Inovasi Kurikulum - p-ISSN 1829-6750 & e-ISSN 2798-1363
Volume 22 No 1 (2025) 567-582

JURNAL UPI

Inovasi Kurikulum
https://ejournal.upi.edu/index.php/JIK

HIPKIN

Development of STEM-based worksheets to improve student literacy skills

Cahaya Febriyanti Simanjuntak[1], Hasruddin[2], Daulat Saragi[3]
[1,2,3] Universitas Negeri Medan, Medan, Indonesia
cahayafebri02@gmail.com[1], hasruddinlbs@gmail.com[2], saragios@yahoo.co.id[3]

ABSTRACT

This research focuses on the lack of utilization of student worksheets in science lessons as students continue to rely on textbooks that contain mixed questions. The study employs a Development Research approach, specifically developing STEM-based worksheets using the ADDIE development model. Sampling was conducted using a purposive sampling technique. The data collection methods included qualitative analysis by validating the STEM-based worksheets by media and material experts and quantitative analysis to assess students' literacy abilities through tests and likert scales. This was done to measure differences in students' literacy abilities before and after the learning process. The results indicated that the initial skills of the experimental and control groups were not significantly different. However, the t-test results related to the student's scientific literacy abilities showed a significance level of 0.00 smaller than 0.05, meaning the research hypothesis is accepted. Additionally, the data t-test yielded a significance result of 0.018 smaller than 0.05. This indicates that the STEM-based worksheets positively impact students' literacy abilities.

ARTICLE INFO

Article History:
Received: 10 Oct 2024
Revised: 2 Feb 2025
Accepted: 5 Feb 2025
Available online: 12 Feb 2025
Publish: 28 Feb 2025

Keywords:
ADDIE development model; literacy skill; STEM; worksheets

Open access
Inovasi Kurikulum is a peer-reviewed open-access journal.

ABSTRAK

Penelitian ini didasarkan pada belum digunakannya LKPD dalam pembelajaran yang secara khusus membahas pelajaran IPA dan siswa masih menggunakan buku yang berisi soal-soal gabungan. Penelitian ini menggunakan Penelitian Pengembangan (Development Research). Pengembangan LKPD menggunakan model pengembangan ADDIE. LKPD berbasis STEM bertujuan untuk membuat pembelajaran menjadi lebih aktif serta menciptakan karakter siswa yang berpikir kritis dan kreatif. Pengambilan sampel dilakukan dengan menggunakan teknik purposive sampling. Teknik pengumpulan data adalah metode kualitatif yaitu melalui validasi LKPD yang dilakukan oleh ahli media dan ahli materi dan metode kuantitatif dengan mengukur kemampuan literasi peserta didik menggunakan tes dan skala likert, untuk mengetahui perbedaan kemampuan literasi peserta didik sebelum dan sesudah pembelajaran. Berdasarkan hasil penelitian, diperoleh bahwa kemampuan awal kelompok eksperimen dan kelompok kontrol berbeda tidak signifikan. Hasil uji-t tes pada kemampuan literasi sains peserta didik dengan taraf signifikansi 0,00 lebih kecil dari 0,05 yang artinya hipotesis penelitian diterima, sedangkan hasil hasil uji t tes data menunjukkan hasil signifikansi tes 0,018 lebih kecil dari 0,05 yang artinya hipotesis penelitian diterima, sehingga dapat dikatakan bahwa penggunaan LKPD berbasis STEM berpengaruh terhadap kemampuan literasi peserta didik pada materi panas dan perpindahannya.

Kata Kunci: *kemampuan literasi; LKPD; model pengembangan ADDIE; STEM*

How to cite (APA 7)
Cahaya, F. S., Hasruddin., Saragi, D. (2025). Development of STEM-based worksheets to improve student literacy skills. *Inovasi Kurikulum, 22*(1), 567-582.

Peer review
This article has been peer-reviewed through the journal's standard double-blind peer review, where both the reviewers and authors are anonymised during review.

https://doi.org/10.17509/jik.v22i1.79569

INTRODUCTION

The real impact of the Industrial Revolution 4.0 on science education is a shift in the pattern and purpose of education; currently, science learning focuses on using technology to meet future needs. Science education has a role in producing human resources that are creative, innovative, and have superior competence, both in soft skills and hard skills so that they can face various global issues. In this era of revolution 4.0, some skills need to be mastered, as indicated by the rapid increase in information. In this era, the education system's primary goal must be to answer students' needs. Era 4.0 is marked by the rapid development of Science, Technology, Engineering, and Mathematics (STEM) (Singgih et al., 2020). STEM learning is an innovation of learning strategies by 21st-century learning because, in STEM, several aspects become demands of 21st-century learning, including communication skills, collaboration skills, critical and creative thinking skills, problem-solving skills, and experimentation skills (research). By using STEM learning, teachers and students can undoubtedly answer a problem, analyze a problem, and finally be able to solve the problem well. STEM learning creates student characters who think critically and creatively in dealing with problems related to real life (Twiningsih, 2020; Tavdgiridze et al., 2024).

In Indonesia, interest in STEM in schools has increased rapidly (Nugroho et al., 2019). The subject aims to eliminate the barriers between school outputs and stakeholders who have been informed of Industry 4.0. To contribute to society, schools must ensure that children's learning outcomes result in the skills and aspirations to participate in an increasingly scientific and technological society. Every STEM learning should be designed to include learning outcomes for at least one other STEM, for example, mathematics or science learning outcomes in technology or arts classes. In this case, it is necessary to develop a Worksheet to support the development of STEM-based learning in the classroom (Sanders, 2009; Hermawan et al., 2022).

