

Correlation between Science Process Skills and the Comprehension of Physics Concept with Critical Thinking Skills on Newton's Laws

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Keywords: Science Process Skills, Comprehension of Physics Concept, Critical Thinking Skills, Product Moment Correlation, Partial Correlation, Multiple Correlation.

Abstract: The goal of this study was to determine: 1) whether there is a correlation between science process skills with critical thinking skills, 2) whether there is a correlation between the comprehension of physics concept with critical thinking skills, 3) whether there is a correlation between science process skills and the comprehension of physics concept together with the critical thinking skills on Newton's Law. This research is a correlation study between three variables using correlation product moment and multiple correlations. The population was all students of Mathematics Education Study Programme of STKIP Singkawang taking Fundamental Physics 1 in Academic Years 2017/2018. Due to consists of only one class, then the sampling technique used was saturation sampling. The instruments in this study were multiple-choice test with reasoned respectively of 10 questions to measure science process skills, the comprehension of physics concept, and critical thinking skills. All datas were analyzed using descriptive statistical analysis techniques. Research hypothesis testing conducted at significance level $\alpha = 0.05$, show that 1) There is a correlation between science process skills with critical thinking skills, demonstrated by correlation coefficient $r_{XY} = 0.812$ and partial correlation coefficient 0.704. This suggests there is a positive correlation between science process skills with critical thinking skills by 70.4%. 2) There is a correlation between the comprehension of physics concept with critical thinking skills, demonstrated by correlation coefficient $r_{ZY} = 0.628$ and partial correlation coefficient 0.321. This suggests there is a positive correlation between the comprehension of physics concept with critical thinking skills by 32.1%. 3) There is a correlation between science process skills and the comprehension of physics concept with science process skills, demonstrated by the multiple correlation coefficients $R^2 = 0.833$. This suggests there is a positive correlation between science process skills and the comprehension of concept physics with critical thinking skills by 83.3%.

1 INTRODUCTION

There are three essential aspects of the objectives of physics learning, namely (1) the ability to process; (2) building knowledge in the form of an understanding of concepts, laws, and theories and their application; (3) scientific attitudes, among others, the tendency of science, critical thinking, analytical thinking, attention to the problem of science, awards on things that are science (Sumaji 1998). It is clear that there are some abilities that must be acquired and developed within the students to achieve the goals of physics learning. These skills include science process skills, conceptual understanding, and critical thinking skills.

Scientific process skills can be defined as a complex intellectual, manual and social, intellectually and intellectually complex physical skills tool used by scientists to conduct scientific investigations (Karamustafaoğlu 2011) (Aji et al. 2014) (Khaeruddin & Wasis 2016). These skills facilitate physical science learning, generate active participation, develop a sense of self-responsibility, enhance learning sustainability, acquire methods and research methods that think and behave like a scientist (Raj & Devi 2015). In addition, the skills of the science process are seen as the basis for the increasingly complex of other thinking skills. Through a series of scientific processes that students must pass through observation activities, problem

formulation and hypothesis, hypothesis testing through experiments, variable control, interpretation of data, conclusion and application of concepts (Choirunnisa et al. 2018) (Rosdianto et al. 2017) (Sulistri & Lisdawati 2017). It is clear that the skills of the science process is very important applied to students in achieving the goals of physics learning as previously described. This is reinforced by Siradjuddin, et al, the skills of the science process is very important to develop the science of education and the quality of student learning both the theory and skills in experimenting, especially in studying physics (Siradjuddin et al. 2018).

