Randwick International of Education and Linguistics Science (RIELS) Journal
Vol. 4, No. 3, September 2023 | Page 695-711 |
https://www.randwickresearch.com/index.php/rielsj

Development of Student Worksheet based on STEM to Improve the Critical Thinking Skills

DOI: https://doi.org/10.47175/rielsj.v4i3.800

| Hayatul Husna[1] | Retno Dwi Suyanti[2] | Anita Yus[3] |

[1] Basic Education Department, Postgraduate program, Universitas Negeri Medan, Medan, Indonesia

[2,3]Universitas Negeri Medan, Medan, Indonesia

ABSTRACT

Based on the results of observations, it shows that the development of student worksheets is not optimal, especially in science learning with water cycle material which should be adapted to developments in the 21st century, as science learning is fun learning if it is created well. The 21st century requires students to have various skills, one of which is critical thinking skills. because students are required to be more responsive in analyzing, solving problems and solving problems in the learning process. The aim of this research is to develop and determine the feasibility of STEM-based student worksheets with water cycle material for fifth grade elementary school students. This research method is Research and Development (R&D), which is a research method used to develop or validate products used in education and learning. The results of the research show that the process of developing student worksheets to train critical thinking skills consists of three stages, namely preliminary study, product development, and test the product. The student worksheets were validated by three expert validators, namely design expert validation, material expert and language expert with respective scores of 84.37%, 94% and 91.42% with very feasible criteria. So, it can be concluded that this STEM-based student worksheets with water cycle material is suitable for use as a learning companion for students to improve students' critical thinking skills

KEYWORDS

STEM student worksheets; critical thinking; water cycle

INTRODUCTION

STEM (Science, Technology, Engineering, and Mathematics) is a learning approach that connects four fields, namely science, technology, engineering and mathematics into one holistic whole. The goal of STEM in the world of education is in line with the demands of 21st century education, namely that students have scientific and technological literacy skills that can be seen from reading, writing, observing, performing scientific skills, and being able to develop the competencies they already have to apply them in facing problems in everyday life. days related to the field of STEM sciences (Jauhariyyah, 2017).

As the 21st century demands that education must be linked to science, technology, engineering and mathematics, STEM-based student worksheets is very necessary so that education is not left behind. However, not all schools can implement STEM-based Student Worksheets, due to several factors, one of which is limited facilities at the school. Mastery of Science and Technology (IPTEK or science that studies technological developments based on science) is currently an important key in facing future challenges. Various challenges that arise include improving the quality of life, equitable development, and the ability to develop human resources.

Learning tools are needed to support the achievement of learning goals. Student Worksheets (Permendikbud, 2013) are a comprehensive learning tool in the learning process. Textbooks need to be developed because they can help teachers deliver textbooks. One of the government's efforts to improve the quality of education is through the development of teaching materials. Teachers need to develop their own student worksheets to activate students' learning abilities, improve critical thinking abilities, and improve learning outcomes.

Critical thinking skills according to Stobaugh (Bahri, S., 2017) that critical thinking is deeply reflective in making decisions and solving problems to analyze situations, evaluate arguments, and draw conclusions. Someone who thinks critically comes to full conclusions about how to solve it, and is able to look for supporting references. STEM (Science, Technology, Engineering, and Mathematics) is a new method of educational development that integrates various scientific disciplines. The learning process must be designed systematically in accordance with the integrated form of STEM (Science, Technology, Engineering, and Mathematics).

The 2013 curriculum learning is centered on students or student centers and educators only as facilitators who create a learning atmosphere where students can explore themselves and express their ideas or opinions (Kemendikbud, 2017). The 2013 curriculum learning can accustom students to think critically, act creatively, productively, independently, collaboratively, communicatively, and can train the skills that students have in accordance with the demands of the 21st century (Kemendikbud, 2016).

Based on data obtained during analysis at school, it shows that the learning process is still centered on the teacher due to a lack of facilities and learning resources which results in students' interest in taking lessons is still lacking and does not make students active due to the lack of direct practical activities carried out by students. The student worksheets used by teachers also only contains material summaries and questions, this is not in accordance with the function of student worksheets as teaching materials which can minimize the role of educators, but rather activate students and make it easier for students to understand the material provided. Therefore, it is considered necessary to develop student worksheets that is adapted to the conditions and needs of students and it is necessary to develop student worksheets with a STEM approach in developing students' critical thinking skills.

Teachers and students need student worksheets, because they need a different way of learning than before and with student worksheets, they can do practicums where learning is not monotonous, which supports them being able to think critically. This is in accordance with research (Arif, A M., Heni, P., & Ria, S., 2020) which states that student worksheets research results are able to improve students' critical thinking skills by 0.43, including the medium category. This result is also in line with the research of Mawar, A. Y. D., Ernaningsih, D., & Syafriati, Y. M. (2020) said that the results of the research concluded that student worksheets based on critical thinking skills was very feasible so that it could be used in the learning process. This is also in accordance with research (Pamungkas, A., & Kusdiwelirawan, A., 2020) as many as 44.8% of the worksheets used were sourced from printed books distributed by educators, 34.4% of the worksheets used were sourced from package books available to students and 20.8% sourced from the internet. Therefore, researchers provide solutions for developing STEM-based student worksheets. before developing student worksheets, researchers must know the need to use STEM-based student worksheets which can train students' critical thinking skills in science learning. The novelty of this research is that the student worksheets that will be developed is different from previous research which only developed student worksheets as a regular learning medium. This research will examine the need for developing student worksheets which includes a

stem approach and critical thinking skills so that students and teachers get learning media in the form of student worksheets which is different from the previous one which has new aspects and critical thinking skills in the student worksheets which will be developed.

