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Analysis of Implementation of Steam-Oriented Science Teaching Modules and Profiles of Critical Thinking Skills of Elementary Students

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ABSTRACT

Objectives: *This research aims to analyze the profile of students' critical thinking abilities regarding the implementation of STEAM-oriented science and science learning development in elementary schools.* ***Method:*** *This research is a preliminary study with a data collection technique in the form of a written test by analyzing the data results descriptively and qualitatively. This research was conducted on 7 students consisting of 3 female and 4 male students in elementary school.* ***Results:*** *This research can be concluded that: It was found that the criteria for students' critical thinking abilities were still very low with an average score of 51.76 or a completion percentage of around 36%. In this research, it is hoped that the application of STEAM-oriented learning can improve students' thinking abilities. So, the conclusion is that if students' critical thinking skills are still low, it is necessary to improve students' critical thinking skills, namely by implementing STEAM-oriented learning.* ***Novelty****: Development of learning tools oriented to the STEAM approach to improve the science and science critical thinking abilities of elementary school students in the independent curriculum, so that it will improve students' critical thinking skills in line with the demands of the 21st century.*

INTRODUCTION

The output of educational quality is influenced by the learning process in the educational unit. The learning process can run well if it is supported by qualified human resource input and educational unit resources (Kemendikbud, 2022). This means that teachers must teach their students to think because school education aims not only to master and understand scientific concepts but also to improve students' thinking abilities and skills, especially high-level thinking skills or critical thinking (P. M. S. Saraswati, 2020). This is intended so that they can survive in an era of globalization full of very tight competition. Rizal (2017), also stated Excellence in competition lies in the ability to search for and use information, critical analytical skills, accuracy in decision-making, and proactive action in exploiting existing opportunities.

Zubaidah 2010, in a quote from A Husna & Masykuri (2019), One of the life skills that must be developed through the educational process is the life skill of thinking. A person's ability to succeed in life is determined, among other things, by thinking skills (Affandy et al., 2019), especially problem-solving efforts. Critical thinking in teaching and learning activities can be done by students who know how to answer questions and how and why these concepts are used. Therefore, the ability to think critically plays a very important role in learning (Fazriyah, 2015). .

According to (Aulia Azizah, 2019),: "One of the indicators that determines the success of a person's life is their thinking ability, especially in efforts to solve the various problems they face." People in the 21st century must be able to think critically, so they must improve the quality, criteria, and standards of their thinking (Rizal, 2017). Critical

thinking is needed to avoid making decisions that will harm oneself or the interests of others.

The ability to think critically is very important in the education and life process (Khasanah et al., 2017a). Critical thinking is also a cognitive ability that students must possess and develop (Hartini, 2017). To solve problems, you need the right data to make the right decision. To make the right decision you need a critical thinking pattern. Besides that, it helps someone to understand and evaluate information objectively and rationally (Makhmudah, 2018).

Glaser (Khasanah et al., 2017b) defines critical thinking as an attitude of wanting to think deeply about problems and things within the range of one's experience, knowledge of methods of logical examination and reasoning and a skill to apply these methods. Critical thinking requires rigorous efforts to examine every belief or assumptive knowledge based on supporting evidence and subsequent conclusions (NI & Putra, n.d.).

There are various ways to develop children's critical thinking skills at school, family, and home. Critical thinking skills that develop in the elementary school environment can be applied to learning, including science and technology. Critical thinking is part of the 21st-century skills that are important for every student (Hadinugrahaningsih et al., 2017). Critical thinking skills, by Science Learning Outcomes. Science material and critical thinking skills are two things that cannot be separated because science material is understood through critical thinking and vice versa. Critical thinking is trained through studying science science. However, in reality, implementing science and science learning in schools needs to pay more attention to critical thinking skills.

