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Analysis of Need for Development of STEAM-SDGS Based Science and Science Learning Tools on Energy Material and Its Changes to Increase Creativity and Science Process Skills of Vocational School Students

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Abstract: The Industrial Revolution 4.0 requires human resources in the world of work to be of good quality and competent in their field of competence. Therefore, educators must be able to innovate in science learning. 21st-century learning must be relevant to developments in science and technology. Students' potential that can be developed in facing the 21st century includes creativity and science process skills in learning. School science learning often tends to be boring and does not develop creativity and science process skills. The development of STEAM-SDGS-based learning tools with the Project Based Learning model is needed to meet the demands of education in the 4.0 era. This research aims to analyze the need to develop STEAM-SDGS-based learning tools. This type of research is survey research using quantitative descriptive research methods. The population in this study were all class X students at SMKS Bhakti Mulia Wonogiri, with a research sample of 62 students. The research was conducted in May 2024. The data collection technique used a questionnaire with a modified Likert scale with four answer choices: strongly agree, agree, disagree, and strongly disagree. The research results showed that the statements submitted to respondents obtained a percentage of 11% -40%, which fell into the categories of strongly disagree and disagree. From these results, science and science learning tools are based on energy and its changes to increase vocational school students' creativity and science process skills.

Keywords: learning tools, STEM-SDGS, Creativity, Science Process Skills

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1. Introduction

The 21st century is called the century of knowledge or the century of industrial revolution 4.0. This revolution is marked by the emergence of cyber-physical systems, the Internet of Things (IoT), Big Data, and various services utilizing IT. Besides, Industrial Revolution 4.0 was a revolutionary change in information technology for all industries. (industriesonzález-Medina, Salas-Puente, Garcerá, & Figueres, 2019). The rapid development of technology has caused changes in various fields. One of them is the field of education. In 21st-century learning, everyone must have 4C abilities: communication, collaboration, creativity and innovation, critical thinking skills, and problem-solving (Erdoğan, 2019). Communication means interaction between educational actors; collaboration means students can work together with friends in groups, society, and the environment; creativity and innovation mean the ability to create something new and provide innovations; and critical thinking and problem-solving mean a person's ability to express, analyze and solve problems (Greenstein, 2012).

In the Industrial Revolution 4.0, human resources in the world of work are required to be of good quality and competent in their field of competence. Therefore, educators must be able to innovate in learning. (Hasibuan & Prastowo, 2019) 21st-century learning must be relevant to developments in science and technology. Learning materials must be designed so students feel challenged to carry out and create solutions to solve learning problems (Trilling & Hood, 1999). The policy for developing the 2013 Revised Curriculum to the Independent Curriculum is based on the Decree of the Minister of Education, Culture, Research and Technology of the Republic of Indonesia Number 56/M/2022 dated 10 February 2022 concerning Guidelines for Implementing the Curriculum in the Context of Learning Recovery. Through this policy, it is hoped that there will be changes in the world of education that focus on developing character and skills based on competency (Rahayu et al.,et022).

One of the essential things in implementing the independent curriculum is the combination of Natural Sciences (IPA) and Social Sciences (IPS) subjects into Natural and Social Sciences (IPAS) (Puspitasari, Patonah, & Sukamto, 2024). Science and science learning at the elementary school level aims to develop students' basic literacy in viewing natural and social phenomena in an integrated manner. This will make students accustomed to inquiry activities such as observation and exploration. Natural and Social Sciences (IPAS) are important subjects in education in Indonesia. It is hoped that IPAS can equip students with the knowledge and skills needed to understand and interact with the nature around us.