According to Saputra, B., & Sujarwanta, A. (2021) that multidisciplinary STEM learning naturally involves many different skills, including reading, writing, mathematics and building knowledge concepts. The application of STEM with experimental activities or projects can improve cognitive learning outcomes, form attitudes and scientific process skills because students are trained with 4C activities, namely creativity, critical thinking, collaboration and communication. In line with this, Jolly (2017) in his research also explains that the application of STEM with student worksheets in the learning process can improve students' skills and cooperation in solving problems and producing products because students are familiarized with the engineering design process steps, namely: define the problem, research, imagine, plane, create, test and evaluate, redesign and communicate.

Learning with STEM-based student worksheets can train students in implementing the knowledge learned at school with phenomena that occur in everyday life so that it can improve students' learning achievements. Based on research conducted by Artiani, L. (2020) that the use of student worksheets with a STEM approach in learning can improve learning outcomes and students' skills. According to Quratulaini (2019)implementing STEM-based student worksheets can improve student learning outcomes. Laisnima, L. (2020) states that the STEM approach can increase student learning outcomes by 0.53 and students' science skills by 78.20%.

RESEARCH METHODS

This research is a type of R&D (Research and Development) research which was developed using the ADDIE model. This research and development produced a Student Worksheet product based on STEM (Science Technology Engineering Mathematics) for science subjects in the water cycle for class V elementary school. This research was carried out at SD Negeri 067251 Medan Deli which is located at Jalan Paltina IV, XI Medan Deli neighborhood, Medan City.

This STEM-based student worksheets was developed through several stages according to the procedures of ADDIE development, namely analysis, design, development, implementation and evaluation. In this study, researchers only reached the implementation stage, namely a small-scale trial on fifth grade elementary school students. The evaluation stage is to solve the questions by thinking critically. The subjects of this research were class V students at State Elementary School 067251 Medan Deli, Medan Municipality. This research used a small-scale trial with 14 people.

RESULTS AND DISCUSSION

Feasibility of STEM-Based student worksheets

Before testing the feasibility of STEM-based student worksheets, researchers conducted a needs analysis first as an initial foundation for feasibility. The stages of feasibility and analysis obtained are described as follows:

Analysis stage

Needs Analysis

The results of the analysis of student needs are obtained based on the answers to the questions that have been asked. There are 10 needs analysis questions, the first of which is "In your opinion, is science subject a difficult subject?" Analysis of the needs of the first question

shows that as many as 20 students answered "Yes" with a percentage of 74.1% and as many as 7 students answered "No" with a percentage of 25.9%.

Next, the second needs analysis, the question is "Choose one material that you think is difficult?". The results of the analysis of the second question showed that 19 students chose the "Water Cycle" material with a percentage of 74.1%, then 3 students chose the "Heat" material with a percentage of 7.4%, and 5 students chose the "form of objects" material. with a percentage of 18.5%.

Next, the third needs analysis, the question is "What learning tools do your teachers usually use?" Analysis of the needs of the third question revealed that 9 students chose the "Module" learning tool with a percentage of 33.3%, then 7 students chose the "Student Worksheet" teaching material with a percentage of 25.9%, and 11 students chose the "Book" learning tool. package" with a percentage of 40.7%.

Next, the fourth needs analysis, the question is "Have you ever used Student Worksheets in science learning?". Analysis of the needs of the fourth question showed that 12 students answered "Yes" with a percentage of 44.4%, then 15 students answered "No" with a percentage of 55.6%.

Next, the fifth needs analysis, the question is "Are the student worksheets given by your teacher interesting and easy to understand?" needs analysis for the fifth question showed that 2 students answered "Yes" with a percentage of 7.4%, then 25 students answered "No" with a percentage of 92.6%.

Next, the sixth needs analysis, the question is "Do you like student worksheets that is interesting and easy to understand?". Analysis of the needs of the sixth question showed that 6 students answered "Yes" with a percentage of 22.2%, then 21 students answered "No" with a percentage of 77.8%.

Next, the seventh needs analysis, the question is "Do the student worksheets given by the teacher direct science learning towards science, technology, engineering and mathematics?". Analysis of the needs of the seventh question showed that 6 students answered "Yes" with a percentage of 22.2%, then 21 students answered "No" with a percentage of 77.8%.

Next, the eighth needs analysis, the question is "Do you need student worksheets that directs science learning to science, technology, engineering and mathematics?". Analysis of the needs of the eighth question revealed that 27 students answered "Yes" with a percentage of 100%, then 0 answered "No" with a percentage of 0%.