Not only for the basis of scientific investigation and the enhancer of complex scientific thinking skills, the application of science process skills to students can also tackle the attitude needed to understand a concept (Anderson 2002) (Jack 2013). The linkage of conceptual understanding with the skills of the process of science is shown in the construction of the student's concept (Sulistri et al. 2016). The more science process skilled, the better the structure of the conceptual understanding acquired, and the decreasing the science process skill possessed, the narrower the structure of conceptual understanding acquired (Siswono 2015). Conceptual understanding is the foundation and important stage in the series in physics learning (Rosdianto 2017). By understanding the concept, students have a foundation to understand the material provided and useful in solving the given problems, such as making assumptions, choosing a procedure that facilitates the solution of the problem. In addition, the understanding of the concept of science can also be a provision for learners to learn about themselves and the natural surroundings, as well as a foundation in solving problems in everyday life (Putra et al. 2015), then this issue provides an opportunity to explore or investigate of course with questions so that theorems, propositions, notions and new concepts can be raised from the issues proposed (Citroesmi & Suratman 2016).

In addition to the science process skills and the ability to understand the concept, the third most important thing according to the aspect of the goal of physics learning is critical thinking skills. Critical thinking is a systematic thinking process that makes it possible to formulate and decide and emphasizes the beliefs themselves both logically and rationally that provide a set of standard procedures to analyze, test and evaluate each decision appropriately (Khaeruddin & Wasis 2016) (Wahyuni et al. 2018) (Nadiya et al. 2016) (Irhamna et al. 2017). Alatas and Sari et al., states that through the skills of critical thinking, students' cognitive intelligence can be trained and

developed, and with the knowledge they possess can connect facts or information to make a predicted outcome. Students who are critical in physics learning can learn how to look at their self-consciousness symptoms, and approach the situation objectively and logically (Alatas 2014) (Sari et al. 2016). For this reason, as reported by Magno and Robert, critical thinking skill strongly supports learners' success in learning, so improving and developing this ability is one of the goals in learning to be achieved (Magno 2010) (Marzano 1988). So by having critical thinking skills in the learning of physics, students will try to find the problem and try to solve it both in learning on campus or in everyday life.

Based on the three capabilities students must possess, this study looks for correlation of science process skills and conceptual understanding of students' critical thinking skills on Newton's legal material. Newton's law is an important part of mechanics and dynamics that describes a force acting on an object (Sari et al. 2016). Newton's law is a meteor that discusses the relationship between internal and external forces acting on an object and its motion (Halliday & Resnick 2008) (Serway & Jewet 2010). In general before the student level, in Newton's legal material, students have difficulty in identifying types of styles, having errors in answering questions about style and motion, many having misconceptions, and students still have difficulty in representing concepts or sentences in the form of a mathematical language, charts, diagrams and so forth (Türker 2005) (Kohl & Finkelstein 2008) (Brookes & Etkina 2009) (Anderson 2002) (Pablico 2010) (Nguyen & Rebello 2011) (Docket & Mestre 2014) (Fadaei & Mora 2015) (Ergin 2016). The difficulties and misconceptions experienced in Newton's legal material are indicated by the conceptual understanding of low style and motion discussions and low critical thinking skills (Chia 1996) (Eraikhuemen & Ogumogu 2014). Obviously this is closely related to the skills of science process skills, because conceptual understanding will be better and meaningful if students find their own concepts learned through the process of science (Putra et al. 2015).

Characteristics of Newton's legal material demanded the balance of processes and products, thus raising questions to the researcher whether the skills of science processes and understanding of student concepts have a positive correlation with their critical thinking skills. The purpose of this research is to know: 1) correlation between science process skills with critical thinking skills; 2) the correlation between conceptual understanding with critical

thinking skills; and 3) the correlation between science process skills and understanding of physics concepts with students' critical thinking skills on Newton's Law material.

2 RESEARCH METHODS

This study includes the type of correlation research between the three variables using methods product moment correlation and multiple correlation. The population of this research is Mathematics Education Students at STKIP Singkawang who take Basic Physics I course in Academic Year 2017/2018. The technique sampling used is sampling saturated. Technique sampling is due to only consist of one sample class only. The instrument in this study is a multiple choice test grounded in which each item consists of 10 items to measure the skills of the science process, the understanding of physics concepts, and the critical thinking skills of the students. Data analysis using descriptive analysis technique. Data processing correlation between variables using correlation equation product-moment and multiple correlation.

