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# Analysis of linear motion kinematics on student's critical thinking skills based on scientific inquiry

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**Abstract.** This purpose of this study was to analyze students' critical thinking skills on linear motion kinematics material using the Scientific Inquiry model. This type of research is a quasi-experimental. The data analysis was carried out through 7 critical thinking skills test in essay form. Before the test instruments are tested on students, expert validation tests were carried out first. The critical thinking skill test indicators used consist of elementary indicators of clarification, basic support, inference, advanced clarification and indicators of strategies and tactics. The results of the study showed that the average value of students' critical thinking skills on linear motion material was 60.02 and included in the sufficient category.

## 1. Introduction

Science basically deals with how to find out and understand about nature. Learning science learns phenomena through a series of processes known as scientific processes that are built on the basis of scientific attitudes and the results are manifested as scientific products composed of three components in the form of concepts, principles, and theories that apply universally [1].

Physics as part of science is an interesting subject and requires a strong basic understanding. Physics lessons focus more on the ability of students to analyze the knowledge possessed by natural events or phenomena that he experiences in everyday life. Physics provides good lessons for humans to live in harmony based on natural laws [2]. Physics studies require students to be able to think logically, critically, creatively, and be able to argue properly. But the tendency of learning physics at this time students only learn physics as a product, memorizing concepts, theories and laws. Learners only learn physics in the lowest cognitive domain so that it impacts the learning outcomes obtained [3].

Based on observations made by researchers at MAN Simalungun, students' interest in learning physics is still very low. Physics is still considered as a subject that is less interesting and less enjoyable. Student activities such as expressing opinions, answering questions and debating statements still do not appear during the learning process. Student learning outcomes for physics subjects are still relatively below the Minimum Mastery Criteria. The low learning outcomes of students' physics is because they are not accustomed to developing their thinking potential. As a result, the knowledge acquired is only temporary. The potential thinking in this case is critical thinking.

Critical thinking is reasonable and reflective thinking focused on deciding what to believe or do [4-5]. Critical thinking is one of the basic capital or intellectual capital that is very important for everyone, besides this ability is a fundamental part in human maturity. Critical thinking is an activity of



analyzing ideas or ideas towards more specific, differentiating sharply, choosing, identifying, studying, and developing it towards a more perfect direction [6]. This mental process analyzes ideas and information obtained from observations, experiences, common sense or communication. Critical thinking allows students to analyze their thoughts in making choices and draw conclusions intelligently. Thus, this mental process will bring up the critical thinking ability of students to be able to master the concepts of physics in depth.

A teacher must be able to choose the right model, method and media to be used in conveying subject matter, one of which is the scientific inquiry learning model. The scientific inquiry model consists of 4 phases, namely the presentation of problems to students, students formulating problems, students identify problems in investigation and students find ways to overcome difficulties. The scientific inquiry learning model is designed to engage students in truly original inquiry problems by exposing students to inquiry, helping students identify conceptual or methodological problems in the field, and inviting students to be able to design ways to overcome those problems [7]. The results of previous studies conducted by Siregar [8] concluded that the influence of the model of scientific inquiry to probe the ability of students.

Students already have their own conceptions about something, including those related to physical material in everyday life. Before they follow the lesson in straight motion, they already have a lot of experience with events about motion (objects that move straight, objects that fall freely, objects that are thrown up, etc.). In everyday life quite a lot of students think that if two objects move in the same time and acceleration then the distance traveled is the same. The initial speed needs to be taken into account because these elements make the distance different [9]. The concept of straight motion is one of the subjects taught in high school class X semester 1.

Based on the description stated above, a study was conducted to analyze the concept of linear motion towards students' critical thinking skills with the Scientific Inquiry.