Next, the ninth needs analysis, the question is "Do you agree that the development of student worksheets for science learning on water cycle material will direct science, technology, science and mathematics?" Analysis of the needs of the ninth question revealed that 26 students answered "Yes" with a percentage of 96.3%, then 1 student answered "No" with a percentage of 3.7%.

Tabel 1. Summary of Needs Analysis Results

Needs Analysis	Positive Responds	
	Total	Persentase
Science subjects are difficult	20 people	74,1%
Water cycle material is difficult	19 people	74,1%
Learning tools that are often used are "package books"	11 people	40,7%
Agree to develop STEM-based student worksheets teaching materials	26 people	96,3%

Based on table 1. summary of the results of the questionnaire analysis of student needs at SDN 067251 Medan Deli, 74.1% of students stated that science lessons were a difficult lesson. data obtained that as many as 19 people or around 74.1% stated that the water cycle material was difficult material in science learning. A total of 11 people or 40.7% stated that teachers more often use textbooks for science learning. And, as many as 26 students or 96.3% stated that they agreed to develop STEM-based student worksheets learning tools.

This material analysis aims to determine the material that will be included in students' worksheets. The material taken was the water cycle material for class V SDN 067251. The reason the researcher took the water cycle material was that it was based on material analysis from the needs analysis that had been carried out, so the material taken was the water cycle. This water cycle material has many applications in everyday life, so that students can understand the concept of the water cycle in the form of evaporation, condensation and infiltration.

There are many applications of the water cycle in everyday life. For example, water evaporation, water freezing, solid and liquid objects and absorption. Apart from that, water discharge is also calculated.

In designing the material, a STEM-based student worksheets learning tool is needed which can help students in the learning process, such as motivation to learn because the student worksheets is made interesting and easy to understand. The stages arranged in designing the material are as follows;

1. Design, the aim of which is to determine the form of a STEM-based student worksheets design with water cycle material. The researcher designed product development in the form of an student worksheets with the contents format typed using Microsoft Word 2013 with A4 paper size with 1.15 spacing used. The types of letters used are 4 types of letters, namely for each page at the top using Segoe Script letters, for the image description section using Calibri (Body) letters, for the title section for application in daily activities using Comic Sans MS letters, for the section Generalization titles, bibliography and conclusions use Berlin Sans FB Demi letters, for the titles of scientific activity section 1 and scientific activity 2 use Comic Sans MS letters, and Times New Roman for the content section. On the cover there are several sections, namely section 1 is the title of the STEM-based student worksheets, section 2 is the title of the student worksheets material, namely Water Hydrology, section 3 is an image related to the material, section 4 is a description of the name and class, section 5 is for elementary school level units, and part 6 is the author's name. The student worksheets cover storyboard is designed to find out what arrangement the parts of the cover consist of.
2. Foreword, at this stage consists of the contents of the foreword, date and year and also the author's signature. The foreword contains the author's gratitude and thanks to the parties who helped the author in completing this student worksheets, namely the supervisors and validators who have provided many suggestions.
3. The next stage is the development stage. At this stage, STEM-based student worksheets products have been produced on the water cycle. The resulting student worksheets product is also revised according to improvement notes from design validity experts, material validity and language expert validity. In the STEM-based student worksheets product on water hydrology, there are the following components:

a. Cover

Figure 1. Design of Front Cover

Figure 1 shows the front cover of the student worksheets which consists of the student worksheets title, material title, picture, description of school level, name and class along with the author's name.

b. Identity

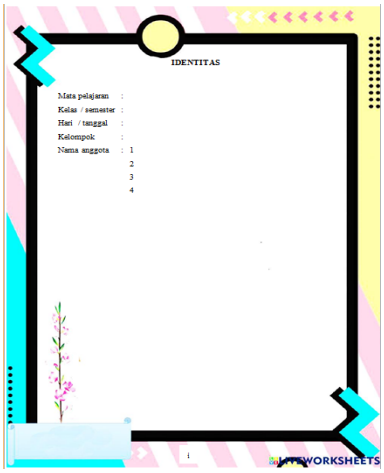
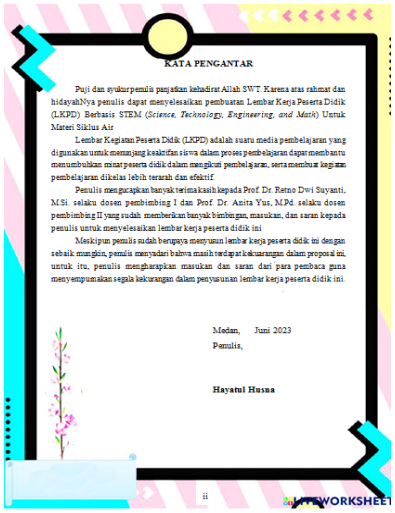


Figure 2. Identity Details

c. Foreword

The foreword contains the author's expression of gratitude to those who have helped in the preparation of this final assignment.



