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The Effect of Process Picture-Based Momentum and Impulse Student Worksheets on Creative Thinking Ability and Physics Learning Outcomes of High School Students

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Abstract

Physics learning in the 21st century needs to be directed to develop the abilities needed in the future, one of which is the ability to think creatively. The use of student worksheets can help students in understanding certain concepts and create physics learning that is oriented to students. This study aims to find the effect of process image-based momentum and impulse student worksheets on creative thinking skills consisting of four indicators namely fluency, flexibility, originality, and elaboration. This study also aims to examine the effect of process image-based momentum and impulse student worksheets on physics learning outcomes consisting of Bloom taxonomy C1-C6, namely remembering, understanding, applying, analyzing, evaluating, and creating. The type of research used was a pseudo-experiment with a research design of nonequivalent control group design. This study was conducted at MAN 2 Jember with the population used was the entire class XI. The research sample was taken by cluster sampling to determine the experimental class and control class. The number of research samples in each class was 31 students. This study used instruments in the form of creative thinking ability tests and student physics learning outcomes tests. Data analysis used in this study used normality test, homogeneity test, and independent sample t-test. The results of the study obtained a Sig. (2-tailed) value of 0.000 <0.05. These results indicate that there is a significant difference between the control class and the experimental class, meaning that students in the experimental class are able to master the indicators of creative thinking skills better than the control class. The significance value of student learning outcomes shows a Sig. (2-tailed) of 0.002 <0.05. This result shows that there is a significant difference between the control class and the experimental class, meaning that students in the experimental class are able to master the indicators of Bloom's taxonomy better than the control class. The conclusion of this research is that the process image-based momentum and impulse student worksheets has a significant effect on students' creative thinking skills and physics learning outcomes.

Keywords: *momentum and impulse student worksheets, process drawings, creative thinking ability, physics learning outcomes*

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1. INTRODUCTION

Physics learning in the 21st century era needs to be directed to develop the abilities needed in the future. The ability to think critically, collaboratively, communicatively, and creatively are 21st century life ability that students must have (Lestari, 2021). In order to achieve these 21st century abilities, it is necessary to update the quality of learning, help students to participate more in learning, use appropriate learning tools, encourage cooperation and communication between students, and cultivate the ability to think creatively and innovatively in learning (Jayadi et al., 2020). In the implementation of physics learning, students are required to master various concepts that will be related to their ability to answer questions and their application to students' daily lives (Wiliyanti et al., 2023). Therefore, the

role of teachers as educators is needed in realizing the achievement of 21st century ability so that students are able to interpret the learning provided.

The implementation of physics learning in the classroom can encounter various obstacles. Students consider physics as an uninteresting lesson, filled with formulas, and difficult problems to do. This makes it difficult for them to understand physics concepts (Ady & Warliani, 2022). Students also have difficulty solving physics conceptual problems due to the lack of application of concepts to solve problems in everyday life (Prihandono et al., 2023). In addition, physics learning that is still teacher-oriented causes students to be less involved in building their own knowledge during learning. Lack of student involvement can result in low students' creative thinking ability (Cemara & Sudana, 2019). This is also in line with observations carried out in one of the schools, the teacher gave a statement that when learning physics the teacher explained more on the board to save time so that students were less involved in learning and caused weak students' creative thinking ability. Creative thinking ability is the desire to produce something new, such as the ability to find solutions to problems with new ideas or as the ability to elaborate ideas (Dwiana et al., 2022). The weakness of students' creative thinking ability can lead to low physics learning outcomes owned by students.

Student learning outcomes are one indicator to assess the extent of their understanding of a material. In physics material, a deep focus is needed in learning physics concepts to solve problems and obtain good learning outcomes (Meilina et al., 2020). According to Dakhi (2020), learning outcomes are students' academic achievements obtained through exams, task completion, participation in asking questions, and the ability to answer questions that support the learning process. These learning outcomes are obtained after students go through a learning process which includes an assessment of three main aspects, namely knowledge, attitudes, and ability which are characterized by changes in behavior. Wati (2021) added that good learning outcomes are reflected in students' ability to understand the material taught by the teacher. In order to improve student learning outcomes, efforts are needed to improve the quality of physics learning in schools.