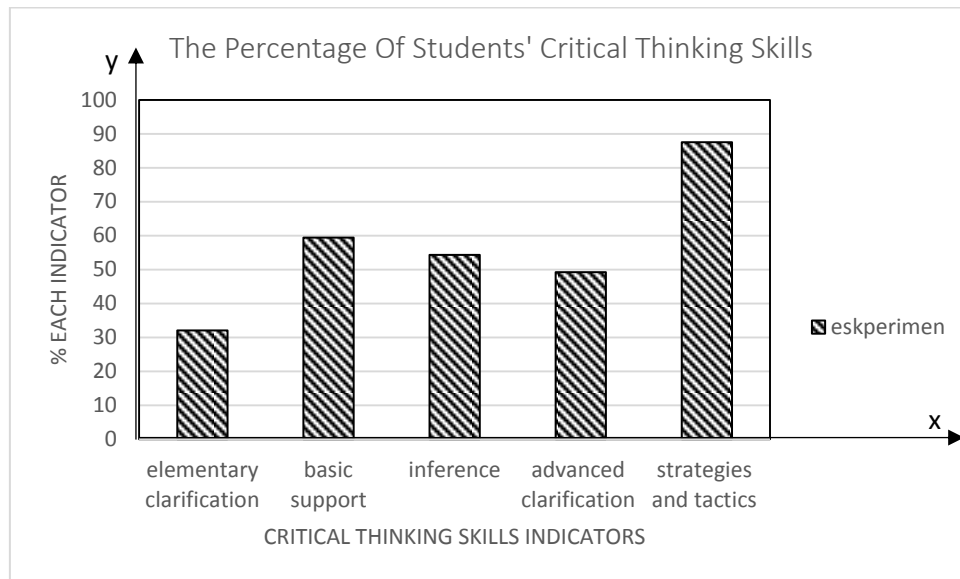
## 2. Research Method

This research is a quasi-experimental using the scientific inquiry model. The instrument in this study consisted of 7 items of critical thinking skill test instruments in the form of essays. Before the test instruments are tested on students, expert validation tests were carried out first. The indicators of critical thinking skills measured in this study are indicators of elementary clarification, basic support, inference, advanced clarification and strategies and tactics. The concept of physics under study is limited to linear-motion material which is one of the subjects taught in high school class X semester 1.

## 3. Results and Discussion

The research begins by carrying out learning on straight motion material using the Scientific Inquiry model, starting with presenting problems to students, then students answering questions from the teacher, after which the teacher explains the material, then students form groups to conduct experiments to answer the problems presented through student worksheets, then students present the results of the experiments of each group in front of the class, after which the teacher gives further explanation. Learning is carried out during 3 meetings. At the end of the meeting, students are given a test to find out the students' critical thinking skills on the linear motion material that has been taught. Indicators used in the instrument of critical thinking skills include elementary clarification, basic support, inference, advanced clarification and strategies and tactics. After the students are given the test, an average value of the students' critical thinking skills is 60.02.

The results of tests that have been carried out for each indicator of critical thinking skill can be seen in Figure 1.



**Figure 1.** Outcomes of Each Indicator of Students' Critical Thinking Skill

Based on Figure 1, it can be seen that the average percentage of students' critical thinking skills scores for each indicator, the lowest indicator obtained is elementary clarification, and the highest is making strategy and tactics.

### 3.1. Indicator of elementary clarification

From the results of the posttest obtained the lowest indicator is to give elementary clarification of 32.03%. This is because the learning process so far tends to be teacher-centered, where the learning activities are fully held by the teacher in order to achieve all the subject matter so that students become passive and only become good listeners. The teacher does not involve students in asking questions why something happened then searching and collecting and processing data to find answers to these questions.

The low indicator of simple explanations obtained is also due to students' initial concepts being wrong. In addition, it is influenced by students' daily experiences, like many students who think that speed and velocity have the same understanding. Students also have difficulty in differentiating velocity and acceleration. In general students assume that when the car's speedometer is always fixed at 60 km / h, the car experiences a constant acceleration. Students learn to think critically gradually through practiced habits in the form of formulating problems and answering questions that require explanation [10].

### 3.2. Indicators of build basic support

In the indicator of building basic support, a percentage of 59.37% was obtained. The concept of physics that students must understand is the concept of regular straight motion and irregularly changing straight motion. When given a story, some students have been able to determine the type of motion experienced by objects and can mention the characteristics of these types of motion. But there are still many students who find it difficult to distinguish irregular straight motion and straight change irregular motion. This is because so far students have not been given the opportunity to actively participate in learning to find and develop concepts, do not have the experience of conducting investigations. Learning only expects students to memorize physical concepts and formulas so that students have difficulty in building their basic abilities. Scientific inquiry can build the basic abilities of students because students are directed to think critically to step out of things to deceive themselves by seeing things directly from various angles and then evaluating them through a rigorous process of

intellectual activity [11]. Strict intellectual activity is observation and measurement of the phenomena that occur.