KATA PENGANTAR

Puji dan syukur penulis panjatkan kehadirat Allah SWT. Karena atas rahmat dan hidayahNya penulis dapat menyelesaikan pembuatan Lembar Kerja Peserta Didik (LKPD) Berbasis STEM (*Science, Technology, Engineering, and Math*) Untuk Materi Siklus Air

Lembar Kegiatan Peserta Didik (LKPD) adalah suatu media pembelajaran yang digunakan untuk memunjang keaktifan siswa dalam proses pembelajaran dapat membantu menumbuhkan minat peserta didik dalam mengikuti pembelajaran, serta membuat lagiatan pembelajaran dikelas lebih terarah dan efektif.

Penulis mengucapkan banyak terimakasih kepada Prof. Dr. Retno Dwi Suyanti, M.Si. selaku dosen pembimbing I dan Prof. Dr. Anita Yus, M.Pd. selaku dosen pembimbing II yang sudah memberikan banyak bimbingan, masukan, dan saran kepada penulis untuk menyelesaikan lembar kerja peserta didik ini

Meskipun penulis sudah berupaya menyusun lembar kerja peserta didik ini dengan sebaik mungkin, penulis menyadari bahwa masih terdapat kekurangan dalam proposal ini, untuk itu, penulis mengharapkan masukan dan saran dari para pembaca guna menyempurnakan segala kekurangan dalam penyusunan lembar kerja peserta didik ini.

Medan, Juni 2023
Penulis,

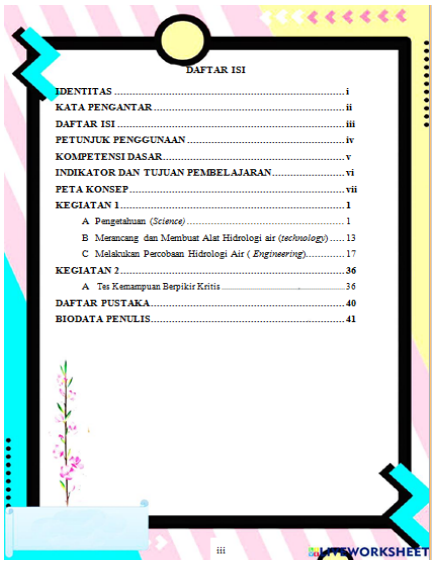
Hayatul Husna

ii

Figure 3. Author's Foreword

d. List of contents

The table of contents aims to make it easier for readers to find the pages and also the contents or components of the student worksheets, the table of contents is as in Figure 4.



DAFTAR ISI

iii

Figure 4. Table of Content

e. Instructions for using student worksheets

instructions for using the student worksheets direct users or readers in studying the student worksheets, so that readers can understand the content of the material, instructions for using the student worksheets are as shown in Figure 5.

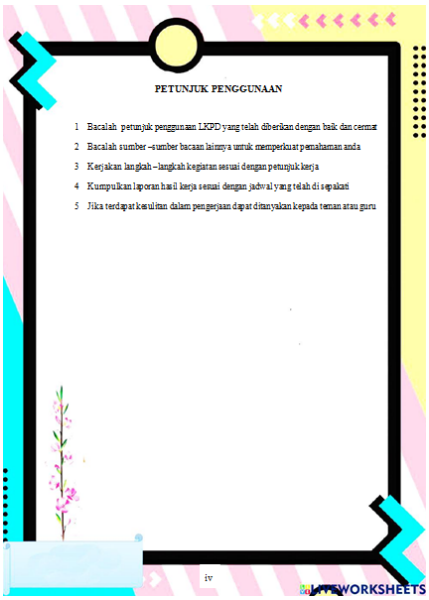


Figure 5. Design Instructions for Using student worksheets

f. Achievement Indicators

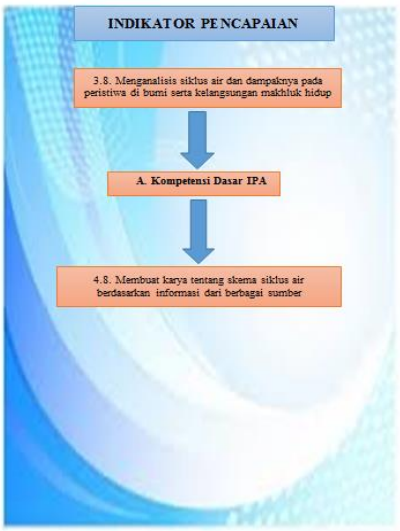


Figure 6. Achievement Indicator

g. Indicators and Objectives

After the instructions for using the student worksheets are basic competencies and indicators. These basic competencies are a reference for formulating indicators for future competency achievement, basic competencies and indicators as in Figure 7.