Students' potential that can be developed in facing the 21st century includes creativity and science process skills in learning (Fitriyani et al., 2020). One effort that can be made is to develop students' creativity. According to (Hidayat Widjajanti, 2018), creativity includes fluent, flexible, original, and detailed thinking. Creativity is a new idea or idea that solves learning problems differently. The aim of the science course in vocational schools is for students to master science knowledge, concepts, and principles and develop knowledge that can be applied in everyday life. Apart from that, IPAS also provides continuing education to a higher level and developing science and technology (Safaria & Sangila, 2018). Rustaman (2005) states that the basic ability to work scientifically combines intellectual and emotional intelligence. (Handriani & Subhan, 2020) Intellectual intelligence is manifested in process skills, such as the ability to analyze, synthesize and evaluate information.

Meanwhile, emotional intelligence is manifested in scientific attitudes, such as curiosity, objectivity, and honesty. In this research, intellectual intelligence includes observation, classification, and communication, while emotional intelligence includes responsibility, curiosity, cooperation, honesty, and discipline. The indicators for basic scientific work skills in this research consist of 8. In this research, three indicators are used, namely process, knowledge, and attitude.

However, school science learning often tends to be boring and does not develop creativity and science process skills. This can cause students to be less interested and unmotivated to study science (Murti, Kresnadi, & Halidjah, 2023). A science and science teacher provides lessons to students about events in nature to equip students with knowledge and develop abilities in science and technology (Latifah, 2013). In studying science, science, of course, processes and steps that contain procedures for finding a science product, facts, principles, concepts, theories, and laws. Suppose students can master science and science concepts well. In that case, they must be supported by a teacher who delivers the learning, providing the material in outline and in a way that is easy for students to understand so that when given questions, students can work on the questions well and correctly. Because IPAS tends to rely on formulas in books or given by teachers, when the questions are edited, students often experience difficulties.

Starting from the background of the problem that has been described, preliminary research needs to be carried out to develop STEAM-SDGS-based science and science learning tools on energy materials and their changes. The research aims are the integration of basic competencies in science subjects, the application of science learning, and the learning available learning tools.

2. Method

This research uses a qualitative descriptive method. This research describes the need to develop STEAM-SDGS-based science and science learning tools for energy materials and their changes. The time of this research was May 2024. The subjects in this research were classified. The data in this research was collected using interview techniques, observation, and student needs questionnaires. Interviews in this research were conducted with the Class. The data analysis technique used in this research is qualitative analysis. The data analysis stages in this research include data collection, data reduction, data presentation, and conclusion, thus forming the Miles and Huberman analysis model. Miles and Huberman's analysis steps can be reviewed in Figure 1

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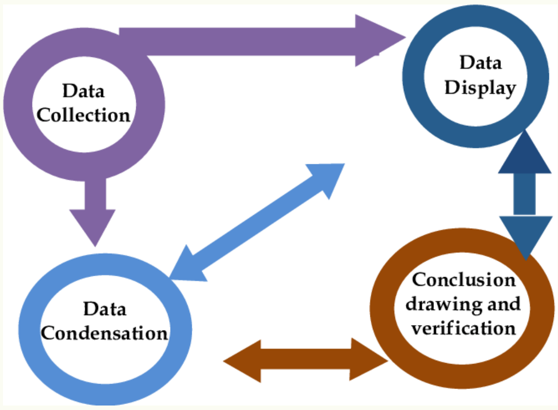

Source: (Sugiyono, 2019: 322)
Figure 1. Miles and Huberman Analysis Stages

Based on Figure 1, the following is an explanation of the data analysis components in this research: (1) Data collection: The researchers data by conducting interviews with teachers, observing the learning process in class, and distributing needs questionnaires to 64 class X students at SMKS Bhakti Mulia Wonogiri; (2) Data reduction: Researchers summarize and sort the core things, focusing on the important things according to the research objectives; (3) Presentation of data: the researcher arranges a collection of information in order to provide possible conclusions. The form of data presentation is narrative text and tables; (4) Concluding: the researcher takes action from the results of the analysis that has been carried out.

3. Result and Discussion

Needs analysis in this research was done by observing the learning process, interviewing teachers, and distributing needs questionnaires to students.