STEM-based learning can be supported by using student worksheets, where student worksheets are sheets containing guidelines for students to carry out their learning activities. From this understanding, it can be seen that in the student worksheets, what must be included as the core is an order or command for students to carry out learning activities such as reading, calculating, writing, discussing, even analyzing, and/or evaluating. Suppose students have carried out activities according to the commands or instructions in the Student Worksheets. In that case, the knowledge students should have mastered can be obtained or realized through or without teacher guidance. Based on the article on the Student Worksheets Preparation Guide by Soekanto in a paper entitled *"Panduan Penyusunan Lembar Kegiatan Peserta Didik (LKPD)"*, the student worksheets that teachers have understood so far is a worksheet that contains practice questions to be answered by students and can measure the extent to which students can answer correctly. Usually, student worksheets are given when students are supposed to do learning activities, not for practice questions or evaluation. Face-to-face activities should contain learning activities where students read, listen, and carry out other learning activities such as observing, counting, measuring, discussing, etc.

Based on the observations conducted at SD Negeri 060843 Medan, currently, the curriculum used is the Kurikulum 2013, where the books used in learning are thematic, so student worksheets have not been used to discuss science learning specifically. Teachers have not been able to design their student's worksheets in developing learning. Students still use the enrichment module book, which contains combined questions made based on the material in the textbooks they hold as a reference for teachers to find out students' mastery of knowledge of the material presented; in other words, the enrichment module is used after learning is delivered and not to support ongoing learning. Due to these problems, an alternative solution was found: developing Student Worksheets, which can provide convenience for

https://doi.org/10.17509/jik.v22i1.79569

teachers and students in conducting learning through the STEM approach to improve science literacy and numeracy skills in students limited to the material of Heat and Its Transfer.

Several relevant studies discuss the development of STEM-based student worksheets. Several studies on worksheet development show that worksheets can help implement learning activities, especially in elementary schools (Febriyanti & Maryani, 2020). The worksheet's design also influences students' critical thinking and creativity in learning activities (Simatupang et al., 2019). This can be seen through the study results, which show that the design of student worksheets based on the STEM approach and expert assessment is included in the feasible category. Because of these problems, an alternative solution was developed by developing STEM-based worksheets, which can make it easier for teachers and students to learn through a STEM approach to improve students' scientific literacy and numeracy skills, which are limited to heat and transfer material.

LITERATURE REVIEW

Science, Technology, Engineering, and Mathematics (STEM)

In science learning, argumentation is agreed as an essential component, considering that science is the result of constructing a theory that contains explanations and evidence that supports the explanation. Argumentation is central to education, especially science education, to create meaning and affect learning. In this regard, improving the quality of learning by implementing STEM education as a preventive approach is expected to help students integrate aspects of science, technology, engineering, and mathematics, which will impact improving argumentation skills. In addition, STEM education has been reported to improve students' high-level thinking skills and technological literacy, train students' problem-solving abilities, promising innovators and inventors, and improve students' non-cognitive learning outcomes such as motivation (Davidi et al., 2021).

Student Worksheets

Student worksheets are one of the learning resources that educators can develop as facilitators in learning activities. The prepared student worksheets can be designed and developed according to the conditions and situations of the learning activities that will be faced (Yase et al., 2020). Student worksheets contain good learning instructions in the form of questions and statements that must be done and answered by students. Student worksheets can be a guide containing a set of essential activities that students must do to maximize their understanding of learning and form abilities according to the indicators of learning achievement. Student worksheets can explore students' knowledge according to the student's level of ability, and the material in the student worksheets is based on the student's abilities with an excellent assessment (Pawestri & Zulfiati, 2020). Student worksheets to improve students' scientific literacy skills can be declared worthy regarding validity, practicality, and effectiveness (Ulya & Rusmini, 2022; Cholifah & Novita, 2022). Worksheets for students as teaching materials creating maximal learning activities that provide space for students to be active in thinking through inquiry-based learning activities, thus improving students' HOTS-Science Literacy (Rozali et al., 2024).

Scientific Literacy and Numeracy

Scientific literacy is part of science, practical, and related to issues about science and scientific ideas. . Citizens must be sensitive to health, natural resources, environmental quality, and natural disasters in personal, local, national, and global contexts. Based on the explanation above, the scope of scientific literacy is comprehensive, not only in science subjects but also in other literacies. According to the

https://doi.org/10.17509/jik.v22i1.79569

Ministry of Education and Culture, the basic principles of Scientific Literacy are: 1) Contextual, by local wisdom and developments; 2) Fulfillment of social, cultural, and state needs; 3) By learning quality standards that are in line with 21st-century learning; 4) Holistic and integrated with various other literacies; and 5) Collaborative and participatory.

Numeracy is the knowledge and skills commonly used to: 1) Solve practical problems in various contexts of everyday life using various numbers and symbols related to basic mathematics; and 2) Analyze information displayed in various forms (graphs, tables, charts, and so on) and then use the interpretation of the results of the analysis to predict and draw conclusions and decisions (Salvia et al., 2022). In simple terms, numeracy can be interpreted as the ability to apply number concepts and arithmetic operation skills in everyday life. Numeracy literacy also includes the ability to translate frequently encountered quantitative information. Numeracy literacy encompasses knowledge, skills, behaviors, and positive attitudes (Ekawati et al., 2022; Agustina & Zayyadi, 2023).

METHODS

This research is an R&D (Research and Development) development research to create a new product. Sukmadinata, in a book entitled "*Metode Penelitian Pendidikan*," explains that Research and development is a research approach to producing or improving a new product. The population in this study were grade V students of SD Negeri 060843 Medan in the academic year of 2023/2024, taken using a purposive sampling technique to find samples that meet the criteria that have been precisely determined, where the research sample was 2 (two) classes that had insignificant differences in Pretest results, then determined which class would be the experimental group and the control group. The object of this study was the Science Student Worksheet with a STEM approach to the material Heat and Its Transfer. Sugiyono, in a book entitled "*Metode Penelitian Pendidikan: Pendekatan Kuantitatif, Kualitatif dan R&D*" states that this development research uses the ADDIE research model consisting of five stages, including analysis, design, development, implementation, and evaluation. The reason for choosing this development model is because the ADDIE type is considered more systematic and more complete. Each stage has an evaluation stage so the developed product can become a teaching material with valid and reliable novelty quality.

