The relationship of students' science process and critical thinking skills in momentum and impulse materials

Astalini[*], Darmaji Dwi Agus Kurniawan, Elza Triani, dan Sri Wina Oktavia
Universitas Jambi, Indonesia
*Email: astalinizakir@unja.ac.id

Abstract: This study aimed to see the description and relationship between students' science process and critical thinking skills of 10th graders at SMAN 10 Jambi City in the Physics subject of Momentum and Impulse. This type of research uses the mix method research method. Researchers took cluster random in 2 classes, namely 10 IPA 1 and 10 IPA 3 at SMAN 10 Jambi City, with a total of 25 students in each class, so the number of samples used was 50. Data analysis began with a descriptive test and then tested the hypothesis using correlation analysis techniques and analysis of interview results. The results showed a significant relationship between the students' science process skills and the critical thinking skills of the 10th graders of SMAN 10 Jambi City in the Physics subject of Momentum and Impulse. Implications The implications of the research are to help students and teachers identify descriptions and relationships between students' science process skills and critical thinking skills of grade 10 students, especially on the topic of Momentum and Impulse.

Keywords: *critical thinking skills, momentum and impulse, physics, science process skills*

INTRODUCTION

Education is very important for the fate of every individual. Education is business conscious and planned to prepare source power humans so that students actively develop their potential and ideals (Setiawan, Innatesari, Sabtiawan, & Sudarmin, 2017; Prasetya & Rahmalia, 2018; Widyastuti, 2019). Education helps children develop optimally to increase human resources (Bentri, 2017; Sukendar, Usman, & Jabar, 2019; Hendri, Pramudya, & Pratiwi, 2020). The main goal of education is to teach students how to think, solve new problems, and create inclusive schools that support learning (Salsabila & Firdaus, 2018; Asrial, Syahrial, Kurniawan, & Amalina, 2019; Faisal, Gi, & Martin, 2019). Therefore, education is a process of forming student attitudes, intellectual development, and skills through learning.

Learning is a process carried out to achieve the success of learning objectives in education (Adijaya, 2018; Budiana *et al*., 2022). Learning objectives can be implemented if students' understanding or success of the subject is as expected (Shodiq, 2019; Giantara & Astuti, 2020; Rahayu & Wirza, 2020), producing qualified generations capable of solving the problems that nation faces (Anugrah, Murwitaningsih, Sofyan, & Susilo, 2020; Fikri, Rahmawati, & Hidayati, 2020; Primayana, 2020). Therefore, learning should be carried out properly, especially in learning physics.

As one of the natural sciences, physics has become a reference in education development. Because physics is very related to various drafts partially scientific its application increases the ability to think problem-solving in life daily (Maison, Syahrial, Syamsurizal, & Tanti, 2019; Ernawati, Muhammad, Asrial, & Muhaimin, 2019; Sudirman, Son, Rosyadi, & Fitriani, 2020). Physics is one of the subjects that some students avoid because the material is real to abstract or even only in theoretical form. Therefore, various aspects of learning physics need to be considered, one of which is in terms of the science process skills students possess.

One of the basic skills in problem-solving is science process skills. Students' cognitive process in systematically analyzing the problems encountered and planning problem-solving strategies is called critical thinking skills (Azizah, Sulianto, & Cintang, 2018; Stender, Schwichow, Zimmerman, & Härtig, 2018). Science process skills are very important for students to improve students' ability to understand analytical concepts and get observations (Labouta *et al.*, 2018; Siahaan *et al.*, 2021). Therefore, students' science process skills must be considered in learning. In addition to students' science process skills, critical thinking skill is one factor influencing physics learning.

Critical thinking skill is something a way of thinking that is carried out with certain provisions carried out by students. Critical thinking can also be said as thinking deeply in decision-making and problem-solving by collecting, organizing, remembering, and analyzing information (Stobaugh, 2013; Ariandari, 2015). Critical thinking skills tend to shape students to be able to review the opinions obtained have to solve problems and look for relevant information as a supporter of solving the problem (Adinda, 2016; Nugraha, Suyitno, & Susilaningsih, 2017). So, students can study not only to understand relevant knowledge but apply what they have learned in solving a given problem (Ilma, Hamdani, & Lailiyah, 2017; Nuryanti, Zubaidah, & Diantoro, 2018). Therefore, science process skills and critical thinking skills are two very important things in learning physics.

This research is in line with Nugraha *et al.* (2017), which states that students with high scientific process skills tend to have high critical thinking skills as well. However, this study differs from previous research by focusing on high school students. While, in fact, many previous studies were conducted at the elementary school level. As a matter of fact, the data analysis technique carried out in the present research is also different from previous studies.

