STEM approach to students' problem solving abilities. Independent sample t-test results N-gain on Table 2 can stated that there is a significant difference from thematic teaching materials with a STEM approach on students' problem-solving abilities during learning (Sig. 0.01 <0.05),with the experimental class N-gain of 0.57 including the medium category. Furthermore, to be able to see an increase in students' problem-solving abilities, the author will explain more clearly the results of the analysis of problem-solving indicators used in research on each student. The results of the analysis can be seen in Table 3.

Table 4. Recapitulation of Problem Solving Ability Indicators

No	Problem Solving Ability Indicator	Question Number	Experiment Class average score		N-Gain (%)	The average value of the Control Class		N-Gain (%)
			Pre-test	Post-test		Pre-test	Post-test	
1	Understanding the problem	1,2,7	17	24	48%	20	22	18%
2	Strategize	8, 10	10.5	9,5	41%	12	16	45%
3	Solve the problem	5,6	7,5	15	55%	7	11	22%
4	Evaluate	3,4,9	13.5	30.5	40%	8,5	9,5	21%
	Average				**46%**			**27%**

The results of the assessment of the three indicators of students' problem solving abilities in the experimental class and the control class can be seen in the table providing a simple explanation for the experimental class the indicator of understanding the problem increased 48% while the indicator of developing a strategy increased 41% and solving problems 55% and evaluating 40% with an average score increase of the four indicators of 46% in the experimental class. The increase in the problem-solving ability of students in the control class in understanding the problem increased by 18% while the indicators for developing strategies increased by 45% and solving problems by 22% and evaluating 21%, so that the average score of increasing problem solving in the control class was 27%. The test criteria are if Sig (2-tailed) < 0.05 is obtained then Ha is accepted and if Sig (2-tailed) is > 0.05 then Ha is rejected. Based on the calculations, it is obtained that Sig (2-tailed) is 0.000 <0.05, then Ha is accepted and Ho is rejected. Thus the development of thematic teaching materials with an effective STEM approach to improve problem solving skills in class III elementary schools has been tested significantly.

Discussion

The average results of students' problem-solving ability tests on each of the problem-solving ability indicators assessed are understanding problems, developing strategies, compiling problems, and evaluating. A higher increase occurred in the experimental class, which was equal to46% compared to the control class 27%. The results of increasing problem-solving abilities through teaching materials thematic with a STEM approach also supported by previous research which produces learning tools that have several characteristics, namely learning devices with the STEM approach, using leaflet media as learning media used to convey information, taking the theme of global warming as the main subject, and there are indicators of problem solving ability in the developed learning tools, there are activity indicators in the developed learning tools (Andini et al., 2018; Isatunada & Haryani, 2021). In line with that, the influence of thematic teaching materials with the STEM approach is also strengthened by the results of research that study aims to look at the influence of STEM education design thinking, created by combining STEM education and design thinking models, tested on preschoolers' creativity and problem-solving skills (Chonkaew et al., 2019; Yalcin & Erden, 2021). The research resulted in preschool STEM education, prepared according to the design thinking model, permanently enhancing children's creativity and problem-solving skills. Creative problem solving skills improve, communication and collaboration improve, and processes contribute to peer learning. In addition, it was concluded that STEM design thinking activities help children transfer the skills they have acquired at school outside of school, increase children's self-confidence, encourage children to generate ideas, and develop empathy skills in children. There is six aspects that can be used to measure the extent of problem solving abilities (Damayanti & Sumardi, 2018; Hidayati, 2017) are: (1) Define the problem. Defining the problem, explaining the problem,

determining the data and information requirements that must be known before being used to define the problem so that it becomes more detailed, and preparing criteria to determine the results of the discussion of the problem at hand; (2) Explore problems. Determining objects related to the problem, examining problems related to assumptions, and stating hypotheses related to the problem; (3) Planning solutions. Students develop plans to solve problems, map sub-material related to problems, choose theoretical principles and approaches that are appropriate to problems, and determine information to find solutions; (4) Carry out the plan. At this stage students apply the plans that have been set; (5) Check solutions. Evaluate the solutions used to solve the problem; (6) Evaluate. In this step, the solution is examined, assumptions related to the solution are made, estimates are obtained, implementing the solution and communicating the solution that has been made. results when implementing a solution and communicating the solution that has been created. Based on the problem-solving ability indicators above, it can be concluded that problem-solving ability indicators include defining problems, exploring problems, planning solutions, implementing plans, checking solutions and evaluating. Based on the average pre-test and post-test scores obtained, from 47.5 it increased to 77from low category to medium category.The difference in the increase in the highest post-test scores in the experimental class was found in the indicator of solving problems which increased by 55%. On the indicator of solving problems, students carry out problem solving in accordance with what has been said planned (Astutiani et al., 2019; Mahmud & Pratiwi, 2019). Students are asked to solve the problem utilization of energy sources. The student's answer is correct so that he gets a score of 10 because the answer given has shown the correct problem solving.During the learning process using thematic teaching materials with the STEM approach, students have been trained in learning activities. Students are asked to solve time problems appropriately.

