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Application of Self Directed Learning Model to Improve Student's Independence and Critical Thinking Skills

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Abstract: The lack of active involvement of students in learning is caused by the lack of students' skills in critical thinking, for example, by asking questions, expressing opinions, and solving problems so that students only memorize existing concepts, theories, and formulas without wanting to dig further to be understood in depth. This study aims to determine the increase in independence and critical thinking skills on momentum and impulse material at SMAN 9 Banda Aceh. The method in this study was quasi-experimental, then the instruments used were questionnaire sheets, observation sheets, and questions. The results of the study indicate that the application of the Self Direct Learning learning model can increase student learning independence. The results of the t-test analysis (independent sample t-test) obtained a significance value of 0.000 <0.05, meaning that there is a significant difference in the average learning independence of students in the experimental class and the control class. The application of the self-directed learning model can improve students' critical thinking skills. The results of the analysis of students' Critical Thinking Skills obtained a significance value of 0.000 <0.05, meaning that there was a significant average difference between students' critical thinking skills in the experimental class and the control class. The conclusion in this study proves that the Self Direct Learning model can increase students' learning independence and Critical Thinking Skills on momentum and impulse materials.

Keywords: Model of Self-Directed Learning; Independence; Critical Thinking Skills of students

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Introduction

The 21st century is referred to as the age of knowledge, the age of knowledge-based economy, the century of information technology, the century of openness or globalization, the industrial revolution 4.0, and so on. In this century, human life undergoes fundamental changes that are different from the order of life in the previous century. Humans living in the 21st century must master science, have metacognitive skills, think critically and creatively, and communicate or collaborate effectively. This situation illustrates the gap between expectations and reality. The preparation of human resources who master 21st-century skills will be effective if taken through education.

21st-century learning is able to keep pace with current curriculum developments, thus requiring students to be able to improve skills in learning to be more active, think critically, and be independent in learning. One of the lessons that must be improved in the process of thinking skills and independent learning of students is in the form of learning physics. Physics is a science that seeks to get answers to the questions of

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what, why, and how natural phenomena can occur (Anaperta, 2015). In essence, physics learning is directed to a goal. Students can develop their intellectual abilities, think critically, logically, and scientifically, understand concepts, and solve problems, especially those related to everyday life (Nurmayani et al., 2018).

Critical thinking skills are students' cognitive processes in systematically analyzing the problems encountered, distinguishing these problems carefully and thoroughly, and identifying and reviewing information to plan problem-solving strategies (Azizah et al., 2018). Critical thinking skills in the learning process are essential, so educators must create learning activities that are able to encourage students to be active and creative.

The best efforts to develop critical thinking skills can be made by linking learning materials and real experiences of students in their daily environment so that in learning the 2013 curriculum. It is necessary to design learning strategies that allow the development of students' critical thinking skills (Susilawati et al., 2020). Critical thinking skills can be trained for all students through learning and assessment (Ridho et al., 2020 & Afriana et al., 2021). To be able to carry out meaningful learning, teachers must be able to train so that students can think critically in analyzing and solving existing problems to make a decision (Khasani et al., 2019).

Students' critical thinking skills provide encouragement in students to think for themselves, question hypotheses, analyze and synthesize events to go further by developing new hypotheses and testing them against facts (Karakoc, 2016). Critical thinking is in the form of thinking that involves reasoning and logic to solve problems (Fuad et al., 2017). Critical thinking is how a person processes information by analyzing, observing, and evaluating before determining whether they reject or accept information (Arisa et al., 2021). In addition, to improve critical thinking skills, students are also required to have independence in learning.

Learning independence is an important element because student success and achievement will be easier to obtain (Aziz, 2017). Independence always helps the learning process by activating knowledge, strengthening and securing what has been learned, as well as providing motivation in connection with a willingness to learn (Sari, 2019). The importance of student learning independence also affects students' critical thinking skills, so a learning model is needed to improve students' critical thinking skills and independent learning. The purpose of applying the learning model is so that it is easy for teachers to improve the active learning process.