Observing the learning process shows that teachers do not apply STEAM-SDGS-based learning with the Project Learning learning model and often give assignments or homework to students. Learning in class is taught using the lecture method; the material taught is only science content. Teachers only use teaching materials from school, namely textbooks and worksheets made by MGMP. The teacher gives assignments to work on the questions on the LKS; after completing the assignments, they are discussed together. The existence of textbooks is only an addition to independent learning.

The results of interviews with class X science teachers were that the implementation of learning had referred to the independent curriculum. The learning tools used in classroom learning are textbooks and worksheets. Often used Learning methods include lectures, discussions, and questions and answers. Implementation of learning in class utilizes an LCD projector as a learning tool. Teachers have never implemented STEAM-SDGS-based learning using the Project Based Learning model, so this shows that there are no appropriate learning tools.

Table 1. Results of filling out questionnaires by respondents regarding teacher equipment

No.	Pernyataan	Persentase	Keterangan
1.	I use steam-SDGS-based science and science learning tools that represent the material very clearly	21%	Do not agree
2.	I use the STEAM-SDGS Based Science Learning Toolkit with a good sequence and structure	11,3 %	Do not agree
3.	I use the STEAM-SDGS Based Science Learning Toolkit with good language	1,6 %	Do not agree
4.	I use the STEAM-SDGS Based Science Learning Toolkit with good graphics	4, 8 %	Strongly Disagree

he results of filling out a questionnaire regarding the presentation of material on learning tools showed that 21% of teachers did not agree with the clarity of the presentation of the science and technology learning tools used by teachers. Presentation of clear and structured material is one of the key factors in learning effectiveness. According to Arsyad (2017), the clarity of the presentation of material can influence students' understanding and their involvement in the learning process. If the teacher feels that the presentation of the material is not clear, this can hurt student motivation and learning outcomes. Using less varied media that does not suit students' characteristics can confuse them in understanding the material. Research by Supriyadi (2020) shows that interactive learning media can improve students' understanding. Presenting material that is not well structured can make it difficult for students to follow the learning flow. This aligns with the findings by Rahman (2019), who stated that a logical and systematic presentation structure is very important to facilitate student understanding.

The results of filling out a questionnaire regarding the presentation of material on learning tools showed that 11.3% of teachers did not agree that the existing learning tools had a good sequence and structure. Structured and sequential presentation of material is very important in the learning process. According to Gagne (1985), a good order in presenting material can help students understand and remember information more effectively. Teachers' dissatisfaction with the structure of learning tools can indicate that certain aspects need to be improved to improve the quality of learning. Some learning tools may not provide clear enough guidance regarding the order in which material is presented, making it difficult for

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teachers to develop effective learning plans. This aligns with the findings by Hidayati (2019), who stated that learning tools must have clear guidelines to make teaching easier for teachers. A curriculum that is inconsistent in presenting material can confuse teachers and students. Research by the Ministry of Education and Culture (2020) shows that a clear, structured curriculum can increase learning effectiveness.

The results of filling out a questionnaire regarding the use of language in learning tools were 1.6% of teachers who did not agree with the use of language in existing science learning tools. Using appropriate and clear language in learning tools is crucial to support student understanding. According to Santoso (2018), the language used in learning materials must be appropriate to the level of student understanding and the learning context. Teachers' dissatisfaction with the use of language in learning tools can indicate problems that need to be addressed to increase learning effectiveness. Although most learning tools may use appropriate language, some terms or phrases may be unfamiliar to students. Research by Rahmawati (2020) shows that using terms that are too technical can confuse students. Inconsistent use of language variations in learning tools can confuse. According to Sari (2021), it is important to maintain consistency in using terms and phrases so that students can participate in learning better.