One way that can be done is to support learning by using teaching materials. According to Kelana & Pratama (2019), teaching materials are a collection of tools and resources made to support educators and are planned systematically for learning activities. Material books, student worksheets, posters, leaflets, and other printed materials can be used as teaching aids (Nana, 2020). One of the uses of teaching materials that can support students is student worksheets (learner worksheet). The use of student worksheets can help students understand certain concepts and create student-oriented physics learning (Ahmad et al., 2020). Based on observations carried out at one school, students stated that they could better understand the material if they used media that could be seen visually. The innovation that can be done as an effort to overcome these problems is the use of student worksheets teaching materials accompanied by process image media in it.

Process images can be defined as a sequence of images representing an object, event, or phenomenon that varies in terms of location, shape, condition, and combination. When viewed as a whole, these images show phases that are interrelated with each other (Sutarto & Indrawati, 2017). student worksheets accompanied by images of the process can be used on physics material that is known to be abstract. One of them is momentum and impulse material. This is because the concepts of momentum and impulse are often found in various phenomena of everyday life, but are abstract because they take place in a very short time. Therefore, educators must be able to present visualization of material that is abstract or difficult to understand, not only delivered through verbal communication. (Sari et al., 2022). According to Handayani (2022) using image media can make the delivery of material during learning clearer and easier for students to accept because seeing images can further activate the sense of sight that will attract students' attention so that they are able to digest complex concepts. Therefore, the use of process image-based student worksheets is expected to improve students' creative thinking ability and can also improve student learning outcomes.

Research on the use of process image-based student worksheets on momentum and impulse physics material has not been widely conducted. In addition, it is important to examine students' creative thinking ability because this ability plays a role in building the competencies needed in the future. Research on students' creative thinking ability is also needed to develop 21st century ability. Therefore, in an effort to examine the effect of creative thinking ability and learning outcomes in

physics learning at the high school level, it is necessary to conduct a study entitled The Effect of process image-based momentum and impulse student worksheets on students' creative thinking ability and physics learning outcomes in high school.

Several previous studies have discussed the use ofprocess images related to creative thinking skills and student learning outcomesshows relevant results. One of them is research on the use of student worksheets based on process images significantly improves learning outcomes andstudents' critical thinking skills on light material (Khoirunnisa et al, 2021).Meanwhile, research by Mukti & Medriati (2018) discusses the development of Physics student worksheets shows an increase in students' creative thinking abilitiesSint Carolus High School, Bengkulu City and the average pretest-posttest score was 76.25with a pass rate of 78.5% indicating an increase in resultsstudent learning in the knowledge aspect.

Based on previous research, it is known that research related to student worksheets based on process images of momentum and impulse physics material has not been carried out. In addition, it is important to conduct research related to students' creative thinking skills to build the skills needed in the future. Research related to students' creative thinking skills is also important to develop the skills needed in the 21st century. Therefore, to examine the influence of creative thinking skills and learning outcomes on physics learning in high school, a study is needed entitled The Influence of Momentum and Impulse student worksheets Based on Process Images on Creative Thinking Skills and Physics Learning Outcomes of Students in High School.

2. METHODS

This study used a quasi-experimental design with a nonequivalent control group design. The location of the study was MAN 2 Jember with a population of all students of Class XI. The research sample was selected using a cluster sampling technique through a lottery to determine the experimental class and control class, with each class consisting of 31 students. This cluster sampling technique was selected according to the classes that received mathe physics lesson, which has 5 classes. Then, a lottery was held to select the control class and the experimental class because there were no significant differences in characteristics from the five classes (there were no superior classes), so that sampling could be done by lottery. The student worksheets has also gone through a validation sheet assessment carried out by media expert validators and material experts, namely two lecturers from the Physics Education Study Program, University of Jember. The validator stated that the student worksheets was suitable for use with several notes that had been given. The research was conducted after the student worksheets was revised and approved by the validator.

Momentum and impulse student worksheets based on process images can be interpreted as sheets containing material concepts and assignments related to daily events that are visualized using process images so that students can better understand the process related to an event or phenomenon in depth related to momentum and impulse. This material in the student worksheets based on process images is divided into three sub-chapters, namely momentum and impulse, the law of conservation of momentum, and collisions. Momentum and impulse student worksheets based on process images that are made according to the creative thinking indicators in the assignment section and for the practice questions section are adjusted to the learning outcome indicators.