Students' lack of active involvement in learning is caused by the lack of critical thinking skills, such as asking questions, expressing opinions, and solving problems so that students only memorize existing concepts, theories, and formulas without wanting to dig further to be understood in depth. Based on the preliminary study and observation results at SMAN 9 Banda Aceh, the learning activities carried out so far still apply teacher-centered learning, where learning is teacher-centered. The learning process that has been carried out so far has not been able to improve students' critical thinking skills and learning independence so that it affects the low achievement or learning outcomes obtained. In contrast, the 2013 curriculum is a learning activity that encourages students to be more active, critical and analytical, so that learning is more dominantly student-centered. Therefore, a learning method is needed that can bring the 2013 curriculum more effectively to students.

Physics is not a difficult subject to understand, but many students fear that such an assumption will negatively impact their learning and learning outcomes. Physics is used as a subject that students must master because physics is a subject in the National Examination (UN), so to be able to master it requires thinking skills. In general, critical thinking skills consist of six levels, namely interpreting, analyzing, concluding, evaluating, explaining, and self-regulation. Sumiyati et al. (2019) say that the principles of science (physics) have the ability to build critical thinking skills and other scientific abilities that can improve the quality of human resources.

In the last three years, data from the UN results prove that physics lessons at SMAN 9 Banda Aceh are below the average. The average result of the physics exam in the 2016/2017 school year is 24.72 (Puspendik, 2017). The results in the 2017/2018 school year were 32.77 (Puspendik, 2018). The results of the physics UN in the 2018/2019 school year were 35.87 (Puspendik, 2019). This achievement is quite low and shows a level of understanding of physics that is far from expectations. This proves that it is necessary to apply learning that is able to improve students' critical thinking skills so that the learning outcomes obtained can be above average. Therefore, teachers must be able to choose an active learning model and instill student-centered learning independence.

Based on the results of interviews with teachers in the field of physics studies at the school, students' average physics learning score is below the Minimum Completeness Criteria score, which is $\leq$ 75. The results obtained encourage teachers to be extra in improving physics learning better and meet the Completeness Criteria. Minimum specified. A learning model is

needed to support a more effective learning process to enhance students' critical thinking skills and independent learning.

One of the learning models that can improve students' critical thinking and independent learning is a self-directed learning model. This is in accordance with what was stated by Albaar et al. (2015) that learning models that can develop independent learning and critical thinking skills include the self-directed learning model. This is because there are three stages of self-directed learning, namely planning (the initial activity of the learning process), monitoring, and evaluating. Sukmono (2015) says that self-directed learning is a student-centered constructivist learning model.

Handayani (2017) says that self-directed learning is a process in which students identify what needs to be learned and control finding and organizing answers. Zamnah & Ruswana (2018) also say that the self-directed learning model is an independent learning system.

Method

This research method uses a quasi-experimental method with a pretest-posttest control group design. This method contains steps consisting of pretest, treatment, and posttest. The class consists of two classes, namely the experimental class and the control class. In more detail, the research design can be seen in Table 1.

Table 1. Quasi-experimental Research Design

Subject	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2
Control	O_3	-	O_4

(Sugiyono, 2018:110)

Information:
O1 = pretest in the experimental class
O2 = Posttest in the experimental class
O3 = pretest in the control class
O4 = Posttest in the control class
X = Implementation of Self-Directed Learning

The population in this study was class X SMAN 9 Banda Aceh in the even semester of the 2020/2021 academic year. Class X consists of three classes, with a total of 79 students. The sample selection in this study used the purposive sampling technique. The selection of this technique is determined based on the final test scores of each class in the first semester, then compared to select classes with learning outcomes with the same average value. So, the research samples taken were class X IPA1 as the experimental class and class X IPA2 as the control class. The number of students in class X IPA1 is 27, and the number of students in class X IPA2 is 26 people.

The instruments used in this study were questionnaires, observation sheets, and questions. The data collection procedure was carried out by distributing student learning independence questionnaires and pretest Critical Thinking Skills questions before applying the learning treatment to the experimental and control classes. During the learning activities, several observers observe the independence of student learning through observation sheets. After teaching and learning activities in both classes took place, then the final stage was distributing learning independence questionnaires and posttest questions. The data analysis technique in this study used the N-gain equation and hypothesis testing (independent sample t-test).