In short, because critical thinking is an important and essential topic in modern education (Sugiarti & Dwi Suryanti, 2017), all educators should be interested in teaching critical thinking to their students. Educational professionals and coaches must be deeply involved in planning critical thinking learning strategies. This skill aims to explain the definition of critical thinking skills, the characteristics of high-grade elementary school students, science and science learning in elementary schools, and how to apply critical thinking skills in science and science learning in elementary schools. As we know, critical thinking is high-level thinking. This critical thinking skill begins with observing, asking, reflecting, analyzing other people's opinions or statements, drawing conclusions, and presenting a report on the results of observations.

Based on the observation results, students have yet to be able to determine the information and problems presented through indicators in analyzing problems. Students tend not to be able to relate learning concepts to the real world because elementary school students aged 7 - 11 are still in the concrete thinking stage (Andesta Bujuri, 2018). So it is difficult for students to come up with new ideas or ideas. This can be seen during learning activities in the science and science subject content; some students struggle to understand the material presented, and some students need to focus when the teacher delivers the lesson material. This happens because current learning is still teacher-centered, still classical. Apart from that, so far, students only focus on worksheets, and teachers need to explore students' thinking more because there is also no assessment tool for critical

thinking skills. These facts are suspected because the learning model is not suitable. Therefore, students' thinking abilities need to be improved again through the development of learning tools, which include teaching modules, project modules for strengthening Pancasila student profiles, textbooks (teaching materials), examples of educational unit operational curricula, learning videos, and critical thinking ability test questions in science and technology learning (Kemendikbudristek, 2022).. The teaching tools provided by the government for use include:

Teaching Module

According to the book Curriculum for Learning Recovery, published by (Akademik Badan Standar et al., 2022) Teaching Modules are one of the teaching tools used in the learning process. The Teaching Module was developed from a learning implementation plan (RPP), a guide for teachers in compiling and planning learning. The Teaching Module is more detailed than the RPP because it is equipped with various information needed in the learning process, such as: Guide to compiling a syllabus, subject matter to be taught, learning objectives, activities to be carried out by students, assessments used to measure achievement of learning objectives, student worksheets, learning evaluation.

Project Module Strengthening Pancasila Student Profiles

The project to strengthen the profile of Pancasila students is cross-disciplinary learning, which has the purpose of increasing students' understanding, appreciation, and practice of Pancasila values as good citizens with noble character and observing and thinking about solutions to several problems that occur in their environment (Rachmawati et al., 2022).

Teaching Materials

In quotations (Rahmadayanti & Hartoyo, 2022) Textbooks in the Merdeka Curriculum consist of main and companion textbooks. The main textbook is used in learning, consisting of a student's book and a teacher's guide. The student book is the student's handbook, and the teacher's book is the teacher's reference for learning based on the student's book.

The preparation of learning tools must follow current developments and use appropriate models so that teachers can see student development during the learning process (Chodijah et al., 2012). To overcome this problem, teachers must be able to develop learning tools orientedSTEAM (Science, Technology, Engineering, Arts, and Mathematics) to carry out the learning process well, meaningfully, and even innovate. The STEAM approach can improve thinking skills so that interactions that occur will run smoothly (Prasetya et al., 2022).

(Triastuti, 2020) that the STEAM learning approach (*Science, Technology, Engineering, Arts and Mathematics) Focuses* on the learning process of solving problems in real life, STEAM learning trains students on concepts and principles *Science, Technology,*

Engineering, Arts and Mathematics (Triprani et al., 2023), which *is* used in an integrated manner to develop products, processes and systems that provide benefits to human life.

The goals of STEAM education according to Bybee, 2013 in Triastuti, (2020), include that students are expected to be STEAM literate, who have the knowledge, attitudes and skills to identify questions and problems in their lives, explain natural phenomena, design and draw conclusions based on evidence regarding STEM-related issues . In other words, to solve science and technology problems, thinking and creative skills are needed.