The instruments used in this study include momentum and impulse student worksheets based on process images, creative thinking ability tests, and physics learning outcome tests. The creative thinking ability test consists of 4 essay questions and the physics learning outcome test consists of 15 multiple choice questions. The implementation of the study in the experimental class by providing momentum and impulse student worksheets treatment based on process images, while in the control class using student worksheets without process images. Before learning with the treatment is carried out, a pretest is first given to both classes, then after the treatment is given it will be continued with a posttest. The posttest is carried out if both classes have received learning on this momentum and impulse material. An example of a momentum and impulse student worksheets design based on process images is shown in the following image.

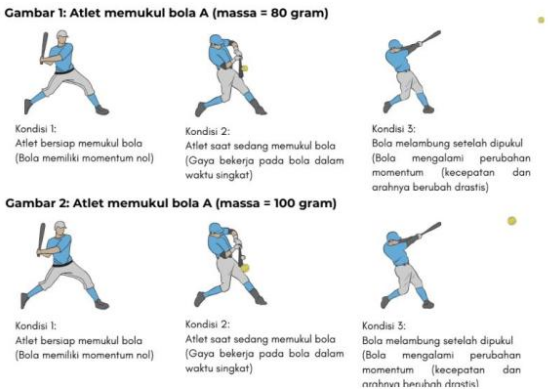


Figure 1. Design of momentum and impulse student worksheets based on process images

The data analysis used begins with a normality test to determine whether the data obtained is normally distributed or not.If the data is normally distributed, it is included in the parametric test.Next, a homogeneity test is carried out to determine whether the data obtained is homogeneous or not. If the data is homogeneous, it can be continued with an independent sample t-test to test the effect of using student worksheets based on momentum and impulse process images on students' creative thinking skills and physics learning outcomes. However, if the data is not normally distributed, it is included in the non-parametric test so that the Mann-Whitney test can be carried out.

RESULT AND DISCUSSION

A. Creative Thinking Ability Data

Research in the experimental class received learning treatment learning treatment using process image-based momentum and impulse LKPDs while in the control class, the learning used conventional LKPDs that are usually used by teachers at school. Research using process image-based LKPD This research is relevant to the curriculum applied at MAN 2 Jember school, which prioritizes that students have 21st century skills in terms of prioritizes that students have 21st century skills, in this case the ability to think creatively. creative thinking. In addition, the use of process image-based LKPD also aims to make students gain a deeper understanding of the material. In addition, the use of this process image-based LKPD also aims for students to gain a deep understanding of momentum and impulse so that it will affect the physics learning outcomes of students.

This study aims to examine the effect of process image-based momentum and impulse student worksheets on students' creative thinking ability. The measurement results showed that in the experimental class, the pretest average value was 39.81 and increased to 57.90 in the posttest. Meanwhile, in the control class, the average value of the pretest was 40.68 and only increased to 44.23 in the posttest. The increase occurred because students had received learning through student worksheets which contained assignment components and also practice questions based on process images that had been adjusted to indicators of creative thinking skills. This made students able to describe the process of an event related to momentum and impulse and could describe the process of occurrence sequentially.

The data obtained were then analyzed using the Shapiro-Wilk normality test, where the control class posttest results had a significance value (Sig.) of 0.063, while in the experimental class a significance value of 0.143 was obtained. Both values are greater than 0.05, so the data is categorized as normally distributed. Furthermore, the homogeneity test was carried out which resulted in a significance value of 0.70 (more than 0.05), so the data was considered homogeneous. After ensuring that the data were normally distributed and homogeneous, an independent sample t-test was conducted to analyze the differences between the two classes. The results of this test are presented in Table 1 below.