Result and Discussion

Learning independence is one factor that determines student success in learning so that this independent attitude is important for anyone who wants to achieve success in life. Independence in this study consists of six indicators proposed by Suid et al. (2017), including; self-confidence, being able to work alone, value time, be responsible, have a competitive desire to move forward, and being able to make decisions. Student learning independence was measured through the results of questionnaire analysis and student observation sheets which five observers observed. Increasing students' learning independence in each indicator of the experimental class and control class can be seen in Tables 2 and 3.

Table 2. Results of Experimental Class Students' Learning Independence Analysis

No	Indicator	Pretest	Category	Posttest	Category
1	Believe	55.80	Negative	86.40	Very Positive
2	Able to work alone	57.00	Negative	85.70	Very Positive
3	Appreciate time	56.30	Negative	88.10	Very Positive
4	Responsible	59.60	Negative	86.70	Very Positive
5	Have passion	59.80	Negative	86.20	Very Positive
6	Able to make decisions	58.80	Negative	89.40	Very Positive

The results of the analysis in table 2 show that there is a very positive increase in student learning independence after applying the self-directed learning model. After applying the self-directed learning model, the results obtained for each indicator are on average between $80 \leq X \leq 100$ very positive categories. This proves that the self-directed learning model can increase student learning independence in each indicator.

Increasing students' learning independence on the indicator of trust because, on average, students have an optimistic feeling when doing the learning, then always believe in the results of the answers submitted based on the questions asked by the teacher. Increased student confidence is also caused by students' confidence to learn, so they don't give up if the answers are wrong but always find out until they get the right answer. Students have strong confidence in the results of the presentations submitted through practical activities.

Increased student learning independence on the indicator of being able to work alone because students can do the tasks given by the teacher independently during the learning process without looking at other friends. Students always do the assignments given by the teacher according to their abilities. During practicum activities, students are more active in learning, so that students' understanding of concepts is increased compared to conventional learning. This is because the involvement of students in the learning process through practical activities makes students more independent.

Increasing students' learning independence on the indicators of respecting time can be seen from the involvement of students in the learning process, where students do not use learning time to play. Students feel that the learning delivered by the teacher is able to attract their attention to learning, so that when in the learning process, students use their time as well as possible. Increased student learning independence on the indicators of responsibility can be known through perseverance in completing the tasks given by the teacher on time. Students always work on group assignments with their friends in one group so that they work together with each other.

Increasing students' learning independence on the indicator of having a desire can be known through students' interest in learning because learning activities are carried out in an interesting way. Every student has a desire to stand out and get better learning outcomes. Increasing student learning independence on the indicator of making decisions because students can solve problems in learning independently without involving the teacher or other friends.

Furthermore, to find out the increase in student learning independence in the control class before and after applying the conventional learning model, more details can be seen in table 3.

Table 3. Results of the Analysis of Control Class Students' Learning Independence

No	Indicator	Pretest	Category	Posttest	Category
1	Believe	55.80	Negative	61.00	Positive
2	Able to work alone	57.10	Negative	63.30	Positive
3	Appreciate time	56.20	Negative	64.20	Positive
4	Responsible	58.80	Negative	72.70	Positive
5	Have passion	58.20	Negative	70.80	Positive
6	Able to make decisions	59.20	Negatif	70.30	Positive

Based on the results of the analysis of student learning independence in table 3, there is a positive increase after applying the learning treatment using the conventional model. The results obtained that the average student on each indicator has a score between 60 X 80. This proves that the DI model is able to increase student learning independence. However, the increase in student learning independence in the experimental class was higher than in the control class.

Based on the results of the analysis of student learning independence, it can be concluded that the learning independence of students in the experimental class is more increased than the control class. This is because the application of the self-directed learning model is able to involve students in the learning process so that students have the confidence to learn. Student involvement can also increase students' active participation in practical activities to solve problems in learning independently.

This is in line with what was stated by Handayani (2017) that the average learning independence of students who follow the self-directed learning model is higher than the learning independence of students who take conventional learning. The analysis results prove that the self-directed learning model can increase student learning independence because it guides students to be more active in learning. The advantage of this self-directed learning model compared to conventional models is because this model is able to instill an attitude of trust

in students to be directly involved in the teaching and learning process.