The results of filling out a questionnaire regarding graphics on learning tools showed that 4.8% of teachers strongly disagreed, and 24.2% disagreed with using graphics on existing science learning tools. Graphics are an important visual aid in learning, especially in subjects that require a visual understanding of data and information. According to Mayer (2009), effective use of graphics can improve students' understanding of complex concepts. However, teacher dissatisfaction with using graphics in learning tools can indicate problems that must be addressed. Graphics that are unclear, uninformative, or difficult to read can confuse students. Research by Tufte (2001) shows that poor graphic design can reduce the effectiveness of information communication. Using irrelevant graphics that do not fit the context of the material taught can make it difficult for students to understand the information. This is in line with findings by Rahman (2018), who stated that graphics must be adapted to learning objectives so that they can support student understanding.

The questionnaire results stated that as many as 4.8% said they strongly disagreed, and 24.2% disagreed. It can be concluded that the STEAM-SDGS-based science and science learning tools used by students have poor graphics. So, it is necessary to develop a STEAM-SDGS-based science and science learning tool with various color combinations; the images provided are not black and white and are based on the conditions in the environment around students.

Table 2. Results of filling out questionnaires respondents regarding the PjBL learning process STEAM-SDGS

No.	Pernyataan	Persentase	Keterangan
1.	I am used to determining basic questions	32,3 %	Do not agree
2.	I often design project plans	8,1%	Strongly Disagree
		48,4 %	Do not agree
3.	I cannot prepare a project creation schedule	8,1%	Strongly Disagree
		51,6 %	Do not agree
4.	I am not checking the progress of a project	9,7%	Strongly Disagree
		43,5 %	Do not agree
5.	I always test project results	6,5%	Strongly Disagree
		32,3%	Do not agree
6.	I can evaluate the experience in project activities	1,6%	Strongly Disagree
		29,0%	Do not agree

The results of the next questionnaire are related to the STEAM-SDGS process with the project-based learning model, which is shown in Table 2. The statements given serve to determine the extent of students' understanding of the STEAM-SDGS learning syntax with the project-based learning model. The results of filling out a questionnaire regarding the stages of determining basic questions show that as many as 32.3% of students stated that they did not agree, which means they could not determine basic questions. This is in line with research by Ahmadani (2019) and Nisa et al. (2023,) which states that the questions asked by students do not show critical questions related to the material being studied. Students do not dare to ask questions because they are afraid and reluctant to ask the teacher. Students still tend to be lazy in exploring their thinking abilities in the learning process, so learning becomes passive and impacts low student learning outcomes.

Meanwhile, determining basic questions, according to The George Lucas Educational Foundation in Darmayoga (2021), begins with essential questions that can assign students to carry out an activity, a topic corresponding to real-world reality, and begins with an in-depth investigation. Teachers try to make the topics raised relevant to students. Students on the scale of asking simple questions still have difficulty, especially when asked to determine basic questions. Students still have difficulty asking simple questions, especially determining basic questions, so

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the learning tools that will be developed include guidelines for making basic questions.

The results of filling out a questionnaire regarding the stages of preparing a project creation schedule showed that 8.1% stated that they strongly disagreed, and 51.6% of students stated that they did not agree, which means that most students were unable to prepare a project creation schedule. This is reinforced by several studies, including Riak and Hananto (2023), stating that students cannot monitor the progress of assignments independently; assignments given are also collected beyond the specified time limit. The learning tool developed contains a guidance text for students and a table of assistance compiling a project creation schedule.

The results of filling out a questionnaire regarding the stages of checking the progress of a project stated that as many as 9.7% said they strongly disagreed, and 43.5% said they disagreed, meaning that most students are not used to checking the progress of doing projects. Sari et al. (2023), in their research, based on observations in the form of interviews with teachers at school, the teacher said that he had given project-making assignments to students but was only limited to giving projects and had not implemented them using a learning model. The learning tools developed contain guidance texts for students and tables of assistance in checking the progress of project creation.

The results of filling out the questionnaire regarding the stages of testing project results stated that as many as 6.5% said they strongly disagreed, and 32.3% said they disagreed, which means that most students are not used to testing project results. Sar et al.(2023), in their research, based on observations in the form of interviews with teachers at school, the teacher said that he had given project assignments to students but was only limited to giving projects and had not implemented them using a learning model. Students must carry out the task of testing the project and are not given guidance. The learning tools to be developed contain guidance texts for students and tables of assistance in testing project results.