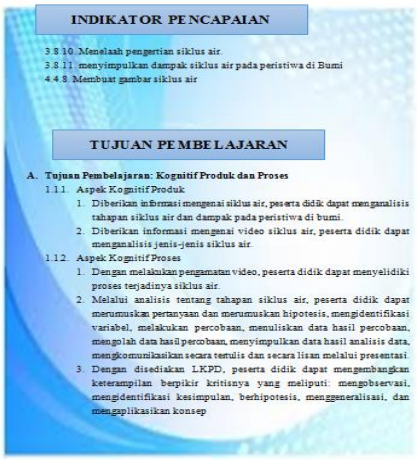


Figure 7. Indicator and Goals

h. Water Cycle Activities

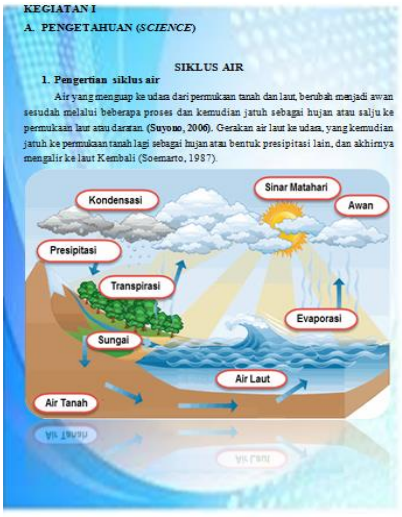


Figure 8. Water Cycle Activities

i. Conduction

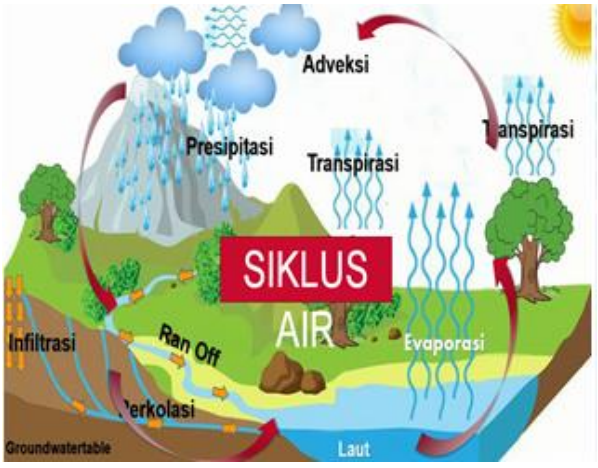


Figure 9. Conduction

j. Exercise

Figure 10 shows a practice question to determine the ability to understand the material discussed previously.

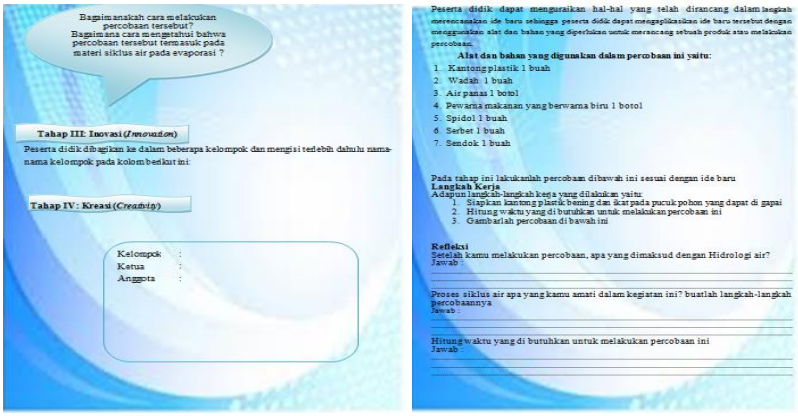


Figure 10. Exercise

k. Evaluation

The final stage of STEM-based learning activities is evaluation. Evaluation is useful for deepening learning material that has been studied previously. The evaluation in this student worksheets contains questions regarding the material being studied. The preparation of evaluation questions is based on KD, and indicators that have been prepared on the second page of the student worksheets, as in Figure 11.

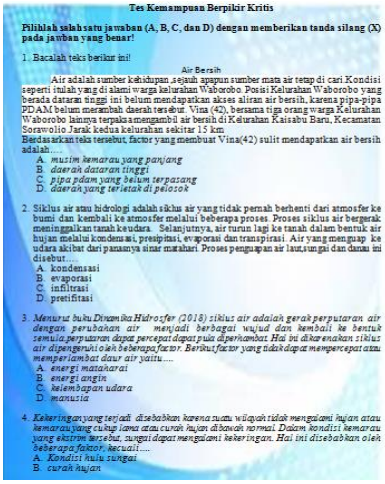


Figure 11. Evaluation

l. Glossary

This glossary contains terms contained in the material, the aim of which is to make it easier to understand dynamic fluid material, as in Figure 12.

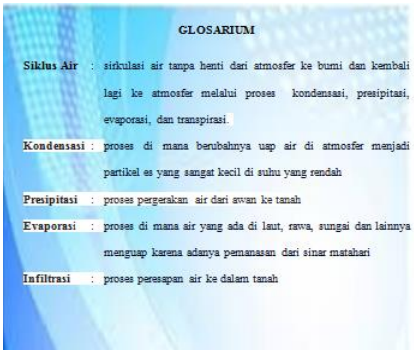


Figure 12. Glossary

m. Author Profile

Then on the last page is the author's profile which contains the author's personal biodata and educational history, as in Figure 14.

Figure 14. Author Profile

Developing STEM-Based Student Worksheets

STEM-based learning is learning that uses a learning model that is more student-centered to find out learning skills in terms of science, technology, engineering and mathematics. STEM-based learning is learning where students are asked to make observations of various phenomena found in everyday life. -day. After observing and obtaining information about various phenomena related to science that are discussed, students are asked to look for something new or unique from the various phenomena that have been previously observed, then the stage of describing things that have been obtained previously, then implementing all the suggestions and views resulting from discussions regarding something new and obtaining results or values regarding something new and unique.