The STEAM approach is also believed to be by the spirit of the Independent Curriculum, which prioritizes project-based learning that is more interactive and relevant, providing more opportunities for children to explore the character development and profile of Pancasila Students (Nisa Fadillah et al., 2022). Besides that, it gives students opportunities to work autonomously in constructing their learning. From this opinion, the following research formulation can be made: "Will learning using the STEAM approach improve students' critical thinking skills?" By making this research formulation, the researcher aims to find out whether there is an increase in students' critical thinking skills by implementing STEAM-oriented learning. It is hoped that STEAM-oriented learning will increase students' understanding and knowledge regarding science, technology, engineering, art, and mathematics, so that this understanding can be used to solve problems and make decisions for human progress in the future (Lestari, 2021).

Based on the things explained above, there has yet to be a study regarding the development of science critical thinking learning tools oriented to the STEAM approach. The novelty of this research is the development of learning tools oriented to the STEAM approach to improve the science and science critical thinking abilities of elementary school students in the independent curriculum so that it will improve students' critical thinking skills in line with the demands of the 21st century.

RESEARCH METHOD

This research uses a preliminary study with a descriptive research design and does not test hypotheses (Abubakar, 2020) but uses a descriptive research design. Researchers carried out this preliminary research to find out the actual situation at school and add information related to problems in more detail (Saphira & Prahani, 2022). The results of this research are used to improve innovative learning models and tools in the school to improve elementary school students' critical thinking skills.

The research was conducted on 7 fourth grade students at SD Negeri Banyudono 2 Magetan, Indonesia in March 2023, consisting of 3 female and 4 male students. The research instruments used in this research were written tests, student response questionnaires, and interviews with science teachers. Written tests determine student learning outcomes in the cognitive domain (Neswary & Prahani, 2022). The written test questions are in the form of essays totaling 10 questions to estimate critical thinking skills (Neswary & Prahani, 2022) regarding changes in the form of objects that are equipped with critical thinking indicators. The student response questionnaire (Neswary & Prahani, 2022) was used for data collection and distributed via printout to 7 students.

Then, the researcher also interviewed the teacher, containing 7 questions that could explain the conditions related to the science and science learning process at school. Interviews were conducted to gather information about the science learning situation at school. The information sought is whether STEAM-oriented learning has been implemented to improve students' critical thinking skills and what teachers think about STEAM-oriented learning.

The data analysis technique used in this research is a qualitative descriptive technique, according to the opinion of Tiswarni, 2019 (Neswary & Prahani, 2022). This research stage was carried out as in Figure 1.