The ADDIE development model in developing student worksheets based on the STEM approach goes through several stages: 1) Analyze. In the ADDIE development model, the first stage is to analyze the need for product development and then analyze the feasibility and requirements for product development; 2) Design, the design activity in the ADDIE development model is a systematic process starting from designing the concept and content of the student worksheet product which is developed and written clearly and in detail; 3) Development, Developing student worksheet product tools (materials/ingredients and tools) needed in STEM Approach-based development on product design results, at this stage the product (materials/ingredients, tools) begins to be made following the model structure and create instruments to measure product performance; 4) Implementation: Starting to use new products in real learning or classroom environments using a direct learning model. Reviewing product development goals, interactions between students, and asking for feedback early in the evaluation process; 5) Evaluation, looking back at the impact of learning in a critical way, measuring the achievement of product development goals, measuring what the targets have been able to achieve, looking for any information that can enable students to achieve good results.

https://doi.org/10.17509/jik.v22i1.79569

RESULTS AND DISCUSSION

Student Worksheets Development Stage with the ADDIE model

The development results are carried out through several stages.

1. Analysis. From the results of the analysis carried out, it was found that the study of student characteristics carried out through observations and interviews conducted at SD Negeri 060843 Medan obtained information that the learning process in class V tends to be conventional and teacher-oriented, whereas in the learning process teachers still predominantly use lecture and question and answer methods without variations in other models. However, sometimes they use discussion or question-and-answer methods. Competency analysis is carried out by looking at what competencies are required of students. In this case, the learning material developed in this learning media is heat material, which transfers to book theme 6. Analysis of school facilities and environment carried out through observations and interviews at SD Negeri 060843 Medan obtained information that the facilities in the school can support learning in a class and teachers who use learning media. LCD projectors, speakers, WiFi, and adequate electricity sources are available to support classroom learning media use.
2. Design at the design stage is carried out through several stages. The first stage is selecting the software used. At this stage, the software used is Canva, which functions to produce attractive teaching media with displays, text, fonts, and images that make students interested in learning and websites used to create barcodes.
3. Development, at this stage, begins with compiling a media assessment instrument. The instrument used to assess product validity was first tested for validation of the instrument items by two lecturers who taught in the basic education study program.
4. Implementation: The focus is on implementing media at this stage. This implementation aims to test the developed product's validity and functionality. Experts assess the media's validity, including both media and material validation. Additionally, product testing was conducted with fifth-grade students at SD Negeri 060843 in Medan, utilizing student worksheets and learning media during instruction. This testing resulted in an improvement in the students' literacy skills.
5. Evaluation: The evaluation stage aims to validate the learning media products developed through expert and product testing. Each stage of the development process includes evaluations and revisions to enhance the final product.

Assertion that the ADDIE model consists of five stages: Analyze, Design, Develop, Implement, and Evaluate. While some stages are carried out sequentially, some instructional design models may not follow a strict procedure; they can be cyclical or may start from a specific stage, as well as integrative learning design models (Hidayat & Muhamad, 2021).

Questionnaires whose validity was tested were material expert instruments and media expert instruments. Next, namely the preparation of a learning implementation plan aimed at directing learning activities in the classroom, which are integrated with the implications of learning media. At the implementation stage, the activities are carried out, testing the validity and testing of the product that has been developed. Experts test the media's validity, consisting of media and material validation. Meanwhile, product testing was carried out on class V students at SD Negeri 060843 Medan using student worksheets learning media learning, and an increase in students' literacy skills was observed through test results using a likert scale. In the final stage, evaluation is carried out to validate learning media products developed through expert and product testing. At each stage of the development of this

https://doi.org/10.17509/jik.v22i1.79569

learning media, evaluations and revisions are carried out to improve the resulting product. The results of the student worksheets development can be seen in the following **Figure 1**.

Figure 1. Initial Display
Source: Processed by the Author 2024

Figure 2 shows instructions for using student worksheets.

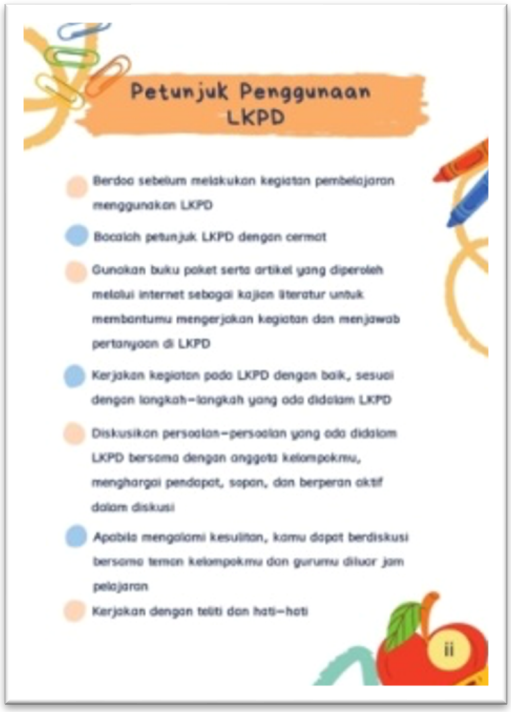

Figure 2. Instructions for Using Student Worksheet
Source: Processed by the Author 2024

https://doi.org/10.17509/jik.v22i1.79569

The scope and aspect of STEM are shown in **Figure 3**.