This study aimed to see the description and relationship between students' science process and critical thinking skills in grade 10 students at SMAN 10 Kota Jambi with the material of Momentum and Impulse in Physics. This research is urgent to help students and teachers understand the description and relationship between students' science process skills and critical thinking skills in grade 10 students at SMAN 10 Kota Jambi. The formulation of the problem from this research is; (1) What is the description of the students' responses in science process and critical thinking skills with the material of Momentum and Impulse in Physics subject? and (2) How is the relationship between science process skills and critical thinking skills in grade 10 students at SMAN 10 Kota Jambi?

METHOD

The type of research used in the research this use study mix-method. Mix-method is a research method that combines quantitative and qualitative methods (Wijatiningsih & Prasetyawan, 2019). Mixed methods have many advantages and are more complex than

other methods. Therefore, the researcher chose to use this method. The research uses two variables: variable independent (X), namely, students' critical thinking skills, and variable dependent (Y), i.e., science process of students.

The population is the object of study or the characteristics studied (Banks, Flores, Langlois, Serio, & Sindi, 2018). The population in this study was conducted in grade 10 at SMAN 10 Kota Jambi. The sample selection in this study used a random sampling technique. Researchers use a simple random sampling technique (simple random sample), a way of taking/selecting samples randomly by giving equal opportunities to each population (Juliyanti & Pujiastuti, 2020). In this study, researchers took random samples in 2 classes, namely 10 IPA 1 and 10 IPA 3, with a total of 25 students in each class at SMAN 10 Kota Jambi with a total sample of 50 students.

Instruments used in research are in the form of Questionnaire Observation sheets to get quantitative data and interview sheets to obtain qualitative data. Observation sheets were distributed to students with statements according to the indicators and Likert scale used. Then the interview sheet is used to see the teacher's response to the variables used by the researcher at his school. Likert scale used in this research are alternative strongly agree (SS) with point 5, agree (S) with point 4, with point 3, no agree (TS) with point 2, and really does't agree with point.

The observation sheet of students' science process skills and critical thinking skills in Physics of Momentum and Impulse materials are shown in Table 1 and 2. As for the categories of science process skills and students' critical thinking skills in Physics of Momentum and Impulse materials is shown in Table 3.

Table 1
The observation of science process skills

No	Variable	Indicator	Number of test items
1		Observation	1, 2
2		Classification	3, 4
3		Communication	5, 6
4		Measuring	7
5		Prediction	8
6	Science process skills	Identification Variable	9, 10
7		Making Hypothesis	10
8		Make Chart	11
9		Describe Connection between Variable	12
10		Define variable by Operational	13
11		Design Investigation	14
12		Analyze Investigation	15
13		Do experiment	16,17
14		Gather & Organize Data	18
15		Creating Table Data	19
16		Making Conclusion	20

Table 2

The observation sheet in physics of momentum and impulse materials

No.	Variable	Indicator	Number of test items
1	Critical thinking	Formulate the problem	1,2,3,4
2		Give arguments	5.6
3		Carry out deduction	7,8,9
4		Carry out induction	10,11,12
5		Carry out evaluation	13,14,15,16
6		Make decisions and taking action	17,18,19, 20

Table 3

Categories of science process skills and students' critical thinking skills in physics of Momentum and Impulse materials

Category	Variable Indicator Interval	
	Science Process Skills	Critical Thinking Skills
Very Not Good	20.0 - 36.0	20.0 - 36.0
Not Good	36.1 - 52.0	36.1 - 52.0
Enough	52.1 - 68.0	52.1 - 68.0
Well	68.1 - 84.0	68.1 - 84.0
Very Good	84.1 - 100	84.1 - 100

To test the quantitative data, the researcher used an instrument like an observation sheet. The data from the observation sheet was carried out by a descriptive test, a prerequisite test, and a hypothesis test consisting of a correlation test. Data analysis begins by looking at the description of respondents' responses with descriptive statistics. Descriptive statistics is a type of statistics used to present data in tables, diagrams, graphs, or other quantities (Nuzula, Rohadi, & Noor, 2020). Next, before conducting the Hypothesis Testing, the prerequisite tests used in this study were normality, linearity, and homogeneity. A prerequisite test is done to see if the data is normally distributed, see the level of homogeneity and linear relationship or not using SPSS. Then after the prerequisite test, the hypothesis test can be done, namely the correlation test. The correlation test determines the relationship between variable X and variable Y.

FINDINGS AND DISCUSSION

The Descriptive Test Results of the science process skills from grade 10 students at SMAN 10 Kota Jambi in Physics of Momentum and Impulse materials were in Table 4. Based on the table, the results of the students' science process skills from grade 10 students at SMAN 10 Kota Jambi in Physics of Momentum and Impulse materials, it was found that the highest percentage was class 10 IPA 1 was 69%, with a good category. Then the highest dominant percentage was class 10 IPA 2 is 72.9% in the good category. Thus, it can be said that the description results found in class 10 IPA 2 significantly good.