Table 1. *Independent Sample T-test* of Creative Thinking Ability Data

Independent Samples Test

		t-test for Equality of Means						
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Kemampuan Berpikir Kreatif	Equal variances assumed	-6.130	60	.000	-13.677	2.231	-18.141	-9.214
	Equal variances not assumed	-6.130	55.785	.000	-13.677	2.231	-18.148	-9.207

Based on the results of the independent sample t-test test in the table above, the experimental class obtained a significance value (Sig. 2-tailed) of 0.000. The significance value is smaller than 0.05, so according to the guidelines for decision making in statistics, the null hypothesis (Ho) is rejected and the alternative hypothesis (Ha) is accepted. This shows that there is a significant difference between the experimental class and the control class. Thus, it can be seen that the process image-based momentum and impulse student worksheets has an influence on students' creative thinking ability. Categories of creative thinking ability based on the data obtained can be seen in the table below.

Table 2. Criteria for Assessment of Creative Thinking Ability Data

Nilai	Criteria
0-39	Failed
40-55	Less Creative
56-65	Creative Enough
66-79	Creative
80-100	Very Creative

(Arikunto, 2008)

Based on the pretest and posttest results that have been carried out in the control class, the pretest result is 40.68 while the posttest result is 44.23. This shows that the ability to think creatively in the control class has not changed and is included in the less creative category. Meanwhile, the experimental class obtained a pretest value of 39.81 and a posttest value of 57.90. These results indicate a change in the creative thinking ability of experimental class students which was initially included in the failed category to be better until it was included in the moderately creative category. The increase in the category in the experimental class was influenced by the use of momentum and impulse student worksheets during the learning process. This is because the student worksheets is designed in accordance with the indicators of creative thinking ability. Creative thinking ability itself consists of four main indicators, namely fluency, flexibility, originality, and elaboration. Some parts of the student worksheets based on process images include a brief explanation of the material, assignments, and questions accompanied by process images related to daily life events on the material images related to the process of occurrence of an event in everyday life on the material momentum and impulse. The following are details of the data obtained for each indicator.

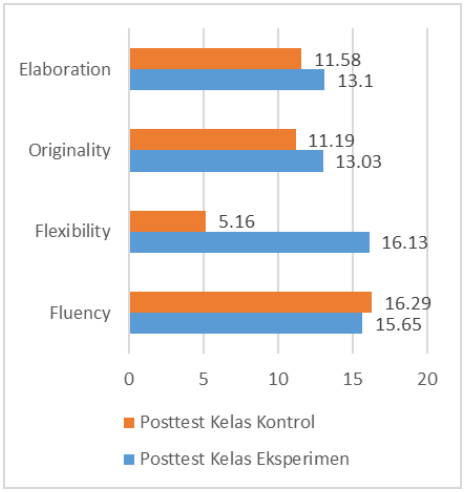


Figure 2. Average Graph of Posttest of Creative Thinking Ability for Each Indicator

Based on the graph above, the score obtained on the fluency indicator shows that the control class has a score of 16.29, while the experimental class obtained a score of 15.65. These results show that the fluency ability in expressing ideas in the control class is slightly higher than that in the experimental class, although the difference is not too large. This difference is likely due to differences in student characteristics.in the control class and experimental class. Students in the experimental class tend to be passive, so they are less interested in asking questions or looking for the correct answers during the learning process. Meanwhile, in the control class, students tended to be more active in asking questions and looking for the correct answers during learning so that the posttest results obtained were not much different from the experimental class. This is supported by research by Febrianti et al. (2016) which states that students with a good level of fluency are able to ask various questions and convey their ideas or ideas effectively. based on this research, it can be seen that the ability of control class students to ask questions and convey ideas is slightly better than the experimental class. In the flexibility indicator, the control class scored 5.16, while the experimental class reached 16.13. This difference shows that students in the experimental class experienced a significant increase in thinking flexibility. They were able to provide answers to a problem with various approaches or different points of view. Furthermore, in the originality indicator, the control class scored 11.19, while the experimental class reached 13.03. This shows that students in the experimental class have a better ability to solve problems in their own way, without just copying existing answers. Finally, in the elaboration indicator, the control class scored 11.58, while the experimental class scored 13.1. These results indicate that students in the experimental class were better able to provide a more detailed, detailed, and structured explanation in elaborating their ideas or answers compared to students in the control class. One part of the student worksheets can be seen in the following figure.