This model provides sufficient space for students to construct knowledge, develop their abilities, collaborate with their groups to discuss, freely give opinions, respect and acknowledge the strengths of their friends, build an atmosphere that cares for each other and supports the learning process, and fosters a sense of belonging.

Independent learning of students in the experimental and control classes can also be seen based on direct observations during the learning process or during experimental activities. Five observers observed observations of student learning independence in these two classes. Observations were made in each observer observing five to six students. The average student learning independence in the two classes before and after applying the learning treatment can be seen in table 4.

Table 4. Results of Student Learning Independence Analysis Using Observation Sheets

No	Indicator	Experiment Class	Category	Control Class	Cate-gory
1	Believe	100.00	Very Positive	73.10	Positive
2	Able to work alone	93.80	Very Positive	66.70	Positive
3	Appreciate time	96.30	Very Positive	66.70	Positive
4	Responsible	92.60	Very Positive	60.30	Positive
5	Have passion	92.60	Very Positive	66.70	Positive
6	Able to make decisions	92.60	Very Positive	65.40	Positive

The results of the analysis of student learning independence in both classes, namely the experimental class and the control class through direct observation. The analysis results prove that the average score of students in the experimental class is higher than in the control class. This proves that the self-directed learning model is better than the conventional learning model in the form of Direct Instruction. Furthermore, students' learning independence can also be analyzed by indicators.

The hypothesis test of student learning independence used the independent sample t-test. This test aims to determine whether there is a difference in the mean of two unpaired samples. To find out the testing of student learning independence in the experimental class, the normality and homogeneity tests were first tested. Normality test is a test conducted to determine whether the pretest and posttest of student learning independence are normally distributed or not in the experimental class and control class, then the test is carried out using the Shapiro-Wilk test. The homogeneity test aims to determine whether the pretest and posttest data in the experimental class and control class are included in the population with the same variance. The results of the hypothesis testing of student learning independence after applying the self-directed learning model in the experimental class and the Direct Instruction model in the control class can be seen in table 5.

Table 5. The Results of the Difference Test on the Average of Student Learning Independence

No	Classes	Normality*	Homogenity	Significance
1	Experiment	0.594 > 0.05		
		normally distributed	0.907 > 0.05	0.000 < 0.05
2	control	0.099 > 0.05	Homogen	there is a significant difference
		normally distributed		

Based on the test results prove that the results of the pretest and posttest of student learning independence in the experimental class and control class are normally distributed. This is the result of the Shapiro-Wilk test, the Sig value > 0.05, then the data obtained is normally distributed. The results of the analysis of the homogeneity test in the experimental class and control class obtained the value of Sig. 0.907 > 0.05. In this case, it can be interpreted that the homogeneity test results in the two classes are homogeneous or come from the same variance, the results of the independent sample t-test data analysis of the pretest experimental class and control class. Based on the results of the analysis shows the value of Sig. (2-tailed) < 0.05 means a difference in the average student learning independence after applying the learning model. This proves that the learning model in the experimental class in the form of a self-directed learning model is better than the Direct Instruction model applied to the control class. The low learning independence of students in the control class is because some students are less enthusiastic in learning and have self-confidence.

The purpose of applying this self-directed learning model is also to improve students' critical thinking skills. Critical thinking skills instill critical thinking patterns so that students are able to build their minds in the form of basic ideas, principles, and theories they learn with relevant facts. This study's critical thinking skills were measured from the six indicators proposed by Focione (2015), namely interpretation, analysis, conclusion, evaluation, explanation, and self-regulation. Students' critical thinking skills were measured using a question instrument consisting of HOTS questions and included in the cognitive domains C4 to C5. Based on the results of data analysis in the two classes consisting of the experimental class and the control class, the average pretest, posttest, and N-gain of students in both classes can be seen in Figure 1.