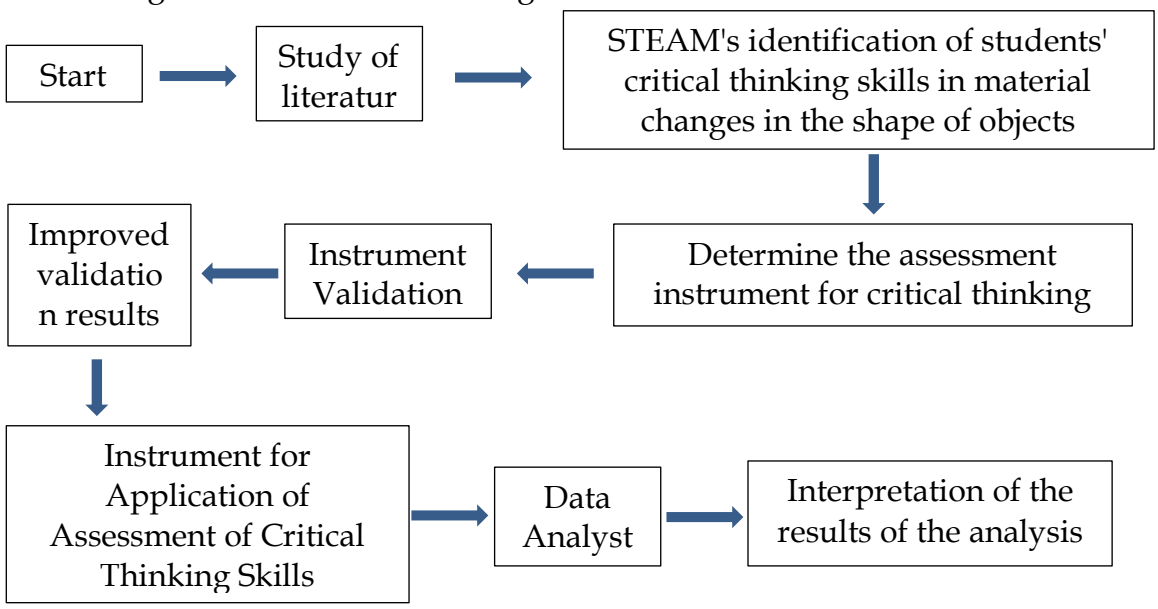


Figure 1. Research stage

RESULTS AND DISCUSSION

Results

The results of the preliminary study were obtained from the results of a field study in the form of written tests, observations and teacher interviews to determine the level of critical thinking skills of elementary school students. The written test given contains 5 descriptive questions that correspond to 4 indicators of critical thinking. Facione in Neswary & Prahani (2022), including: interpretation, analysis, inference and evaluation. Students are expected to be able to interpret, analyze questions, make conclusions and evaluate questions according to the question instrument (Neswary & Prahani, 2022). Based on the research that has been carried out, the results of critical thinking skills have been obtained on the material of changes in the form of objects in accordance with the Facione indicators as in Figure 2.

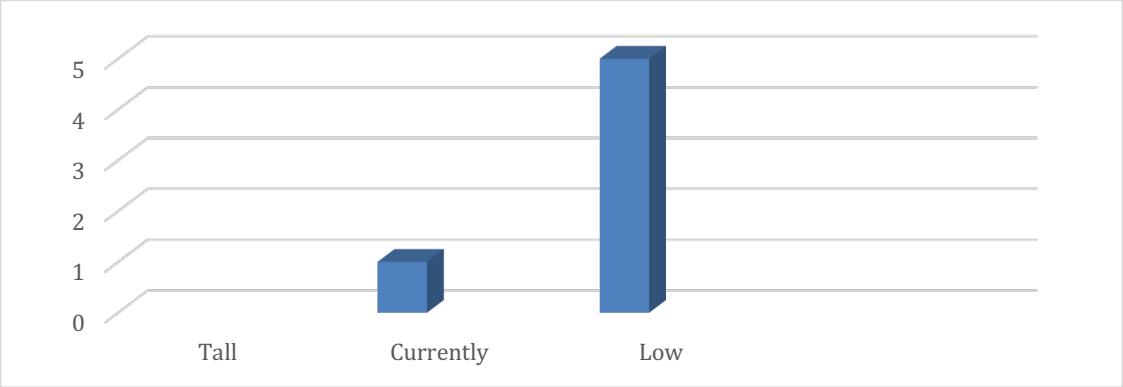


Figure 2. Categories of Critical Thinking Skills

From Figure 2, it can be seen that from 7 students in total, 2 students have medium category scores and 5 students have low category scores. There are no students who fall into the high category.