STEM learning can be displayed in the form of sheets containing learning activities that must be completed by students. This activity sheet is usually known as a student worksheet. Student Worksheets are a guide to the activities that students must carry out in the learning process. The existence of this Student Worksheets is to make it easier for students to understand the concepts in the material being studied. Student Worksheets on fluid dynamic material were developed using the ADDIE model, namely analysis, design, development, implementation and evaluation. Development is carried out in stages to produce a product that is good and suitable for use in the learning process.

The first stage is analysis or the stage of analyzing the needs for student worksheets learning devices which is carried out by observing schools, interviewing class teachers and filling out student needs questionnaires. School observations to determine the condition of the school as well as facilities and infrastructure. Interviews with class subject teachers aim to find out the usual learning process at school, student learning outcomes and what learning tools are used. Meanwhile, filling out the needs analysis questionnaire is useful for finding out the difficulties experienced by students.

Based on needs analysis, 74.1% of students stated that physics subjects were difficult to understand. This is supported by research by Samudra, Suastra and Suma (2014) which reveals that science is a difficult and less popular lesson.

Because monotonous learning using textbooks is difficult to understand. In fact, when teachers deliver practical explanations, students tend to remain silent because they do not understand what the teacher is saying. So, this research developed student worksheets learning tool to deal with this statement. Researchers also collected relevant reference sources by looking for school books and syllabi used in class V science lessons at SDN 067251 Medan Deli. This is done to determine the suitability of the product being developed.

The second stage is design which begins with the need, namely the water cycle. Next, prepare basic competencies and indicators of competency achievement, then determine the content components of the student worksheets learning tool which includes cover, foreword, table of contents, instructions for using the student worksheets, material competencies, experiments, evaluation, glossary and author profile.

The third stage is the development stage, where at this stage the initial student worksheets product is produced. The initial product produced is then validated to determine the quality and suitability of the student worksheets learning device. During the validation process there are improvements according to input and suggestions from the validator. Validation carried out includes media and design validation, language validation and material validation.

The fourth stage, namely the implementation stage, is carried out after validation is complete and it is said to be ready for use. At this stage the researcher asked students to carry out small-scale trials. The small-scale trial aims to determine responses from students regarding the use of it being developed.

Student Worksheets based on science technology engineering mathematics are prepared by adapting the steps from the STEM learning model. The parts of a STEM-based Student Worksheet include cover page, foreword, table of contents, basic competencies, indicators, instructions for use, learning activities arranged according to the STEM model, evaluation questions, glossary and profile writer. Student Worksheets which are prepared based on the steps of the STEM model include:

I. Observation
   In this observation step, they are asked to make observations of various phenomena found in their daily environment that are related to the scientific concepts being taught. At this stage, students are faced with something that raises questions from themselves so that the desire to carry out an investigation arises. According to Yuliana, R. (2018) providing stimulation in the form of images by presenting a problem creates a feeling of curiosity to investigate.
II. Image Description
   In this image description, the researcher explains the purpose of observing the previous image. Images can be used as a tool in learning to write descriptive text. Image description is a form of discourse that attempts to present an object in such a way that the object appears to be in front of the reader, as if the reader sees the object for themselves (Brotowijoyo, 2002). The use of these images can foster

creativity so that they can develop their reasoning power and can be seen actively in learning situations.

III. Technology and Engineering (Innovation)
This section explains the application of the material in everyday life. And the application of the material is related to technology and engineering. For example, in the student worksheets, namely experiments on evaporation, condensation and precipitation. This experiment is closely related to the mathematical concept of calculating time.

IV. Data analysis
In STEM-based student worksheets, data analysis activities include data collection. Data collection was carried out through simple experimental activities. experimental activities were carried out in accordance with the steps stated in the student worksheets. After the data is collected, students are directed to carry out data processing.

V. Conclusion
Conclusion is the process of drawing conclusions obtained in previous activities. It explains that the conclusions obtained are used as general principles and apply to all incidents, then principles are formulated to base the conclusions.

The STEM-based student worksheet developed has several advantages, namely, it is simple, easy to use, has attractive designs and images, is easy to use and helps students in the learning process. However, apart from having advantages, the worksheet developed also has disadvantages, namely that this worksheet is a printed student worksheet, so the images contained in the student worksheets are still or not moving images.

Feasibility of STEM-Based Worksheets

Design Expert Validation Data

Design expert validation or carried out by Mr. Prof. Dr. Abdul Hamid K., M.Pd. This validation aims to obtain input and suggestions for improving the quality of student worksheets products with rational thinking, not yet based on facts in the field. The validator reviews the student worksheets product that was developed to fill in the media expert validation sheet. The assessment carried out by media experts on four aspects, namely, graphic aspects, layout and display design, and presentation of problems and activities in the student worksheets is appropriate.