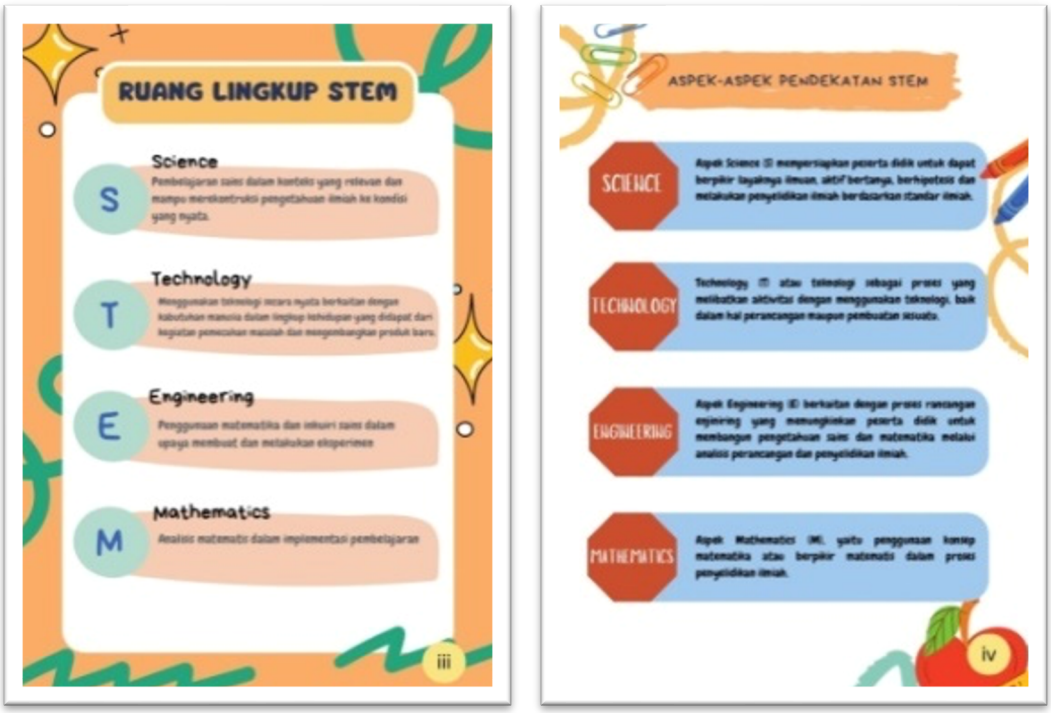

Figure 3. Scope and Aspects of STEM
Source: Processed by the Author 2024

Figure 4 shows concept maps.

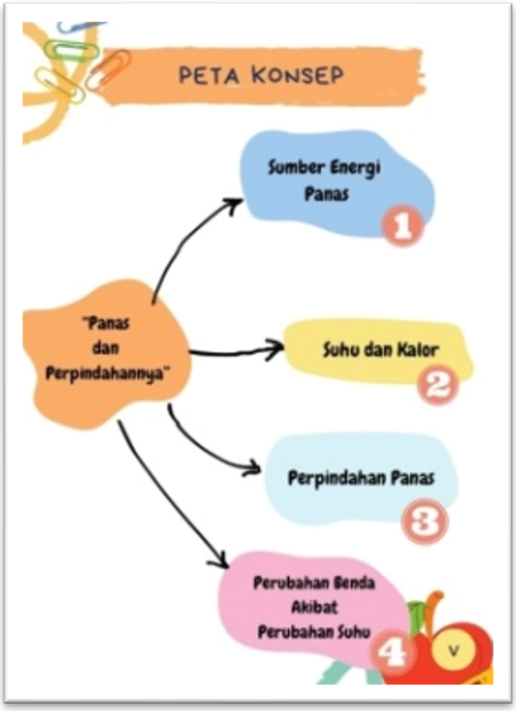

Figure 4. Concept Maps
Source: Processed by the Author 2024

https://doi.org/10.17509/jik.v22i1.79569

Essential competencies, indicators, and objectives are shown in **Figure 5**.

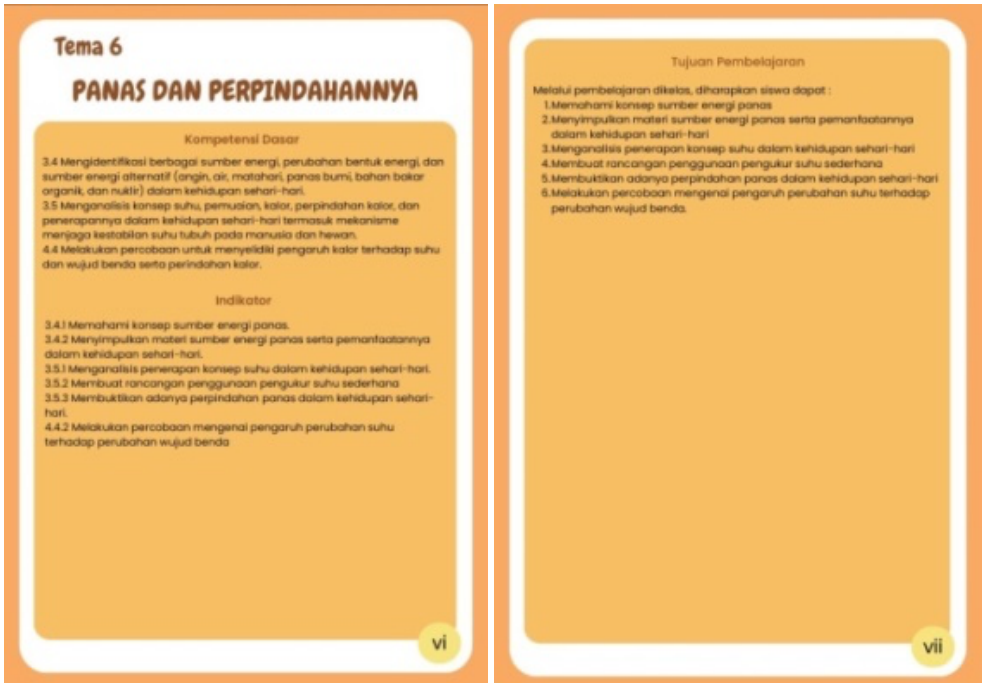

Figure 5. Essential competencies, indicators, and objectives
Source: Processed by the Author 2024

Figure 6 shows learning activities and material-deepening activities.