The results of filling out the questionnaire regarding the stages of evaluating experience in project activities showed that 1.6% said they strongly disagreed, and 29.0% said they disagreed, which means that some students were not used to evaluating experience in project activities. Sari et al. (2023, in their research, based on observations in the form of interviews with teachers at school, the teacher said that he had given project assignments to students but was only limited to giving projects and had not implemented them using a learning model. Students must carry out the task of testing the project and are not given guidance. The learning tools to be developed contain guidance texts for students and tables of assistance in evaluating experience in project activities.

Table 4. Results of filling out questionnaires by respondents regarding creativity

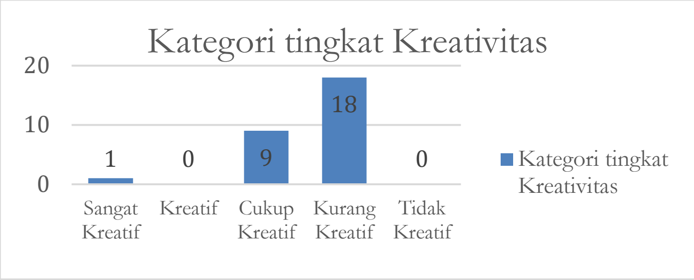
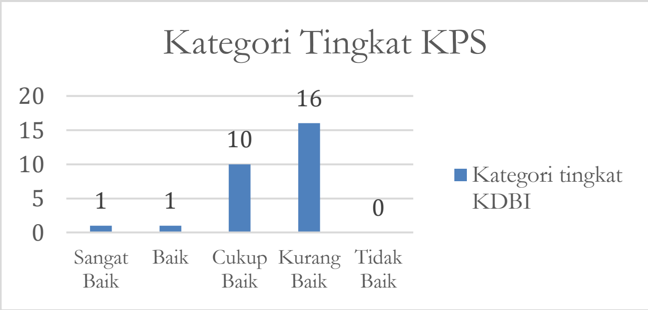


Table 5. Results of filling out questionnaires by respondents regarding KPS



The next research result is student creativity. A test is the data collection technique used to determine students' creativity. The instrument used to collect data was a student creativity test sheet given to 64 students.

Indikator fluency

Based on research data, the fluency indicator of students at SMKS Bhakti Mulia Wonogiri has an average score of 54.29%, which means the creativity category is still lacking. Even though students are expected to be able to express ideas or thoughts accurately and clearly, many students are still limited in responding to reading material and only answering what students have read. One of the main causes of low fluency is the use of learning methods that are less varied and do not encourage the exploration of ideas. Hidayati et al. (2023) emphasize the importance of developing learning media to improve students' critical thinking skills and creativity. If the method does not actively involve students, their creative potential will not develop properly. Limitations in access to resources that support creative learning can also be an inhibiting factor. Research by Cahyani et al. (2022) shows that developing project-based learning modules integrated with STEM can increase student creativity. Without adequate resources, students may not have the opportunity to experiment and develop new ideas. A learning environment that is not supportive can hinder the development of student creativity. According to research by Yuniar et al. (2023), a positive and collaborative environment is crucial to improving students' creative thinking abilities. Students who feel uncomfortable or pressured are less likely to dare to express their ideas.

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Therefore, further efforts are needed to improve student's fluency and creativity so that they can express ideas more freely and innovatively. This can be done in various ways, such as practicing speaking, reading and studying, or participating in training or courses.