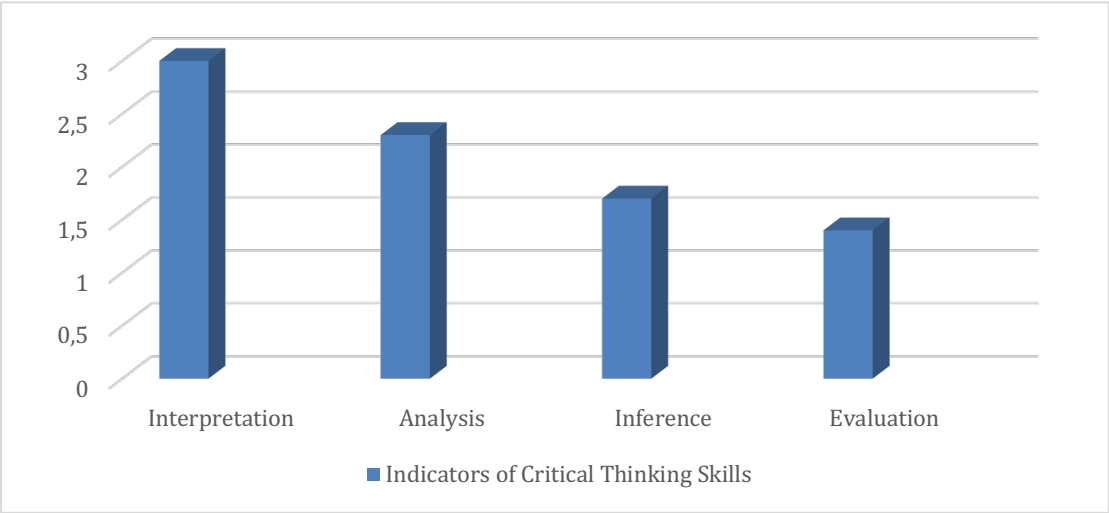
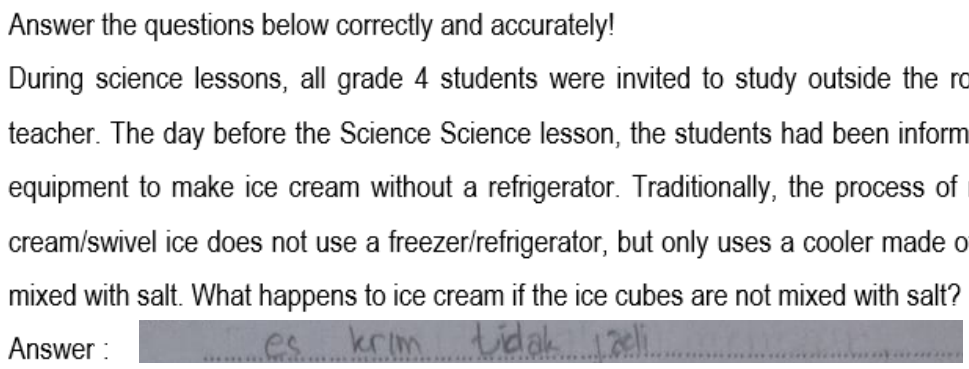


Figure 3. The average of each indicator of critical thinking skills.

Figure 3 shows the results of the average indicators of students' critical thinking skills in one class. Based on this figure, it can be seen that the highest average indicator of critical thinking skills is the interpretation indicator which shows that students can provide opinions that are appropriate to the problems presented. The second highest average which differs slightly from interpretation is the analysis indicator. This shows that students are able to analyze the types of changes in the form of objects that are appropriate to the problems presented. Meanwhile, the third and fourth rankings are inference and evaluation which are still low. So, it can be seen that students have not been able to conclude and evaluate the problems presented in the questions. Examples of questions and student answers in critical thinking skills tests are as follows:

Interpretation


Answer the questions below correctly and accurately!

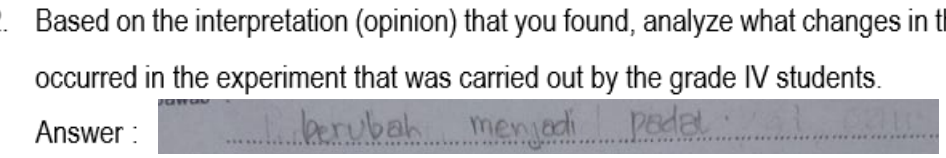
1. During science lessons, all grade 4 students were invited to study outside the room by the teacher. The day before the Science Science lesson, the students had been informed to bring equipment to make ice cream without a refrigerator. Traditionally, the process of making ice cream/swivel ice does not use a freezer/refrigerator, but only uses a cooler made of ice cubes mixed with salt. What happens to ice cream if the ice cubes are not mixed with salt? Explain!