Figure 6. Learning Activities and Material Deepening Activities
Source: Processed by the Author 2024

https://doi.org/10.17509/jik.v22i1.79569

Figure 7 shows evaluation activities.

Picture 7. Evaluation activities
Source: Processed by the Author 2024

Implementing STEM-based worksheets effectively trains students' creative thinking skills, as seen in the increase in students' thinking skills in each indicator (Fithri et al., 2021).

Expert Validation Results

Validation is carried out by providing validation questionnaires and printed student worksheets to experts. Then, the validator offers an assessment and input or suggestions for the student worksheets. Based on the results of validation tests carried out by material design media expert validators in assessment I, they got a score of 63% in the appropriate category by making revisions on suggestions and input from material design media experts. In comparison, in assessment II, after revisions, they got a score of 95%. It is a very feasible category and can be used without revision. Meanwhile, in the layout design media expert validator assessment, I received a score of 97% in the very appropriate category, and it can be used without revision. Assessment by material expert validators in assessment I with a score of 82% in the very good category and can be used by making slight revisions on suggestions and input from material experts; after revising the score in assessment II, the score was 82% in the very good category and suitable for use. The expert test percentage results presented can be seen in **Figure 8** below.

https://doi.org/10.17509/jik.v22i1.79569

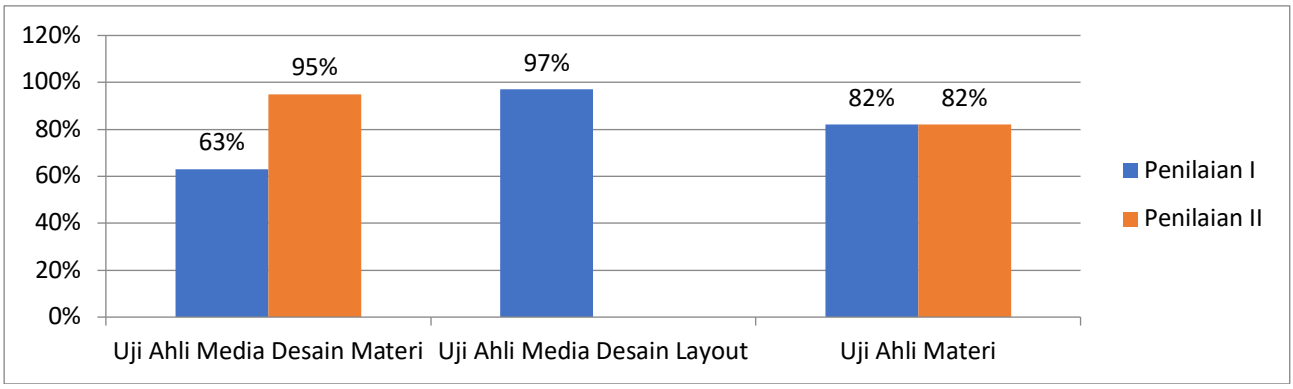

Figure 8. Expert Validation Percentage Results
Source: Processed by the Author 2024

At the implementation stage, the activities carried out are testing the validity and testing the products that have been developed. Experts test the media's validity, consisting of media and material validation. The product test was carried out on grade V students of SD Negeri 060843 Medan using student worksheet learning media in learning and seeing the increase in students' literacy skills through test results using a Likert scale. The last stage, namely evaluation, is carried out to validate the learning media products developed through expert and product tests. At each stage of the development of this learning media, evaluations and revisions are carried out to improve the products produced.

Results of Student Literacy and Numeracy Abilities

Based on testing the pretest data of the experimental group and the control group using the t-test at a significance level of α = 0.05, it shows that t count < t table (0.68 < 1.68) so that there is a difference in initial ability that is not significant between the experimental group and the control group, meaning that the experimental group and the control group have the same initial ability. The experimental group has an average value of 42.25, while the control group has an average of 40. This shows that the average class of the experimental group is greater than the control group, with results that are not significantly different. The learning carried out during the research as a whole has been following the steps in learning. The results of the student's initial ability test are presented in the following **Table 1**.

Table 1. Description of Initial Ability of Class 5.3 (Experimental Class) and Class 5.4 (Control Class) of State Elementary School 060843 Medan Academic Year 2023/2024

Data	Class 5-3 (experiment group)	Class 5-4 (control group)
N	20	20
Lowest values	20	25
Highest values	55	60
Mean	40	42,25
Standard deviation	10,13	10,69

Source: Processed by the Author 2024

Students' scientific literacy and numeracy skills were assessed before and after learning. At the beginning of learning, students were given provocative questions related to the learning that would take place. A literacy and numeracy assessment instrument will assess each student's answer. Scoring was carried out using a Likert scale so that the initial literacy skills of students before learning and the final literacy and numeracy skills of students after learning were carried out would be visible.

https://doi.org/10.17509/jik.v22i1.79569

The results of the assessment of students' scientific literacy skills in the experimental class before learning using STEM-based student worksheet on the heat and its transfer material showed that the average initial literacy skills of students were at an average score of 2.44 and were included in the "good" category, while after learning using STEM-based student worksheet on the heat and its transfer material showed that the average score of students in the experimental class was at an average score of 3.02 and was included in the "good" category. This shows that there has been an increase in students' scientific literacy skills, as seen through the average scores of students' initial and final abilities, which have increased. **Table 2** shows the N-Gain for experimental class science literacy ability test results.