Indikator fleksibilitas (flexibility)

Based on research data, the flexibility indicator in students' creativity at SMKS Bhakti Mulia Wonogiri has an average score of 53.93%, which means it is in the "Less creative" category. This indicator emphasizes students' ability to express varied and not monotonous ideas by looking at them from various points of view. However, there are still many students who are not able to produce diverse and non-monotonous ideas. Using rigid and unvaried learning methods can hinder students' ability to think flexibly. According to Geok and Yee (2020), implementing project-based learning (Project-Based Learning) can increase student creativity, including flexibility in thinking. If the methods do not allow students to explore various approaches, their flexibility will be hampered. A learning environment that is not supportive can also be an inhibiting factor. Gwasira et al.(2022) show that learning designs that allow interaction and dialogue between students can increase the flexibility dimension of creativity. Students uncomfortable with sharing ideas or collaborating probably will not develop the ability to think flexibly.

Therefore, efforts must be made to improve students' ability to think creatively, hone different points of view, and explore more innovative ideas. Several steps that can be taken to increase students' creative flexibility include practicing alternative thinking by discussing and collaborating to find alternative and diverse solutions to overcome a problem.

Indikator Keaslian (originality)

Based on the research results, the originality indicator in students' creativity at SMKS Bhakti Mulia Wonogiri has an average score of 54.64%, which is categorized as lacking creativity. However, there are still many students who have not been able to come up with unique and new ideas. This is caused by students' inability and lack of confidence to determine unique answers. In this context, the conclusion that can be drawn is the need for further efforts to increase students' creativity and produce innovative ideas. Using rigid learning methods that do not provide space for exploring ideas can hinder students' thinking ability. Saputri et al. (2023) originally thought that applying STEM-integrated project-based learning could improve students' creative thinking abilities, including originality. If the methods do not encourage students to think outside existing boundaries, their ability to generate new ideas will be hampered. A learning environment that is not supportive can also be an inhibiting factor in developing originality. According to Scherbakova et al. (2022), students who do not get enough social support from teachers or peers tend to have lower originality scores. A positive and collaborative environment is very important to encourage students to dare to put forward unique ideas.

So, it is necessary to take a more open learning approach, provide space for students to experiment, and strengthen students' self-confidence in expressing new ideas. Introducing creative thinking techniques and providing challenges that stimulate imagination can help students develop their originality abilities.

Indikator keterincian (elaborasi)

Based on the research results, the elaboration indicator in students' creativity at Bhakti Mulia Wonogiri Vocational School has an average score of 54.82%, which is still lacking in the creativity category. This indicator requires students to be able to explain the factors that influence and add details to their ideas or concepts so that they are more valuable. However, there are still many students who are not able to elaborate well. This is caused by the lack of student's ability to communicate the results of their work in detail and detail. A lack of practical experience in applying knowledge can reduce a student's ability to provide necessary details in elaboration. According to Ivana et al. (2022), students involved in activities encouraging exploration and experimentation tend to have better elaboration abilities. Without sufficient experience, students may struggle to develop their ideas in depth. A learning environment that is not supportive can also be an inhibiting factor in developing detail. Lestari and Fitriyah (2023) emphasize that a positive and collaborative environment is very important to encourage students to dare to express their ideas in detail. Students who feel uncomfortable or pressured may not dare to elaborate.n

Therefore, efforts need to be made to improve students' abilities to dig deeper, elaborate, and provide more in-depth explanations of the ideas that students produce. Learning approaches that strengthen communication skills and teach elaboration techniques can help students develop these abilities. Additionally, providing opportunities for students to discuss, collaborate, and provide feedback on students' work results can also improve elaboration abilities.

Indikator proses (process)

Based on the research results, the process indicators in science process skills at Bhakti Mulia Wonogiri Vocational School have an average score of 55.71%, which is in the "Poor Good" category. This shows that, in general, students' abilities in applying scientific work processes still need to be improved. Using less effective learning methods can be one of the main causes of low science process skills. According to Nahdi et al. (2020), learning models that do not facilitate science process skills, such as traditional lecture learning models, can hinder the development of these skills. More interactive methods like Guided Inquiry have improved students' science process skills more effectively. Science process skills depend heavily on the practical experience students gain during learning. Dewi and Muhiri (2022) emphasize that science process skills must be trained through practical activities and experiments. Students who lack opportunities to engage in practical activities will find it difficult to develop the necessary process skills. An unsupportive learning environment can also contribute to low science process skills. Lestari and Pusparani (2023) indicate

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that a positive and collaborative environment is very important to encourage students to participate actively in science activities. If students feel uncomfortable or unsupported by their teachers and peers, they may not dare to ask questions or undertake the exploration necessary to develop process skills.