Answer : es krim tidak jadi

Figure 4. Interpretation of student answers

Figure 4 is an answer to an interpretation indicator question, students are asked to interpret the understanding of the problem presented. Namely about how to make ice cream without a refrigerator. However, the students' answers were not correct in understanding changes in the form of objects. The correct answer should be hard to freeze. Because in the question the problem has been presented that making ice cream without a refrigerator requires salt which will be mixed with ice cubes to help it freeze. The student's answer that making ice cream requires salt is still ambiguous. Why salt is needed is not explained. Therefore, Students feel challenged to solve complex problems that require them to think critically and are expected to find innovative solutions. The student's answer that making ice cream requires salt is still ambiguous. Requires salt for what is not explained.

Analysis

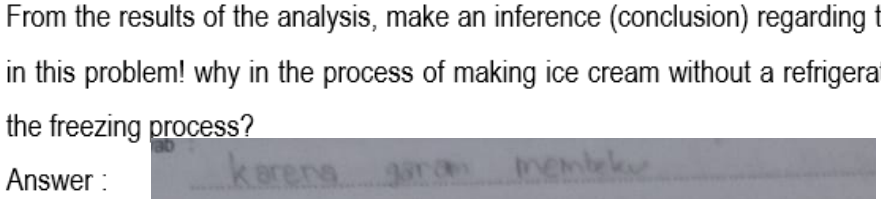

2. Based on the interpretation (opinion) that you found, analyze what changes in the state of matter occurred in the experiment that was carried out by the grade IV students.

Answer : berubah menjadi padat

Figure 5. Analysis student answers

Figure 5 is the answer to the analysis indicator question, based on the answer to the previous question. Students are asked to analyze changes in the shape of an object when an experiment is carried out. However, the students' answers were still not correct. The student answered by melting, even though in the previous question in part number 1 the student answered that the object became frozen. This shows that students still do not understand and cannot analyze based on the problems presented.

Inference


4. From the results of the analysis, make an inference (conclusion) regarding the things that exist in this problem! why in the process of making ice cream without a refrigerator requires salt for the freezing process?

Answer : karena garam membeku

Figure 6. Inference indicator student answers

Figure 6 is a student's answer to the inference indicator (conclusion). Students are asked to understand and conclude matters related to the problem presented. Then they were asked to create tools or ideas to help speed up the freezing process. However, the students' answers still did not produce a conclusion, and most of the students were not able to come up with ideas to speed up the freezing. The conclusion from the problem presented above is that to help speed up the freezing process, salt is needed because salt has properties functions to keep the temperature of the ice low and not melt easily.

Evaluation

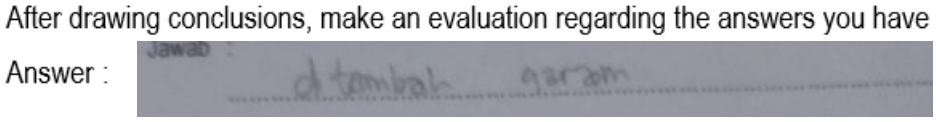


Figure 7. Student answers to evaluation indicators

Figure 7 shows a representation of student answers to evaluation indicators. Students are asked to make an evaluation of the conclusions they have made. From the conclusions in the previous question, it can be evaluated that to help speed up the freezing process, more salt can be added from the original dosage to twice or more than the initially determined dosage. However, because students still have difficulty in making conclusions, this has an impact on evaluation. Most students still have difficulty evaluating their own answers.