The first validation of the quality of the student worksheets product for water cycle material is still lacking. As for input and suggestions for improvements from design experts, namely, the Validator provides input and suggestions for improvements to the student worksheets, namely:

1. Improved the full screen background display so that the colors are not too dominant and the writing can be read.
2. Complete the missing cover with information about what school level and class.
3. Add a song to the opening section that is related to the water cycle
4. There are no page numbers, fix it so you know what page is open.

The assessment results based on data analysis carried out by the first validation design expert obtained an assessment score of 122 which stated that the student worksheets product included appropriate criteria with a percentage of 76.25%. Based on an assessment by media experts, the second validation obtained an assessment score of 135 with a percentage of 84.37% which stated that the student worksheets product included very feasible criteria.

Student Responses to STEM-Based Student Worksheets

Responses according to Ahmadi (2009:68) are a person's impressions or responses after making observations. Students' responses to something that has been shown through assessing an object. Where the object in question is a STEM-based student worksheets that researchers have created. Students' responses are seen from conveying the opinions that have been given. Researchers conducted small-scale trials to determine the response.

A small-scale trial was carried out to determine the response involving 14 class V students at SDN 067251 Medan Deli. fill out the response questionnaire to the student worksheet developed. From the distribution of response questionnaires, data was obtained as in table 2.

Table 2. Rating Response By

Assessment Points	Respondent to -														Average Score
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
	Score														
Can you follow every step on the student worksheets without asking a lot of other people for help?	4	3	2	2	4	3	3	3	1	4	3	3	3	3	3,15
Does Early student worksheets provide an opportunity To learn?	4	3	3	3	3	3	3	3	3	4	3	3	3	3	3,38
Is it appropriate with your thinking ability?															
Is this student worksheets able to help you in the process learning?	4	3	3	2	4	3	3	3	3	4	3	3	3	3	3,38
Is the description in the student worksheets clear?	4	3	3	3	2	3	3	3	3	3	3	3	3	3	3,23
Are the stages of the experiment described in this student worksheets?	4	3	3	3	4	3	3	3	3	3	3	3	3	3	3,38
Is this student worksheets able to explain the water cycle material well?	4	3	3	3	3	3	3	3	3	4	3	3	2	3	3,30
Does this student worksheets guide you through the practicum sequentially from the first stage to the final stage?	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3,07
Are you happy and interested in using student worksheets in practicum?	3	3	3	2	3	3	4	3	3	4	3	3	3	3	3,30

Do the pictures in this student worksheets match the water cycle material?	3	3	3	4	3	3	3	3	3	4	3	3	3	3	3,38
Do pictures or illustrations make data collection clear?	3	3	4	4	4	3	3	3	3	4	3	3	3	3	3,30
Is the shape and size of the letters used correct and easy to read?	4	3	4	4	3	3	3	3	3	4	3	3	3	3	3,53
Is the language in this student worksheets clear and easy to understand?	4	3	3	4	2	3	3	3	3	4	3	3	3	3	3,38
What is the overall appearance of this student worksheets?	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3,07
Total of Score															42,85
Average of Score															3,29

The researcher conducted a small-scale trial by means of a small-scale test which was carried out to determine students' responses to the student worksheets which was developed as a result of science subject research on the student worksheets, getting a student response assessment score of 42.85 with an average score of 3. 29 in the very good category. After carrying out a trial run by the students, they explain to the students about each part of the worksheet. After students observe and listen to the student worksheets, students are asked to fill out a response questionnaire.

The effectiveness of student worksheets means achieving learning objectives which are reflected in student learning outcomes. This is in accordance with the opinion of Astuti, Y. (2016); Kurniawati, D., Widodo, A. T., dan Sumarti, S., (2018), that "The effectiveness of learning can be seen from the extent to which learning can create students who have learning independence. The effectiveness of STEM-based student worksheets products is reviewed from the responses of teachers and all students at SDN 067251. A summary of the effectiveness of STEM-based Student Worksheets products in improving students' critical thinking based on student surveys is presented in table 3.

Table 3. Recapitulation of the Effectiveness of STEM-based Student Worksheets by Students

No	Validator	School	Percentage (%)	Category
1	Students	SDN O67251	90%	Very Effective
	Average		88,75%	Very Effective

Based on the data in table 3, the analysis results show that the average percentage of effectiveness of student worksheets by students is 88.75% in the very effective category.

This research also had obstacles when the research was carried out so that this research also had the following weaknesses:

a. This research was only carried out at the evaluation stage with critical thinking characteristics

b. This research only focuses on student worksheets.
c. Student worksheets arrive in print media, not in electronic form.