The next indicator is understanding the problem, the difference in the increase in post-test scores on the indicator of understanding the problem has increased by 48%. In the indicator of understanding the problem, students determine what is known about the problem and what is being asked (Astutiani et al., 2019; Khikmiyah, 2021). In this aspect, students are asked to understand the problem sketch. The student's answer is correct so that he gets a score of 10 because the answer given has shown the ability to understand the problem correctly.During the learning process using thematic teaching materials with the STEM approach, students have been trained to understand the problems provided in the teaching materials. The third indicator is developing a strategy. The difference in the increase in the value of the post-test on the strategy strategy indicator has increased by 41%.On the strategy strategy indicators that is identify appropriate problem-solving strategies to solve the problem (Astutiani et al., 2019; Effendi et al., 2021). In this aspect, students are given questions by asking participants to develop activity strategies related to saving energy and time. This problem encourages the development of students' insights because students try to develop strategies by making appropriate problem-solving plans to be able to solve problems correctly. The fourth indicator is evaluation. The difference in the increase in post-test scores on the evaluation indicators increased by 40%. On the evaluation indicators that is check whether the results obtained are in accordance with the provisions and there is no contradiction with what was asked.

There are four important things that can be used as guidelines in carrying out this step, namely: match the results obtained with the questions asked, interpret the answers obtained, identify if there are other ways to get the problem resolved, and identify whether there are answers or other results that meet (Astutiani et al., 2019; Dharmayanti et al., 2019). In this aspect, students are given questions by asking participants to evaluate activities with respect to time. This activity encourages the development of students' insights because students try to evaluate by check whether the results obtained are in accordance with the provisions and there is no contradiction with what was asked. The increase in students' problem-solving abilities in this study was because students in the experimental class had been trained with teaching materials in the learning process, namely materials thematic teaching with a STEM approach which has an impact on students' problem-solving abilities. Problem solving abilities in the experimental and control classes were seen through the post-test questions in answering the questions, the experimental class students had been accustomed to reading or observing the stimulus presented in the questions, either in the form of pictures or data or facts. This causes students to think broadly and learn more deeply about how to relate stimulus to the theoretical concepts they already have. The learning implementation was carried out in six meetings. The results of the pretest and post-test showed that the experimental class and the control class experienced an increase in problem solving abilities because the students' knowledge had increased. The increase in problem solving abilities in the experimental class was higher than the control class because the syntax in the STEM approach trained students to think about problem solving abilities. They rely more on their thinking abilities, as a result students become more active in seeking and finding answers from various information to solve predetermined problems without relying on educators as a source of information, so that the information obtained makes students gain new insights about the material. This statement is supported by research

which shows that students those who complete the problem solving indicators up to the fourth step can write down the solution properly, completely, and correctly (Astutiani et al., 2019; P. Sari, 2017).

This is in line with research who defines problem solving as involvement in a task whose method of completion is not known beforehand, in order to find a solution, students must bring in their knowledge, and through this process, they will often develop new understandings of mathematics (Khikmiyah, 2021; Sumartini, 2016). Improving students' problem-solving skills in learning using materials thematic teaching with a STEM approach also inseparable from the activeness of students in the process of presenting the results of assignments on teaching materials and exchanging opinions regarding answers to teaching materials. Because during the learning process students look enthusiastic in expressing their group opinions. So, using materials thematic teaching with a STEM approach students better understand the material. While in the control class using classical learning. Students in the control class were given material. However, some groups were less active and less enthusiastic and some groups were late in presenting their answers. The results of the study as a whole can be seen that there is a difference in the average learning outcomes of students between the experimental class and the control class and there is a significant increase from the application of the material thematic teaching with a STEM approach on students' problem-solving abilities (Sig. 0.01 <0.05). The N-gain value for the experimental class is 0.57 which is included in the medium category.this shows that the development of thematic teaching materials with the STEM approach is effective for increasing students' problem-solving abilities.

4. CONCLUSION

Thematic teaching material products with the STEM approach developed are valid for use. Based on the suggestions and validation results, the teaching materials are valid to be used in thematic teaching materials with the STEM approach in grade III elementary schools. The thematic teaching material products with the STEM approach developed are very interesting, very useful and very easy to use. Effective teaching materials to improve students' problem-solving abilities. There are differences in the problem-solving abilities of students using thematic teaching materials with the STEM approach and those who do not use them in class III elementary school students.

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