3 RESULTS AND DISCUSSION

3.1 Results

3.1.1 Correlation between Science Process Skills with Critical Thinking Skills

The first hypothesis in this study is about the correlation between science process skills with students' critical thinking skills on Newton's Law material tested by using product moment correlation and partial correlation. The results of the correlation test between the skills of the science process with students' critical thinking skills on Newton's Law materials are presented in the following Table 1.

Table 1: Correlation Analysis Between Science Process Skills And Critical Thinking Skills

r_{X1Y}	r_p	Description
0.812	0.704	Positive

Based on Table 1 shows that the correlation coefficient $r_{X1Y} = 0.812$ and partial correlation coefficient of 0.704. This shows that there is a positive correlation between science process skill and student's critical thinking skill which is 70.4%. Furthermore, to see linearity between science process

skills with students' critical thinking skills on Newton's Law material conducted a simple linear regression analysis test. The result of simple linear regression test of linearity between science process skill and student's critical thinking skill is presented in Table 2 below.

Table 2: Linearity Test Between Science Process Skills And Critical Thinking Skills

a	b	t_{obs}	$t_{c.v.}$	Decision
18.635	0.981	54.614	3.35	Ho rejected

Based on Table 2, it is known for data with a significant level of 0.05 value $t_{c.v.}$ that is equal to 3.35, hence can be concluded that Ho is rejected, so the equation is linear or Science process skill (X_1) has relationship with Critical Thinking Skill (Y).

3.1.2 Correlation between Understandings of Physics Concept with Critical Thinking Skills

The second hypothesis in this research is about the correlation between the understanding of physics concepts with students' critical thinking skills on Newton's Law material tested by using product moment correlation and partial correlation. The results of the correlation test between the understandings of physics concepts with students' critical thinking skills on Newton's Law materials are presented in the following Table 3.

Table 3: Analysis Correlation Between Understandings Of Physical Concepts With Critical Thinking Skills

r_{X2Y}	r_p	Description
0.628	0.321	Positive

Based on Table 3 shows that the correlation coefficient $r_{X2Y} = 0.628$ and partial correlation coefficient of 0.321. This shows that there is a positive correlation between the understanding of physics concept and students' critical thinking skill which is 3.21%. Furthermore, to see linearity between the understandings of physics concepts with students' critical thinking skills on Newton's Law material conducted a simple linear regression analysis test. The result of simple linear regression test between the understanding of physics concept and students' critical thinking skill is presented in Table 4 below.

Table 4: Linearity Test Between Understanding Of Physics Concept And Critical Thinking Skills

a	b	t_{obs}	$t_{c.v.}$	Decision
19.534	0.750	18.218	3.35	Ho rejected

Based on Table 4, it is known for data with a significant 0.05 value of t_{obs} that is equal to 19.534 bigger than value $t_{c.v.}$ that is equal to 3.35, hence can be concluded that H_0 is rejected, so the equation is linear or understanding of physics concept (X_2) has relationship with critical thinking skill (Y).

3.1.3 Correlation between Science Process Skills and Understanding of Physics Concepts with Critical Thinking Skills

The third hypothesis in this research is about the correlation between science process skills and understanding of physics concepts with students' critical thinking skills on Newton's Law material tested using multiple correlation. The results of the correlation test between the understandings of physics concepts with students' critical thinking skills on Newton's Law materials are presented to the following Table 5.

Table 5: Correlation Analysis Between Science Process Skills And Understanding Of Physics Concepts With Critical Thinking Skills

$r_{X_1X_2Y}$	R^2	Description
0.833	0.694	Positive

Based on Table 5 shows that the double correlation coefficient of 0.833. This indicates a positive correlation between the science process skills and the understanding of physics concepts with critical thinking skills of 8.33% students. Furthermore, to see linearity between the science process skills and understanding of physics concepts with students' critical thinking skills on Newton's Law material conducted a simple linear regression analysis test. The result of simple linear regression test of linearity between science process skill and understanding of physics concept with students' critical thinking skill is presented in Table 6 below.