Student Response Questionnaire

Table 1. Student Response Questionnaire Table to Improve Critical Thinking Skills

Component	Percentage (%)			
	SD	**D**	**A**	**SA**
1. IPAS is a fun lesson	12%	51%	31%	6%
2. The matter of changing the state of things (Freezing and Thawing) is important to understand	1%	13%	52%	35%
3. Material changes in the form of objects (Freezing and Thawing) are difficult to understand	3%	38%	51%	9%
4. Conventional book-assisted learning methods are often used by teachers rather than experimental or project learning methods	5%	45%	44%	6%
5. You feel comfortable and happy with the learning method that your teacher is currently teaching	10%	37%	39%	14%
6. You have carried out learning activities to improve Critical Thinking Skills	0%	11%	39%	50%
7. You have been frequently trained on the Critical Thinking Skills test	3%	26%	48%	23%
8. Critical Thinking Skills are important to teach in schools	5%	28%	48%	19%
9. You know what STEAM oriented Learning is	3%	27%	51%	20%
10. You are interested in acquiring STEAM-oriented science learning	8%	27%	41%	23%

Table 1 Students do not agree that science subjects are boring. The next student statement agrees that the material on changes in the form of objects is important to learn. However, students feel that the material on changing the shape of objects is difficult to learn. Students often ask if they don't understand the material presented by the teacher.

Students strongly agree that critical thinking skills in IPAS are important. Students have carried out activities to improve critical thinking skills and have been trained on critical thinking ability tests. That way, students are interested in using STEAM learning in science learning. The use of media for a learning model is considered important (Neswary & Prahani, 2022). In the student questionnaire, students felt interested in learning using STEAM-oriented learning to improve students' critical thinking skills. STEAM learning provides more meaningful teaching and it is easier for students to understand the learning material because students are directly involved in the learning process, here students are invited to practice directly and can apply the knowledge and skills acquired in real-world situations, preparing them for challenges in the workplace, so that students will learn to think critically to find new solutions.

Teacher Interview

From the results of interviews submitted to class IV science and science teachers at the school regarding the analysis of planning documents in learning, it can be stated that teachers generally have created learning tools that are prepared based on the format that applies in the school. Learning tools include teaching modules, P5 modules and assessment instruments. This assessment instrument is an assessment of attitudes and performance. The preparation and planning of teaching modules are generally written based on learning objectives, learning steps (which include the learning media that will be used), assessments, as well as other learning information and references that can help teachers in implementing learning.

Based on the results of interviews with science and science teachers regarding the learning process in class, it was found that the learning process sometimes still uses conventional methods. Teachers never implement learning using a learning model with a STEAM approach. In the learning process, students only receive knowledge in one direction and students only listen. This results in students not being able to identify phenomena scientifically, students easily forgetting the material that has been taught, and students not being able to apply the science and science material they learn to solve a problem. This will result in a low level of students' critical thinking abilities. The low level of students' critical thinking abilities has an impact on low student learning outcomes. From the results obtained in the field, 51.76% of students still obtained learning results below the minimum completeness criteria (KKM). Meanwhile, only 36% of students have obtained learning outcomes above the minimum completeness criteria (KKM). This shows that the low level of students' critical thinking skills has an impact on student learning outcomes.

Discussion

Based on the results of identifying problems experienced by teachers and students, it can be said that the learning process in the classroom still does not apply appropriate learning

methods so there are still many students who do not have high critical thinking skills. This is demonstrated by several results obtained from various indicators regarding students' critical thinking abilities.

To overcome this, further research is needed regarding appropriate learning models to improve students' critical thinking abilities. One learning model that can improve students' critical thinking skills is the STEAM-oriented learning model. This learning model focuses on project-based learning that allows students to collaborate, explore, and complete complex and relevant tasks in real-world contexts so that students acquire relevant skills for the future, such as critical thinking skills, creativity, innovation, and solving. problem. This learning model also prepares students to enter the future world of work which strengthens the concept of interdisciplinary thinking and strong STEAM skills (Lu et al., 2022).