Table 2. N-Gain Test Results of Experimental Class Science Literacy Ability
SD Negeri 060843 Medan Academic Year 2023/2024

Data	Initial Abilities	Final Ability
N	20	20
Lowest score	2,00	2,67
Highest score	3,17	3,67
Mean	2,44	3,02
Standard deviation	0,43	0,40
N-Gain	0,40	

Source: Processed by the Author 2024

Meanwhile, students' numeracy skills at the beginning of learning had an average score of 1.75 and were in the "sufficient" category. After learning how to use a STEM-based student worksheet on heat and its transfer material, I found that the average student score was 2.85 and was in the "good" category. **Table 3** shows the N-Gain for the experimental class's final numeracy ability test results.

Table 3. N-Gain Test Results for Final Numeracy Ability of Experimental Class
SD Negeri 060843 Medan Academic Year 2023/2024

Data	Initial Ability	Final Ability
N	20	20
Lowest score	1,00	2,00
Highest score	2,50	3,50
Mean	1,75	2,85
Standard deviation	0,66	0,46
N-Gain	0,50	

Source: Processed by the author 2024

In the control class, the results of assessing students' scientific literacy skills in the experimental class before conventional learning was carried out showed that students' average initial literacy skills were at an average score of 2.34 and were in the "good" category. In contrast, after learning was carried out, it showed that the average score of students in the control class was 2.59 and were in the "good" category. This shows an insignificant increase in students' scientific literacy skills, as seen in the average scores of students' initial and final abilities, which increased slightly. **Table 4** shows the N-Gain for control class science literacy ability test results.

https://doi.org/10.17509/jik.v22i1.79569

Table 4. N-Gain Test Results of Science Literacy Ability Control Class SD Negeri 060843 Medan Academic Year 2023/2024

Data	Initial Ability	Final Ability
N	20	20
Lowest score	2,00	2,17
Highest score	3,00	3,17
Mean	2,34	2,59
Standard deviation	0,36	0,34
N-Gain	0,15	

Source: Processed by the author 2024

Meanwhile, students' numeracy skills at the beginning of learning had an average score of 1.63 and were in the "sufficient" category. After learning how to use a STEM-based student worksheet on heat and its transfer material, I found that the average student score was 2.63 and was in the "good" category. **Table 5** shows the N-Gain for control class science numeracy ability test results.

Table 5. N-Gain Test Results for Final Numeracy Ability of Control Class SD Negeri 060843 Medan Academic Year 2023/2024

Data	Initial Ability	Final Ability
N	20	20
Lowest score	1,00	2,00
Highest score	2,50	3,00
Mean	1,63	2,58
Standard deviation	0,53	0,41
N-Gain	0,40	

Source: Processed by the author 2024

The results show that the science literacy skills of students in the experimental and control classes have increased, as seen from the initial and final abilities of students who experienced an increase in the literacy test scores that had been carried out; in the experimental class, there was a higher increase compared to the control class. This is influenced by the use of STEM-based student worksheets on the material of heat and its transfer in the experimental class. Students in the experimental class have higher levels of literacy and numeracy due to the presence of questions and experiments that can hone students' thinking skills so that they arouse curiosity in students. In STEM-based student worksheets, some questions and problems are solved using predetermined steps. The problems given in the experimental class are problems related to learning. In contrast, in the control class, conventional learning is used, whereas the control class is used to compare the learning outcomes of the experimental class. Conventional learning is learning that teachers often apply in a class. Preparation for education and learning requires STEM-based learning materials to support learning guidelines (Rizkika et al., 2022). Learning instructors state that the teaching materials educators use are pictures, and instructors also use instructions. Students' initial abilities are the abilities that students already have before they take part in the learning that will be given (Juniawan, 2020). Initial abilities are a prerequisite needed to follow the next learning material. How quickly students master mathematics subject matter is influenced by the student's initial ability level.

Learning outcomes also experienced improvements between the experimental class that used STEM-based student worksheets on heat and its transfer material, and the control class that used conventional methods. Using a STEM-based student worksheet on the heat and its transfer material effectively

https://doi.org/10.17509/jik.v22i1.79569

improved student learning outcomes. In contrast, using conventional methods on the heat and its transfer material was less effective in improving student learning outcomes. This increase in learning outcomes can occur because learning requires students to be more active, and learning becomes more enjoyable. Learning using STEM-based student worksheets directs students to the material they will learn. It helps them to try and recall related information that can be used to help instill new knowledge that can link science, technology, engineering, and mathematics in learning. The STEM approach provides meaningful learning experiences by integrating science, technology, engineering, and mathematics, enabling students to relate learning concepts to real-life contexts (Milala et al., 2024). With low interest in teaching, teachers must improve by seeing how students understand mastering a material taught using an appropriate learning model (Rahmayani, 2019). The appropriate learning model will make students active, and learning will be centered on students.

Another thing found in this study is the results of the observations, which obtained information that students still find difficult to express ideas and put forward opinions or answers to a question. In this case, the researcher assumes that students are not used to expressing their opinions because the learning patterns developed so far are still conventional. Using a STEM-based student worksheet in science learning provides opportunities for students to conduct experiments or experiments by proving things that have been learned. In the learning process, students can experience it themselves or do it themselves, follow the experimental steps, observe objects, analyze, prove, and draw conclusions about a particular object or condition (Bani, 2023). Wisudawati, in a book entitled "*Metodologi Pembelajaran IPA*", said that experiments aim to improve students' thinking skills in finding and understanding the concepts or science materials being studied.