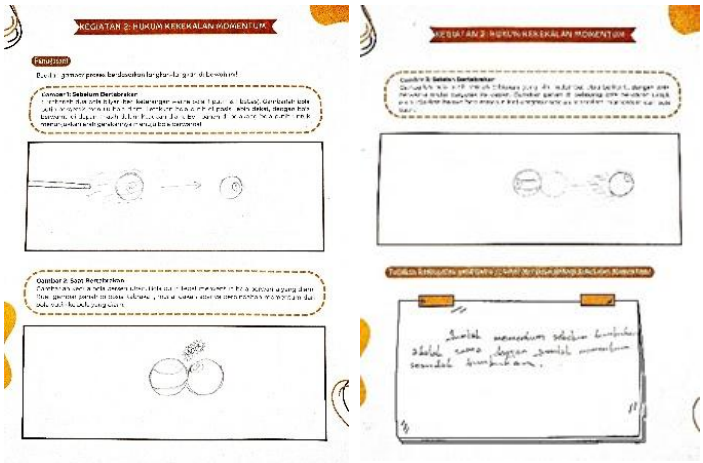


Figure 3. Results of student worksheets Work by Students

Based on the results of the student worksheets work above, students are trained to describe the process of an event that has a connection to everyday life, such as hitting a billiard ball. In this process, several indicators of creative thinking appear. The first indicator is fluency, where students are able to generate various ideas or variations in describing the process of the event, for example by describing the position of the billiard ball before and after the impact. This finding is in line with the opinion of Dewi & Machromah (2022) who said that students with good fluency ability can solve problems by providing different solutions. The second indicator is flexibility, which can be seen from students' ability to describe events from various points of view, such as the point of view of the pool table or the player's point of view. These results show that most students are able to provide diverse and varied solutions. This finding is in accordance with the research of Qomariyah & Subekti (2021) which states that flexibility is related to students' ability to produce diverse answers and ideas in solving a problem. The third indicator is originality, which is reflected in students' ability to produce unique drawings without simply copying the examples already available. This is in line with the opinion of Samura (2019) who explains that originality is the ability of students to solve problems in their own way or use approaches that are different from others. The fourth indicator is elaboration, which is shown through students' ability to add details to the drawing, such as arrows to show the direction of motion of the ball. This opinion is supported by Tanjung et al. (2022) which states that well-structured learning will improve student understanding, so that students are able to communicate, explain, and specify their ideas.

The results of this research are in line with previous research conducted by Sari et al., (2019), which stated that the ability to think creatively is closely related to the ability to think fluently. (fluency), which allows students to generate a wide variety of ideas and solutions; think flexibly (flexibility), which helps them to present answers from different points of view; and authenticity (originality), which allows them to create something unique and different from what already exists. Learning in the experimental class using momentum and impulse worksheet based on process images encourages students to be more curious about events related to the concept. Apart from that, this student worksheets also allows students to carry out activities that they may have never tried before. This is in accordance with the characteristics of creative thinking proposed by Faizah (2022), namely: (1) have high curiosity, (2) think flexibly, and (3) respond to questions asked & tend to give various answers. With these characteristics, students are encouraged to think more openly and increase their understanding of a concept, thereby contributing to developing their creative thinking abilities in solving problems.

B. Physics Learning Outcome Data

This research also aims to examine the effect of using momentum and impulse student worksheets on students' physics learning outcomes. The posttest was conducted after the control class had been taught with the commonly used student worksheets. fter the posttest, the data that has been obtained can be processed by conducting a normality test, homogeneity test, and independent sample t-test. Based on descriptive statistical analysis, it is known that in the experimental class, the average pretest score was 55.29 and increased to 63.77 in the posttest. Meanwhile, in the control class, the average pretest score was 55.13 and only increased slightly to 56.61 in the posttest. The results of data analysis show that the data is normally distributed, with a significance value (Sig.) in the control class posttest of 0.071 and in the experimental class posttest of 0.068, both of which are greater than 0.05. Apart from that, the homogeneity test produces a significance value of 0.490 which is also greater than 0.05, so the data is considered homogeneous. After ensuring that the data met the assumptions of normality and homogeneity, an independent sample t-test was carried out to determine the differences in learning outcomes between the two classes. The results of the independent sample t-test are presented in the following table.