CONCLUSSION

Based on research results from "Development of Student Worksheets Based on Science Technology Engineering Mathematics (STEM) Class V SDN 067251 Medan Deli:

1. Feasibility of the student worksheets product developed by the three experts, namely the design expert got an average score of 84.37% in the very feasible category, while the results from the material experts got an average score of 94% in the very feasible category. And for validation from language experts, an average score of 91.42% was obtained in the very appropriate category.
2. The effectiveness of student worksheets based on Science Technology Engineering Mathematics (STEM) to improve students' critical thinking skills at SDN 067251 with a score of 88.75%.
3. Student responses to STEM-based student worksheets resulted in an average score of 3.33 in the very good category

REFRENCES

Astuti, Y. (2016). Pengembangan lembar kerja siswa (LKS) berbasis kontekstual sebagai sumber belajar di SMPN 2 Semaka untuk kelas VII pokok bahasan segi empat [Undergraduate thesis, UIN Raden Intan Lampung]

Artiani, Leni. (2020). *Pengembangan Lembar Kerja Peserta Didik (LKPD) Dengan Pendekatan Science, Teknology, Engineering, and Mathematics (STEM) Berbasis Picture.* Lampung: Universitas Negeri Raden Intan.

Brotowidjoyo, Mukayat D. (2002). *Penulisan Karangan Ilmiah.* Jakarta: Akademika Pressindo.

Ahmadi. 2010. Ilmu Pendidikan. Jakarta: Rineka Cipta.

Almuharomah, Farida Amrul. 2019. Pengembangan Modul Fisika STEM Terintegrasi Kearifan Lokal Beduk Untuk Meningkatkan Kemampuan Berpikir Kreatif SMP. Jurnal Berkala Ilmiah Pendidikan Fisika Vol 7, No 1: 2549-2764.

Arif, A M., Heni, P., & Ria, S. (2020). Pengembangan Media Pembelajaran STEM dengan Augmented Reality untuk Meningkatkan Kemampuan Spasial Matematis. *Journal Reset Guruan Matematika*, 7(1), 59-73.

Bahri, Saiful. 2017. Pengaruh Penerapan Model Contextual Teaching and Learning (CTL) Tipe Inquiry Terhadap Kemampuan Berpikir Kritis. *Jurnal Pendidikan Islam*, 8(1), 45-59.

Jauhariyyah, R., Suwono, H & Ibrohim. (2017). Science, Technology, Engineering and Mathematics Project Based Learning(STEM-PjBL) pada Pembelajaran Sains. *Jurnal Pendidikan*, 2(1), 434-435.

Pamungkas, A., & Kusdiwelirawan, A. (2020). Analisis Kebutuhan Pengembangan Lembar Kerja Peserta Didik Berbasis Android. *Prosiding Seminar Nasional Fisika (E-Journal)*, *9*(1), SNF2020PF-69. https://doi.org/10.21009/03.SNF2020.02.PF.11

Jolly, A. (2019). *STEM By Design. Strategies and Activities for Grade 4-8*. Britani Raya: Routledge

Kemendikbud. (2017). *Penduan Penyusunan Rencana Pelaksanaan Pembelajaran Sekolah Menengah Pertama.* Direktorat Jenderal Pendidikan Dasar dan Menengah dan Direktorat Pembinaan Sekolah Menengah Pertama

Kemendikbud. (2016). *Materi Pelatihan Guru Implementasi Kurikulum 2013 Tahun Ajaran 2014/2015: Mata pelajaran IPA SMP/MTs*. Jakarta: Kementrian Pendidikan dan Budaya

Kurniawati, D., Widodo, A. T., dan Sumarti, S. (2018). Dampak model KAPDA terhadap hasil belajar pengetahuan pada pembelajaran CTL. *Chemistry in Education*, 7 (2); 4–21

Laisnima, Lhony, & Tiurlina Siregar. (2020). Modul Pembelajaran Berbasis Science, Teknology, Engineering, and Mathematics (STEM) untuk Meningkatkan Hasil Belajar dan Keterampilan Proses Peserta Didik pada Materi Redoks dan Sel Ektrolisis. *Jurnal Ilmu Pendidikan Indonesia*, 8 (2), 84-90.

Mawar, A. Y. D., Ernaningsih, D., & Syafriati, Y. M. (2020). Pengembangan LKPD berbasis berpikir kritis pada materi jamur. *Jurnal Bios*, 1–10.

Asri, N. 2020. Penerapan Model Pembelajaran PJBL (Project Based Learning) Berbasis STEM Untuk Meningkatkan Kemampuan Pemahaman Konsep Matematis Ditinjau Dari Gaya Kognitif Peserta Didik. UIN Raden Intan Lampung.

Permendikbud, 2013, Nomor 65 Tahun 2013 Tentang Standar Proses. Permendikbud Nomor 24 Tahun 2016 tentang Kompetensi Inti dan Kompetensi Dasar.

Quratulaini, (2019). Pengembangan LKS IPA berbasis STEM (Sciensi Technology, Engineering, and Mathematics) untuk Meningkatkan Kemampuan Berfikir Kreatif dan Hasil Belajar Siswa SMP/Mts. Jember: FKIP.

Saputra, B., & Sujarwanta, A. (2021). Transformasi Pembelajaran Berbasis Proyek Science, Technology, Engineering and Mathematics Di Masa Pandemi Covid-19. *Biolova*, 2 (1), 1-8.

Yuliana, R. (2018). *Media Simulasi Pembelajaran Keamanan Jaringan Berbasis Fungus Unity Untuk Meningkatkan Pemahaman Siswa Smk Jurusan Teknik Komputer Jaringan.* Universitas Pendidikan Indonesia: repository.upi.edu