A student worksheet is a learning resource containing a summary of the material for assignments and assessments (Nurani & Rachmadyanti, 2022; Riyanto et al., 2020). With student worksheets, direct interaction can be formed between students and teachers and can be a learning bridge between students, teachers, and the material taught during the learning process. Student worksheets in learning can support students' learning process in understanding and interpreting learning. In making student worksheets, an approach is needed that can help achieve learning goals. The STEM approach includes 4C: creativity, critical thinking, collaboration, and communication. STEM involves four disciplines: science, technology, engineering, and mathematics (Kusumaningtias & Ningsih, 2022).

STEM learning in student worksheets can build creativity, scientific literacy, and problem-solving skills necessary for the 21st century (Silvia & Simatupang, 2020). STEM can be used to foster an innovative spirit and practical capacity of students by integrating knowledge and enthusiasm from each subject and applying it in real life (Sabila et al., 2023). One way to improve students' scientific literacy skills is through STEM project-based learning. Based on the findings presented above, the development of STEM-based student worksheets supports students' literacy skills and improves student learning outcomes. The learning outcome test also shows a significant difference in students' cognition when applying STEM-based student worksheets because STEM-based student worksheets contain questions and problems related to everyday life (Saputra et al., 2023).

The feasibility of the student worksheets and the substance of the material as a whole falls within the appropriate criteria (Desi & Ida, 2020). Students' responses to student worksheets based on discovery learning on heat material in junior high schools, which have been developed in all aspects, are included in the exciting criteria. In this study, using STEM-based student worksheets in science learning showed better results, so it is good to be applied in learning activities. Using STEM-based student worksheets in learning creates practical, varied, guided learning, making it easier for students to understand learning contextually. In this case, the researcher stated that learning using STEM-based student worksheets can be an alternative learning media that can be applied in learning to create an interactive and meaningful learning atmosphere, not just a transfer of knowledge.

https://doi.org/10.17509/jik.v22i1.79569

CONCLUSION

Validation of the suitability of STEM-based student worksheets was carried out, namely validating the suitability of the student worksheet media and validating the suitability of the material. The results of media expert validation and student worksheet material expert validation are included in the "Very Good" category. The use of STEM-based student worksheets in learning hot material and its transfer is known through the results of the t-test hypothesis test showing that the use of STEM-based student worksheets in learning hot material and its transfer affects increasing students' scientific literacy and numeracy abilities. Using STEM-based student worksheets to learn hot material and its transfer effectively improves student learning outcomes. This is proven by the increase in student learning outcomes through tests carried out at the beginning of learning before using the student worksheet and at the end of learning after using the student worksheet in learning. Future researchers are expected to make observations or look for information regarding the learning process and matters related to research activities that will be carried out at the research location. This research can be used as a bridge to carry out further research, especially in education, to obtain good and maximum results.

AUTHOR'S NOTE

Penulis menyatakan bahwa tidak ada konflik kepentingan terkait publikasi artikel ini. Penulis menegaskan bahwa data dan isi artikel bebas dari plagiarisme.

REFERENCES

Agustina, E., & Zayyadi, M. (2023). Kemampuan literasi numerasi siswa di sekolah inklusi. *Apotema: Jurnal Program Studi Pendidikan Matematika*, *9*(1), 15-20.

Bani, M. (2023). Meningkatkan motivasi belajar siswa melalui penerapan metode eksperimen pada pelajaran ilmu pengetahuan alam. *Jurnal Kolaborasi*, *4*(3), 1-8.

Cholifah, S. N., & Novita, D. (2022). Pengembangan E-LKPD guided inquiry-liveworksheet untuk meningkatkan literasi sains pada submateri faktor laju reaksi. *Chemistry Education Practice*, *5*(1), 23-34.

Davidi, E. I. N., Sennen, E., & Supardi, K. (2021). Integrasi pendekatan STEM (Science, Technology, Enggeenering and Mathematic) untuk peningkatan keterampilan berpikir kritis siswa sekolah dasar. *Scholaria: Jurnal Pendidikan dan Kebudayaan*, *11*(1), 11-22.

Desi, A., & Ida. (2020). Pengembangan Lembar Kerja Peserta Didik (LKPD) berbasis discovery learning pada materi kalor di SMP. *Jurnal Pendidikan Fisika dan Fisika Terapan*, *1*(3), 13-19.

Ekawati, R., Firdaus., & Yulia, S. (2022). Pentingnya literasi numberasi dalam kehidupan sehari-hari bersama radio RRI. *Jurnal Menara Pengabdian*, *2*(2), 46-52.

Febriyanti, D., & Maryani, I. (2020). Pengembangan LKPD berbasis STEM pada materi IPA tema 7 subtema 1 kelas V sekolah dasar. *Jurnal Fundadikdas (Fundamental Pendidikan Dasar)*, *3*(2), 162-180.

Fithri, S., Pada, A. U. T., Artika, W., Nurmaliah, C., & Hasanuddin, H. (2021). Implementasi LKPD berbasis STEM untuk meningkatkan keterampilan berpikir kritis peserta didik. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, *9*(4), 555-564.

https://doi.org/10.17509/jik.v22i1.79569

Hermawan, A. E., Leksono, I. P., & Rusmawati, R. D. (2022). Lembar Kerja Peserta Didik (LKPD) digital Matematika berbasis STEM dengan edmFodo. *Didaktis: Jurnal Pendidikan dan Ilmu Pengetahuan*, *22*(3), 353-366.

Hidayat, F., & Muhamad, N. (2021). Model ADDIE (Analysis, Design, Development, Implementation and Evaluation) dalam pembelajaran pendidikan agama islam. *Jurnal Inovasi Pendidikan Agama Islam*, *1*(1), 28-37.