Table 3. *Independent Sample T-test* of Physics Learning Outcomes Data

Independent Samples Test

		t-test for Equality of Means						
		T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Hasil Belajar	Equal variances assumed	-3.201	60	.002	-7.161	2.237	-11.636	-2.686
	Equal variances not assumed	-3.201	59.819	.002	-7.161	2.237	-11.637	-2.686

Based on the results of the independent sample t-test presented in the table above, in the experimental class a significance value (Sig. 2-tailed) was obtained of 0.002 for the pretest and posttest data. Because the significance value is smaller than 0.05, it is in accordance with decision making guidelines in statistics, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) accepted. This shows that there is a significant difference between the experimental class and the control class, which means that the use of momentum and impulse worksheet based on process images has an effect on students' physics learning outcomes.

Table 4. Criteria for Assessment of Physics Learning Outcomes

Interval Value	Information
$0 < x \leq 45$	Very Less
$46 < x \leq 60$	Not Enough
$61 < x \leq 75$	Enough
$76 < x \leq 85$	Good
$86 < x \leq 100$	Very Good

Based on the table above, it shows that the results *pretest* the control class is included in the less and less results category *posttest* The control class showed no change in category in students' physics learning outcomes. Meanwhile, in the experimental class there was a change in category from initially being included in the inadequate category to being in the sufficient category. These results indicate that the average physics learning outcomes in the experimental class are higher compared to the control class. This difference is most likely caused by the active participation of students in the experimental class who are more involved in learning than students in the control class. This happens because momentum and impulse worksheet based on process images is something new for students, so they are more interested and focused in following each stage of learning. This student worksheets helps students understand the concepts of momentum, impulse and collision through a series of pictures that show the process of an event sequentially. The results of this study are in line with previous research by Khoirunnisa et al. (2021) who also found that process image-based student worksheets had a positive impact on student learning outcomes. Apart from that, the posttest results obtained by students can be analyzed based on the indicators in Bloom's taxonomy. In this study, posttest questions were designed to measure several cognitive levels in Bloom's taxonomy, namely C1 (remembering), C2 (understanding), C3 (applying), C4 (analyzing), and C5 (evaluating). The following graph shows details of the number of students who were able to answer correctly on each indicator in the learning outcomes posttest.

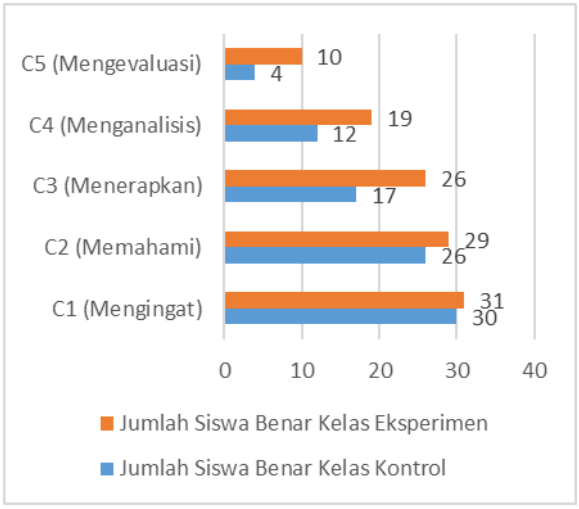


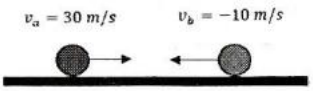
Figure 4. Graph of Details of Students Answering Correctly the Posttest Questions on Learning Outcomes for Each Indicator

Based on the picture above, you can see the comparison of students' abilities in the control class and the experimental class on each indicator. In indicator C1, there were 27 students in the control class who answered correctly, while in indicator C2 there were 20 students in the control class and 21 students in the experimental class who answered correctly. For indicator C3, 15 students in the control class and 16 students in the experimental class gave the correct answer. Meanwhile, in indicator C4, both the control class and the experimental class had 10 students who answered correctly, and in indicator C5, there were 4 students in the control class and 5 students in the experimental class who managed to answer correctly. Furthermore, in Figure 4.4, it can be seen that for indicator C1, 30 students in the control class and 31 students in the experimental class answered correctly. In indicator C2, the results obtained were 26 students in the control class and 29 students in the experimental class. For indicator C3, there were 17 students in the control class and 26 students in the experimental class who answered correctly. In indicator C4, 12 students in the control class and 19 students in the experimental class gave the correct answer, while in indicator C5, there were 4 students in the control class and 10 students in the experimental class who managed to answer correctly.