The Test Results of Critical thinking skills in grade 10 students at SMAN 10 Kota Jambi in Physics of Momentum and Impulse materials are shown in the Table 5.

Table 4
Descriptive students' science process skills in grade 10 students at SMAN 10 Kota Jambi in Physics of Momentum and Impulse materials

Class	Interval	%	Category	Total	Mean	Min	Max
10 IPA 1	20.0-36.0	0	Not good	0	78.2	67.0	100
	36.1-52.0	0	Not good	0			
	52.1-68.0	6.9	Enough	2			
	68.1-84.0	69.0	Well	18			
	84.1-100.0	24.1	Very good	5			
	Total			25			
10 IPA 3	20.0-36.0	0	Not good	0	77.3	55.1	100
	36.1-52.0	0	Not good	0			
	52.1-68.0	15.3	Enough	4			
	68.1-84.0	72.9	Well	18			
	84.1-100.0	11.5	Very good	3			
	Total			25			

Table 5.
The results of critical thinking skills in grade 10 students at SMAN 10 Kota Jambi in Physics of Momentum and Impulse materials

Class	Interval	%	Category	Total	Mean	Min	Max
10 IPA 1	20.0-36.0	0	Not good	0	78.2	67.0	100
	36.1-52.0	0	Not good	0			
	52.1-68.0	6.9	Enough	2			
	68.1-84.0	68.7	Well	18			
	84.1-100.0	24.1	Very good	5			
	Total			25			
10 IPA 3	20.0-36.0	0	Not good	0	77.3	55.1	100
	36.1-52.0	0	Not good	0			
	52.1-68.0	15.3	Enough	4			
	68.1-84.0	73.1	Well	18			
	84.1-100.0	11.5	Very good	3			
	Total			25			

Based on the Table 5, the student's critical thinking skill in grade 10 at SMAN 10 Kota Jambi in Physics of Momentum and Impulse materials was found to be the highest dominant percentage in class 10 IPA 1 was 68.7% with a good category. Then the highest dominant percentage in class 10 IPA 2 is 73.1% in the Good category. So it can be said that the results of the description found in class 10 IPA 2 Dominant are better.

The results of the normality test of students' science process skills and critical thinking skills in grade 10 students at SMAN 10 Kota Jambi in Physics of Momentum and Impulse materials were shown in the Table 6.

Table 6.

The results of the normality test of students' science process skills and critical thinking skills in grade 10 students at SMAN 10 Kota Jambi in Physics of Momentum and Impulse materials

Class	Variable	Kolmogorov-Smirnov		
		Statistics	df	Sig.
10 IPA1	Students' science process skills	.085	25	.200*
	Critical thinking skills	.142	25	.200
10 IPA3	Students' science process skills	.096	25	.200
	Critical thinking skills	.093	25	.200*

Based on the Table 6, normality test students' science process skills and critical thinking skills in grade 10 students at SMAN 10 Kota Jambi in Physics of Momentum and Impulse materials obtained results based on Kolmogorov-Smirnov test, the significance value is >0.05, so it could be concluded that the data is normally distributed.

The results of the linearity test on students' science process skills and critical thinking skills in grade 10 students at SMAN 10 Kota Jambi in Physics of Momentum and Impulse materials are shown in the Table 7.

Table 7.

The results of the linearity test on students' science process skills and critical thinking skills in grade 10 students at SMAN 10 Kota Jambi in Physics of Momentum and Impulse materials

Class	Variable	Kolmogorov-Smirnova	Deviation from linearity
		Sig.	Sig.
10 IPA1	Students' science process skills	0.021	0.027
	Critical thinking skills	0.022	0.029
10 IPA3	Students' science process skills	0.035	0.042
	Critical thinking skills	0.039	0.033

Based on the Table 7, obtained results from the linearity test on students' science process skills and critical thinking skills in grade 10 students at SMAN 10 Kota Jambi in Physics of Momentum and Impulse, the significance value is < 0.05, then it could be concluded that there is a linear relationship between students' science process skills and critical thinking skills in grade 10 students at SMAN 10 Kota Jambi in Physics of Momentum and Impulse materials.

The value of the correlation test regarding the connection among students' science process skills and critical thinking skills in grade 10 students at SMAN 10 Kota Jambi in physics of Momentum and Impulse materials are <0.05. It mean that there is a relationship between students' science process skills and critical thinking skills in grade 10 students at SMAN 10 Kota Jambi in Physics of Momentum and Impulse materials.