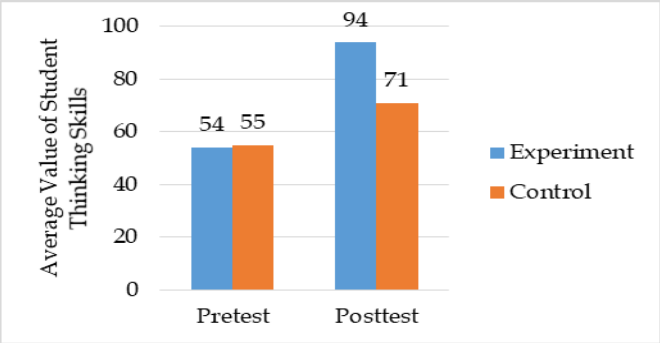

Figure 1. The results of the analysis of the average critical thinking skills of students

Figure 1 shows the analysis results of the average Critical Thinking Skills of students before and after applying the self-directed learning model in the experimental class and the Direct Instruction model in the control class. The results obtained prove that the average student in the experimental class is higher than in the control class. To find out the increase in the average Critical Thinking Skills of the indicator students in the experimental and control classes, the analysis can be seen in Figures 2 and 3 below.

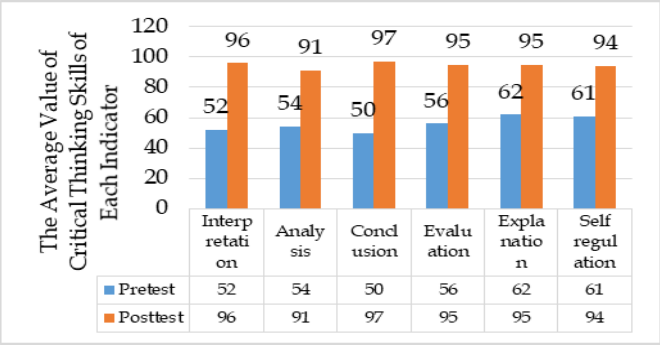

Figure 2. Results of the Average Analysis of Students' Critical Thinking Skills Experimental class indicators

The results of the analysis of the average Critical Thinking Skills of the indicator students in the experimental class increased after applying the self-directed learning model. The results of the data analysis of Critical Thinking Skills consisting of six indicators of interpretation, analysis, conclusion, evaluation, explanation, and self-regulation obtained the percentage on the posttest > 85, including the very good category. The results obtained can be concluded that the application of the self-directed learning model can improve students' Critical Thinking Skills. This is in line with the research conducted by Handayani (2017) that self-directed learning provides freedom for students to explore and elaborate on their knowledge and can confirm the new knowledge they have acquired. Students are invited to learn in a fun way but still focus. Furthermore, to find out the average results of the indicator students' Critical Thinking Skills can be seen in Figure 3.

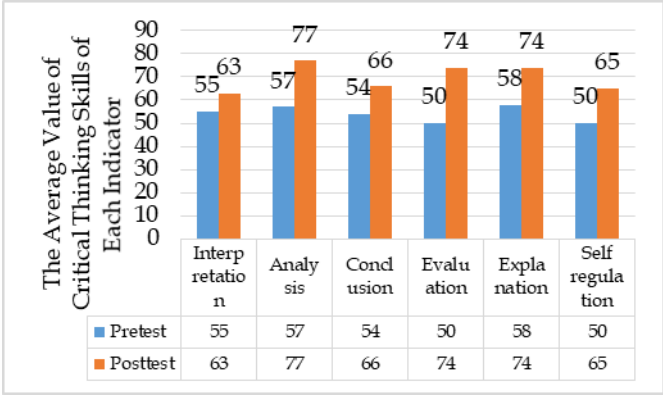

Figure 3. The results of the analysis of the average critical thinking skills of students in the control class indicator

Figure 3 shows the analysis results of the average Critical Thinking Skills of the indicator students in the control class. The results of the field review show that learning activities in the control class using a conventional learning model in the form of direct instruction cannot improve students' Critical Thinking Skills higher than in the experimental class. The results obtained indicate that the self-directed learning model is better used to improve students' Critical Thinking Skills than using the direct instruction model.

After knowing the average results of the pretest and posttest Critical Thinking Skills indicators in the experimental class and control class, it can also be seen the results of increasing students' Critical Thinking Skills through the analysis of the N-gain equation. The results of the N-gain analysis of Critical Thinking Skills indicators, in more detail, can be seen in Table 6.