Table 6: Linearity Test Between Science Process Skills And Understanding Of Physics Concepts With Critical Thinking Skills

a	b	c	t_{obs}	$t_{c.v.}$	Decision
8.685	0.817	0.276	30.668	3.35	Ho rejected

Based on Table 6, data with a significant level of 0.05 value of t_{obs} that is equal to 30.668 bigger than value

of $t_{c.v.}$ that is equal to 3.35, hence can be concluded that H_0 is rejected, so the equation is linear or science process skill (X_1), understanding of physics concept (X_2) together have linear relation to Critical thinking skills (Y).

3.2 Discussion

The results of the first hypothesis and data analysis show that there is a positive correlation between science process skills and students' critical thinking skills. The emergence of a positive correlation because when students have the science process skills in learning, the physical and mental abilities that are intellectual, manual and social also develop. So that critical thinking skills can also increase. This is in line with the results of Spiritual research which shows that there is a strong correlation between the science process skills and students' critical thinking. Means the higher the science process skills, the higher the critical thinking.

Results of research and analysis of the second data indicate that there is a positive correlation between the ability of conceptual understanding with students' critical thinking skills. In accordance with the results of research Sari, et al., the ability to think critically and understanding the concept of Newton's legal material has a very strong positive correlation with correlation coefficient value 0.845 and has a value of 71% determination, so that critical thinking skills has a relationship with understanding the concept on Newton's legal material, whereas students' critical thinking skills on Newton's legal material have increased, the students' understanding of Newton's legal material will also increase (Sari et al. 2016). Positive correlation can occur because when students have a good conceptual understanding, then the knowledge it has will lead to always find out what things are being studied. Things are formulated in a problem to solve the problem, then the students will perform thinking activities. Some studies show that when students have high critical thinking skills, students will easily understand concepts and seek alternative solutions to solve problems and make appropriate and reasonable conclusions (Marzano 1988).

The result of third hypothesis and data analysis shows that there is a positive correlation between science process skill and conceptual understanding to students' critical thinking skill. The existence of this positive correlation because when students have the science processes skill in learning simultaneously the ability to conceptual understanding also developed. So that students' critical thinking skills can also

increase. Science process skills are the physical and mental skills associated with the fundamental abilities possessed, controlled and applied in a scientific activity, so that scientists succeed in finding something new (Nasution 2007). With the science process skills, students become trained to know from the basic things so that they can acquire and develop their knowledge. Simultaneously the ability of conceptual understanding comes along. Conceptual understanding is the individual's ability to understand a particular concept (Nasution 2000). That way, students who have a conceptual understanding, knowledge is also growing and growing. Students become more understanding about a concept, can interpret it, and even apply it. In line with this, according to Putra et al., a student has had a conceptual understanding when students have had meaning or meaning of a concept (Putra et al. 2015). Based on that opinion, students who have a good understanding of the concept will become more critical in facing problems. So that students' critical thinking skills can also improve for the better. It can be concluded that students who have the science process skill and good conceptual understanding in learning will have good critical thinking skills. In other words, the higher the science process skill and the students' conceptual understanding the higher the students' critical thinking skills. So the science process skill and student conceptual understanding are two variables which together give positive correlation to student's critical thinking skill variable.

4 CONCLUSION

Conclusions derived from the correlation between science process skills and conceptual understanding with critical thinking skills students are as follows: (1) there is a positive correlation between the skills of science process with students' critical thinking skill in Newton's Law material is 70.4%, H_0 is rejected. (2) There is a positive correlation between the understandings of physics concepts with students' critical thinking skills on Newton's Law material is 3.21%, H_0 is rejected. (3) There is a positive correlation between the science process skills and the understanding of physics concepts with students' critical thinking skills on Newton's Law material of 8.33%, H_0 is rejected.

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