2. Momentum suatu benda bergantung pada:
   A. Hanya massa benda
   B. Hanya kecepatan benda
   C. Massa dan kecepatan benda
   D. Gaya yang bekerja pada benda
   E. Waktu yang diperlukan untuk mengubah kecepatan benda

Figure 4. Problem indicator C1 (remembering)

13. Perhatikan gambar berikut!



Bola pertama bergerak ke kanan dengan kecepatan 30 m/s menuju bola kedua yang sedang bergerak ke kiri dengan kecepatan 10 m/s sehingga terjadi tumbukan lenting sempurna. Jika masing-masing bola bermassa 1 kg, maka berapakah kecepatan bola pertama dan kedua setelah bertumbukan?

A. -10 m/s
B. 10 m/s
C. -15 m/s
D. 15 m/s
E. 20 m/s

Figure 5. Problem indicator C5 (evaluate)

Figure 5 shows that to work on this question requires an understanding of basic concepts related to momentum and from the posttest results shows that students can understand the concept of momentum as indicated by answering the correct choice. Meanwhile, Figure 5 shows that in working on these questions students need to assess or compare concepts to draw conclusions. The posttest results showed that mostStudents still have difficulty assessing or comparing concepts in working on the questions so that students draw conclusions that are not appropriate. These results show that the majority of students are able to master indicators C1 to C3, which indicates that they can understand the basic concepts of the material that has been taught. According to research conducted by Nimunuho et al. (2023), if students do not experience difficulties in understanding basic concepts, then it is also easier for them to connect and apply these concepts in the given context. However, students' low ability to solve questions with indicators C4 and C5 can be caused by a lack of experience in solving questions with a higher level of difficulty, limited cognitive abilities, and a lack of support from learning facilities and infrastructure at school. This is in line with the opinion of Suluh & Lede (2021) which states that students' low cognitive levels are generally caused by a lack of training and habituation provided by teachers. Asi et al. (2024) also added that the analysis and evaluation process requires time and deeper understanding, so that increases in ability in this aspect do not occur as quickly as increases in basic cognitive domains such as remembering and understanding.

The use of process image-based momentum and impulse student worksheets in learning provides various activities that students must complete, such as viewing examples of process images, reading material summaries, doing assignments, and answering practice questions. The variety of activities in this student worksheets, which is guided directly by the teacher, encourages students to understand the material better and complete their assignments, thus having a positive impact on learning outcomes. This is in line with research by Prastika & Masniladevi (2021), which states that student worksheets can be an effective means of improving learning outcomes and preventing student boredom during the learning process. Apart from that, research conducted by Farliani et al. (2022) also shows that the use of media in learning has a significant influence on student learning outcomes.

There are several obstacles faced during the implementation of momentum and impulse based on process images in classroom learning, namely: (1) the researcher's difficulty in conditioning the class when learning is carried out because there are several students who are absent and students who are less cooperative in the classroom so that it slightly hinders the learning process; (2) the use of student worksheets momentum and impulse based on process images in groups makes some students less attentive to the learning; (3) limited time in providing optimal learning to students so that researchers must manage their time as well as possible so that the implementation of student worksheets momentum and impulse based on process images can run as it should. Based on the discussion above, the use of student worksheets momentum and impulse based on process images has a significant influence on students' creative thinking skills and physics learning outcomes. In addition, the use of process images in learning can be an innovation to improve and improve the quality of learning, as well as develop 21st century skills, especially in creative thinking and understanding physics concepts. In the use of student worksheets momentum and impulse based on process images, it is also necessary to consider various obstacles faced during the implementation of the research. Some suggestions for improving future research, namely for physics teachers, this research is expected to improve creative thinking skills and student learning outcomes by implementing more varied learning methods. The use of student worksheets based on process images can be an alternative during learning implementation. For other researchers, the results of this study can be used as a reference to apply process images to other learning media with different physics materials by adjusting the characteristics of students in the class to improve the quality of learning in schools.

CONCLUSION

Based on the objectives, research results and discussions that have been carried out, it can be concluded that the momentum and impulse student worksheets based on process images has a significant effect on students' creative thinking ability and student physics learning outcomes in high school.

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