Table 6. Results of Analysis of Students' Critical Thinking Skills

No	Pretest Questions	Indicator	*N-gain* Experiment	Category	*N-gain* Control	Category
1	CTS 1: 4	Interpretation	0.92	high	0.18	low
2	CTS 2: 7,8,10	Analysis	0.80	high	0.47	medium
3	CTS 3: 5,6,9	Conclusion	0.94	high	0.26	low
4	CTS 4: 1	Evaluation	0.89	high	0.48	medium
5	CTS 5: 2	Explanation	0.87	high	0.38	Medium
6	CTS 6: 3	Self-regulation	0.85	high	0.30	Medium

The results of the analysis of the improvement of the Critical Thinking Skills of the indicator students showed that the students' Critical Thinking Skills after applying the Self Directed Learning learning model obtained an N-gain score > 0.70, including the high category. While the results of the analysis of increasing Critical Thinking Skills in the control class through the application of the direct instruction model obtained a score of < 0.70, so the results obtained are in the medium and low categories. This is in accordance with the results of research conducted by Arjaya (2013) that creative thinking is a form of higher-order thinking. A person's creativity can be formed and trained through self-directed learning activities ranging from preplanning, monitoring, and evaluating.

Hypothesis testing was conducted to determine the average difference between students' Critical Thinking Skills in the experimental and control classes. Hypothesis testing is used in the form of an independent sample t-test. The prerequisites for testing the hypothesis consist of normality test and homogeneity test. Normality test aims to determine whether the data used is normally distributed or not. Normality test used in the form of Kolmogorov-Smirnov.

To find out the next prerequisite test, a homogeneity test was carried out. The data homogeneity test is a test that provides information that the research data for each data group comes from a population that does not differ much in diversity (Ismail, 2018: 201). The hypothesis test used is an independent sample t-test. The results of testing the hypothesis to find out the average difference in students' Critical Thinking Skills before and after applying the experimental class and control class learning treatment can be seen in table 7.

Table 7. Results of N-gain and Difference Test of Students' Average Critical Thinking Skills

No	Classes	*N-gain*	Normality	Homogenity	Signifi-cance
1	Experimen	0.88	0.06 > 0.05 normal distribution	0.029 < 0.05	0.000 < 0.05
2	Control	0.34	0.185> 0.05 normal distribution	Homogeneous	there is a significant difference

The results of the Kolmogorov-Smirnov normality test in the experimental class and control class after applying the treatment obtained a Sig value > 0.05. The results obtained show that the pretest and posttest data in both classes are normally distributed. The results of the posttest homogeneity test in the experimental and control classes obtained the value of Sig. 0.029 < 0.05, meaning that the data is not homogeneous. This is because the results of students' Critical Thinking Skills in the two classes do not come from the same variance or the average value of students in the experimental class has a higher difference than in the control class.

The independent sample t test results on the posttest data of the experimental class and control class obtained the value of Sig. (2-tailed) 0.00. If the value of Sig. (2-tailed) < 0.05 then there is a significant difference between the Critical Thinking Skills of the experimental class students and the control class. This proves that there is a difference in the average Critical Thinking Skills of students after applying the Self-Directed Learning learning model in the experimental class compared to the Direct Instruction learning model in the control class. This is in accordance with Fadlilah's (2018) research, which says that Self Directed Learning is a learning model that involves students directly by presenting several freedoms of learning styles according to their respective abilities.

Conclusion

The application of the self-directed learning model can increase student learning independence on momentum and impulse material at SMAN 9 Banda Aceh. The results of the t-test analysis (independent sample t-test) obtained a significance value of 0.000 <0.05, meaning that there is a significant difference in the average learning independence of students in the

experimental class and the control class. The application of the self-directed learning model can improve students' critical thinking skills on momentum and impulse material at SMAN 9 Banda Aceh. The results of the analysis of students' Critical Thinking Skills obtained a significance value of 0.000 <0.05, meaning that there was a significant average difference in students' Critical Thinking Skills in the experimental class and the control class.

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