Not only that, in the development of 21st century education, students are required to have logical, analytical, critical and creative thinking skills (Putu. , A. G. Saraswati, 2020). Therefore, a learning approach is needed that can produce a generation that is able to face the demands of 21st-century educational development. The learning approach proposed by researchers is a learning approach in the form of *science, technology, engineering, arts, and mathematics* (STEAM). With STEAM-oriented learning, students' technological literacy will increase, because students are familiar with various technologies and can increase their digital literacy and ability to adapt to technological developments (Atiaturrahmaniah, 2022).

The STEAM approach is a learning approach related to the development of *soft skills* which link the fields of science (science), technology, engineering, art and mathematics. So that students will be given a holistic understanding related to the field of science through 21st-century learning experiences (Ufairiah & Laksanawati, 2020).

The STEAM approach emphasizes active problem solving, where students not only receive information, but also identify, formulate, and solve problems. Additionally, through experiments and STEAM projects, students should be able to analyze results, evaluate the effectiveness of their approaches, and make improvements. This stimulates critical thinking throughout the process. Students engage in collaborative projects that demand critical thinking to identify and solve problems. They learn to detail, analyze, and consider various solutions. With the STEAM approach, students not only receive information but also identify, formulate and solve problems (Mulyani, 2019).

Learning with a STEAM approach will produce contextual learning, where students will be invited to understand phenomena that occur around them and invite students to explore their abilities so that students are able to produce work that is different and unexpected from each individual. Apart from that, the STEAM approach also aims to support the development of students' critical thinking, creativity, collaboration, cooperation and communication skills.

Therefore, in order to improve students' critical thinking skills, researchers are encouraged to conduct research on the development of STEAM-oriented science and science learning tools to improve critical thinking skills for fourth-grade students at SDN Banyudono 2 Magetan.

The findings show that student participation in the creation of the poster work is key to success in bullying prevention. The results of this study emphasize the importance of art as a bullying prevention tool. Art provides a creative way for students to deal with sensitive issues such as bullying. In this case, art is not only a medium for self-expression but also a means to form a positive outlook and a deeper awareness of social issues related to bullying (Juledi et al., 2023). Students' active participation in the process of creating the poster work has a positive impact. It not only gives students the opportunity to contribute to bullying prevention efforts, but also gives them a sense of ownership and responsibility for a safe school environment. The collaborative process of creating the posters also helped to strengthen relationships between students. This underscores the need to actively involve students in anti-bullying initiatives. Student participation gives them responsibility in creating positive change in the school. The use of student poster work in bullying prevention has a positive impact on school culture. By promoting awareness and positive action, poster work can help create a more inclusive and supportive school environment. Students are involved in building a caring and responsible community.

CONCLUSION

Fundamental Findings: Based on the results of the preliminary study research that has been carried out, it is concluded that there are various problems experienced by teachers and also by students. This problem is related to the low level of students' critical thinking abilities which has an impact on students' learning outcomes. **Implications:** Based on the research results, teachers must facilitate the teaching and learning process that is tailored to the needs of students to help them improve student learning outcomes. **Limitation:** This research was limited to obtaining data from student response questionnaires, the results of interviews with 2 teachers, and results *pretest* in matter changes in the form of objects. Furthermore, this data is used to measure student learning outcomes and the learning tools used. **Future Research:** The results of this research can be used as a reference and main alternative for future researchers regarding learning models and approaches that are able to overcome these problems related to the demands of developments in the 21st century. So, researchers are encouraged to develop research development of STEAM-oriented science and science learning tools to improve critical thinking skills for fourth-grade students at SDN Banyudono 2 Magetan. Future researchers can develop learning models related to the demands of the 21st century, that will produce better quality education. Recommendations from this study using the STEAM-oriented learning method provide space for teachers to better understand how teaching and learning process activities (PBM) develop, so that they can carry out more interesting learning designs for the sake of students' critical thinking skills and student learning outcomes but also need to improve the design learning with STAEM

characteristics in aspects of science, technology, arts and engineering as well as more detailed mathematics to improve critical thinking skills.

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