So, more attention needs to be paid to developing students' scientific work skills. Integrating a more active learning approach may be necessary to enrich learning material and provide opportunities for students to discuss and ask further questions. Teaching analysis and synthesis skills can also help students develop their scientific abilities.

Indikator Pengetahuan (knowledge)

Based on the research results, the knowledge indicator in science process skills at Bhakti Mulia Wonogiri Vocational School has an average score of 59.11%, which is in the "Quite Good" category. This shows that, in general, students understand. The low indicator of knowledge in science process skills (KPS) among students can be caused by various interrelated factors. One of the main causes is the lack of effective and innovative learning methods. Research shows that inadequate learning models, such as conventional learning, often cannot encourage students to actively participate in the learning process, thus hindering their mastery of science process skills (Mayasari & Paidi, 2022; Susilawati & Sridana, 2018). In contrast, more interactive approaches, such as inquiry-based learning and POGIL (Process Oriented Guided Inquiry Learning), have improved students' science process skills (Puteri et al., 2022; Yasmin et al., 2015).

In addition, teachers' lack of understanding of scientific literacy and science process skills also contributes to low indicators of student knowledge. Research shows that teachers with insufficient knowledge regarding scientific literacy tend not to be able to direct students well in the learning process (Mayasari & Paidi, 2022; Sumanik et al., 2021). This is exacerbated by the evaluation of the learning process, which is not focused on developing scientific literacy; students do not get adequate learning experience to develop their science process skills (Mayasari & Paidi, 2022; Marisa et al., 2021).

Indikator Sikap dan nilai (attitudes and values)

Based on the research results, the attitude and value indicators in science process skills at Bhakti Mulia Wonogiri Vocational School have an average score of 54.46%, which is in the "Poor Good" category. These findings indicate that, in general, students need to improve attitudes and values related to science and scientific work methods.

Another factor that influences low science process skills is the lack of direct practice in learning. Students are often not allowed to conduct experiments or practical activities to strengthen their understanding of scientific concepts (Sari, 2019; Angelia et al., 2022). Research shows that practicum-based learning can significantly improve science process skills because students can learn through direct experience (Sari, 2019; Angelia et al., 2022). Students may have difficulty applying the knowledge they learn in real contexts without sufficient practice.

Students' motivation and interest factors are important in mastering science process skills. Students with a low interest in science tend not to try hard to understand the concepts taught, negatively impacting their science process skills (Sumanik et al., 2021; Fadhila & Kalsum, 2020). Therefore, it is important to create an interesting and relevant learning environment for students so that they are more motivated to learn and develop their science process skills.

4. Conclusion

Based on the data obtained from the analysis of teacher and student needs, it can be concluded that the availability of STEAM-SDGS-based science and science learning tools for students needs to be developed on a Project Based Learning basis and needs to be accompanied by guidelines to guide students to carry out each stage in project-based learning. STEAM-SDGS-based science and science learning tools must also be developed by considering graphic aspects, structures, and features that can encourage students to learn independently. Students STEAM-SDGS-based science and science learning tools also need to be developed with scientific literacy so that students understand scientific content, attitudes, processes, and the interaction of science with technology and society. Students' creativity and learning independence are relatively low, so they need to be empowered with the STEAM-SDGS Science and Science Learning Tool features that will be developed.

The author hopes that the data from this needs analysis will be the first step or reference in developing STEAM-SDGS-based science and science learning tools for students based on Project-Based Learning integrated with scientific literacy, where these products can be used in the learning process.

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