The results of teacher interview about students' Science Process Skills in momentum and impulse materials are discribe as follow:

Q1 : How are the 10th-grade students' Science Process Skills in momentum and impulse materials?

A1 : Students' science process skills are still lacking because practicum is rarely done

A2 : The science process skills possessed by students are still not optimal due to a lack of time to do the practicum

Q2 : How is the critical thinking skills of grade 10 students in momentum and impulse materials?

A1 : Based on the results of assignments and exams, the results they got were not good overall, so it can be said that critical thinking skills are not completely good

A2 : Many students still have difficulty working on questions that make them think critically.

Q3 : How is the relationship between students' science process skills and critical thinking skills in grade 10 students in Momentum and Impulse materials

A1 : I think it is very related to the science skills they have. It will make it easier for students to understand concepts in difficult material.

A2 : Very related, because in critical thinking, students need to understand concepts, one of which is by having science process skills.

Descriptive statistics are used to draw data conclusions (Rasyad, 2003). Based on the table of descriptive statistical results of students' science process skills in grade 10 students of SMAN 10 Jambi City in Momentum and Impulse materials, it was found that the highest dominant percentage in class 10 IPA 1 was 69%, with a good category. Then the highest dominant percentage in class 10 IPA 2 is 72.9% in the Good category. So, it can be said that the description results found in class 10 IPA 2 Dominant are better. Then based on the results table, the student's critical thinking skill in grade 10 students at SMAN 10 Kota Jambi in Momentum and Impulse materials, it was found that the highest dominant percentage in class 10 IPA 1 was 68.7% with a good category. Then the highest dominant percentage in class 10 IPA 2 is 73.1% in the good category. So it can be said that the results of the description found in class 10 IPA 2 Dominant are better.

An assumption test is conducted before hypothesis testing (Azwar, 2000). In the Normality Test of science process skills and critical thinking skills of 10th-grade students of SMAN 10 Jambi City in Momentum and Impulse Materials, the results were obtained based on the Kolmogorov-Smirnov test with a significance value of > 0.05. It can be concluded that the data were normally distributed. Then in the linearity test, the results of the linearity test of science process skills and critical thinking skills of 10th-grade students of SMAN 10 Jambi City in Physics of Momentum and Impulse Materials, namely Sign Significance <0.05, can be concluded that there is a linear relationship between science process skills and skills critical thinking of 10th graders of SMAN 10 Jambi City in Physics of Momentum and Impulse Materials.

After testing the assumptions of this study to meet the requirements, the hypothesis test is carried out. Based on the results of the correlation test, the results of the correlation test, namely the value of sig. (2-tailed) <0.05, it can be concluded that there is a relationship between students' science process skills and critical thinking skills in grade 10 students at SMAN 10 Kota Jambi in Physics of Momentum and Impulse materials. Then in the results

of the interview, it was also found that according to the teacher, there was a relationship between students' science process skills and critical thinking skills because the science skills they have will make it easier for students to understand concepts in difficult material.

Based on the results of the analysis test, it was obtained that this study is in line with previous research that students who have high scientific process skills tend to have high critical thinking skills as well, this is in line with the results obtained in the study (Nugraha *et al*., 2017). However, what makes this research different from previous research is the school level used, previous research was conducted at the elementary school level, and in this study, the researchers conducted research at the high school level. In addition, the data analysis technique used in this study is also different from previous studies.

This study aims to see how the description and how the relationship between the variables of students' science process skills on the critical thinking skills of 10th graders at SMAN 10 Jambi City in Physics of Momentum and Impulse materials. The urgency of this research is to help students and teachers understand the description and the relationship between students' science process skills and critical thinking skills in grade 10 students at SMAN 10 Kota Jambi in Physics of Momentum and Impulse materials. Implications This research is expected to help students and teachers identify descriptions and relationships between students' science process skills and 10th-grade students' critical thinking skills, especially in Momentum and Impulse materials. This research certainly has shortcomings; therefore, the researcher suggests further research using different variables, subjects, school levels, or data analysis techniques.

CONCLUSION

Based on the results of research testing, the type of research used in this study used Mix Method research. Researchers took random samples in 2 classes, namely 10 IPA 1 and 10 IPA 3, with a total of 25 students in each class at SMAN 10 Jambi City with a total sample of 50 students. Data analysis began with a descriptive test and then tested the hypothesis using correlation analysis techniques and analysis of interview results. The results showed a significant relationship between students' science process skills and 10th-grade students' critical thinking skills at SMAN 10 Jambi City in Physics of Momentum and Impulse materials. Implications This research is expected to help students and teachers identify descriptions and relationships between students' science process skills and 10th-grade students' critical thinking skills, especially in Momentum and Impulse materials.

ACKNOWLEDGEMENTS

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