Kusumaningtias, S. D. A., & Ningsih, P. R. (2022). LKPD berbasis STEM untuk melatih kemampuan berpikir kreatif pada materi fiber optic. *Edumatic: Jurnal Pendidikan Informatika*, *6*(1), 126-134.

Juniawan, E. A. (2020). Pengaruh strategi metakognitif dan kemampuan awal terhadap kemampuan penalaran matematis siswa: Studi eksperimen di kelas VII MTs se-Kabupaten Tangerang. *Pasundan Journal of Mathematics Education (PJME)*, *10*(1), 51-65.

Milala, K. N. B., Harahap, F., & Hasruddin, H. (2024). Developing STEM-based LKPD to improve student's critical thinking abilities. *Inovasi Kurikulum, 21*(4), 2243-2262.

Nugroho, O. F., Permanasari, A., & Firman, H. (2019). Program belajar berbasis STEM untuk Pembelajaran IPA: Tinjauan pustaka, dengan referensi di Indonesia. *Jurnal Eksakta Pendidikan (Jep)*, *3*(2), 117-125.

Nurani, M. C., & Rachmadyanti, P. (2022). Pengembangan lembar kerja peserta didik berbasis literasi budaya pada siswa kelas IV SDN Geluran 3 Taman Sidoarjo. *JPGSD*, *10*(2), 431-441.

Pawestri, E., & Zulfiati, H. M. (2020). Pengembangan Lembar Kerja Peserta Didik (lkpd) untuk mengakomodasi keberagaman siswa pada pembelajaran tematik kelas II di SD Muhammadiyah Danunegaran. *Trihayu: Jurnal Pendidikan Ke-SD-an*, *6*(3), 903-913.

Rahmayani, A. L. (2019). Pengaruh model pembelajaran discovery learning dengan menggunakan media video terhadap hasil belajar siswa. *JP (Jurnal Pendidikan): Teori dan Praktik*, *4*(1), 59-62.

Riyanto, E., Wibowo, T., Purwoko, R. Y., & Purwaningsih, W. I. (2020). Pengembangan lembar kerja siswa sekolah dasar berbasis etnomatematika dengan setting Candi Borobudur. *Jurnal Inovasi Pendidikan Matematika (JIPM)*, *2*(1), 1-9.

Rizkika, M., Putra, P. D. A., & Ahmad, N. (2022). Pengembangan E-LKPD berbasis STEM pada materi tekanan zat untuk meningkatkan kemampuan berpikir kritis siswa SMP. *PSEJ (Pancasakti Science Education Journal)*, *7*(1), 41-48.

Rozali, D., Suyanti, R. D., & Dewi, R. (2024). Development of science LKPD based on inquiry training on HOTS-science literacy skills. *Inovasi Kurikulum, 21*(2), 1099-1112.

Sabila, S., Indayana, F., & Ummi, N. (2023). Pengembangan E-LKPD berbasis STEM untuk meningkatkan kemampuan literasi sains siswa pada materi bioteknologi. *Jurnal of Biological Science and Education*, *4*(1), 33-43.

Salvia, N., Fadya, P., Ismilah, M. (2022). Analisis kemampuan literasi numerasi peserta didik ditinjau dari kecemasan matematika. *Prosiding Seminar Nasional Pendidikan Matematika Universitas Pekalongan*, *3*(1), 351-360.

Sanders, M. (2009). Integrative STEM education: Primer. *The Technology Teacher*, *68*(4), 20-26.

Saputra, F., Srihandono, B., Bevo, W. (2023). Efektivitas LKPD berbasis STEM (Science, Technology, Engineering and Mathematics) untuk meningkatkan literasi sains dan hasil belajar berdasarkan perbedaan level kognitif siswa. *Jurnal Pendidikan Edutama*, *10*(2), 105-112.

https://doi.org/10.17509/jik.v22i1.79569

Silvia, A., & Simatupang, H. (2020). Pengembangan LKPD berbasis science, technology, engineering, and mathematics untuk menumbuhkan keterampilan literasi sains siswa kelas X MIA SMA Negeri 14 Medan TP 2019/2020. *BEST Journal (Biology Education, Sains and Technology)*, *3*(1), 39-44.

Simatupang, H., Sianturi, A., & Alwardah, N. (2019). Pengembangan LKPD berbasis pendekatan Science, Technology, Engineering, and Mathematics (STEM) untuk menumbuhkan keterampilan berpikir kritis siswa. *Jurnal Pelita Pendidikan*, *7*(4), 170-177.

Singgih, S., Dewantari, N., & Suryandari. (2020). STEM dalam pembelajaran IPA di era revolusi industri 4.0. *Indonesian Journal of Natural Science Education (IJNSE), 3*(1), 299-304.

Tavdgiridze, L., Didmanidze, I., Khasaia, I., Sherozia, N., Dobordginidze, D., Akhvlediani, D., & Akhvlediani, Z. (2024). STEM teaching in contemporary education. *Challenges to National Defence in Contemporary Geopolitical Situation*, *1*(1), 1-10

Twiningsih, A. T. (2020). Improving learning outcomes through the use of media STEM based in volcano eruption simulation in the theme of natural events. *International Journal of Theory and Application in Elementary and Secondary School Education*, *2*(2), 64-78.

Ulya, I., & Rusmini, R. (2022). Pengembangan Lembar Kerja Peserta Didik (LKPD) untuk meningkatkan keterampilan literasi sains peserta didik pada materi laju reaksi. *Pendipa Journal of Science Education*, *6*(3), 695-703.

Yase, I. M. D., Basuki, B., & Savitri, S. (2020). Pengembangan Lembar Kerja Peserta Didik (LKPD) berbasis inkuiri pada materi sistem sirkulasi di SMA Negeri 5 Palangka Raya. *BiosciED: Journal of Biological Science and Education*, *1*(1), 8-12.

https://doi.org/10.17509/jik.v22i1.79569