### *3.3. Indicators of Inference*

To conclude means to identify the elements needed to draw conclusions from data, reports, principles, judgments, beliefs or opinions [12]. In the indicators inference, a percentage of 54.29% was obtained. On this indicator, students have difficulty analyzing the data presented in graphical form. When given a graph of distance (s) to time (t) of 4 children who are running straight, then students are given the task to sort the children who move with the smallest speed, some students have been able to deduce correctly. Likewise for the case of a person who is driving a car with a speed of 90 km / hour, suddenly saw a small child standing in the middle of the road at a distance of 200 m in front of him. If the car is braked with a maximum slowdown of  $1.25 \text{ m / s}^2$ , students can already conclude that the car will stop after hitting the child.

From the direct observation data obtained by the researcher, the students were able to carry out the experiment well, but it was still not optimal, for example, only a few students took notes and paid attention during the experiment, some students did not take notes and only waited for the results obtained by a group of friends so that not all students able to provide conclusions at the end of an experiment, because basically an experiment is a method to make students more confident in the truth or conclusions based on their own experiments [13].

### *3.4. Indicators of Advanced Clarification*

From the test results obtained indicators provide further explanation students are still low with a percentage of 49.21%. This is because only a few students who actively ask questions why something happened then search and collect and process data to find answers to these questions. On this indicator, students have difficulty with the concept of free fall motion. In general students assume that object A and object B are at a certain height, then dropped to each other freely. Item A is dropped first and then object B, so the distance between A and B while still moving in the air is smaller first and then fixed. The low ability of students to provide simple explanations also affects the ability of students to provide further explanation. In the learning process, only some students are able to answer the questions given by the teacher, and some are just silent and become good listeners.

### *3.5. Indicators of strategy and tactics*

Students' critical thinking skills on indicators planning strategies and tactics are the highest indicators at 87.5%. In general, students are able to calculate the time needed for a child not to be late to school. Likewise for the case of a speeding car with a speed of 90km / hour passing a police car that was stopped on the side of the road. Students can calculate the distance traveled by a police car until the speeding car's position is level with the police car. Students can already define problems and find solutions to problems. This is because the Scientific Inquiry learning exposes students to the field of investigation, helps them identify methodological or conceptual problems in the investigation and invites them to design ways to overcome those problems. Students can already understand the process that occurs in a straight motion event. If they have been able to predict and do good planning, students will be more confident and confident to communicate their findings to others [14].

The ability to think critically does not mean just gathering information sometimes someone who has good memory and knows a lot of information is not necessarily good at critical thinking. This is because someone who thinks critically should have the ability to make or draw conclusions from all the information he knows, he can also know how to use the information he has to solve a problem, and find relevant information sources to help him solve a problem. Understanding physics material requires thinking and reasoning in order to solve physics problems.

Critical thinking does not only understand teaching materials but a process or activity that should be included in learning any material at a certain level of education. People who think critically will evaluate and then conclude a matter based on facts to make a decision. One of the characteristics of

people who think critically will always look for and explain the relationship between the problem under discussion with other relevant problems or experiences [15]. Critical thinking directs students to step outside of self-deception by seeing things directly from various angles and then evaluating them through a rigorous process of intellectual activity [11].

The scientific inquiry model can be used to improve critical thinking skills because in activities in learning scientific inquiry students are confronted with a scientific activity or investigate through experimentation. Scientific inquiry is learning that trains students to develop their thinking power in developing application of concepts that have been learned in real life. In the scientific inquiry process it is based on three important bases, namely the nature of scientific inquiry, questions are scientifically tested and scientific evidence and explanations.

Scientific Inquiry learning can involve students actively (student center) to investigate the problems presented on student worksheets. Inquiry scientific learning invites students to criticize starting from the problem, temporary answers, collecting and analyzing data and concluding the answers to the problems [16]. Suryani [17] in her research stated that the scientific inquiry learning model makes students more active in learning, fostering an attitude to dare to express opinions, think critically, interact with friends and ask questions that are less understood. According to Safarati [18], a good learning structure in the scientific inquiry learning model makes students have high thinking skills so they can develop their knowledge. Sutama [19] suggested that this inquiry learning model can improve students' critical thinking skills because students are accustomed to studying a problem through hand on activities which are then analyzed through theoretical studies to formulate a hypothesis and be tested through a practicum to get a conclusion. The inquiry learning process that takes place is centered on students (student centered). Students are given the opportunity to be actively involved in learning both mentally, intellectually, and socially emotionally.

Based on the average value of students' critical thinking skills obtained by 60.02. This shows that students' critical thinking skills in the material of straight motion are included in the sufficient category.

#### 4. Conclusion

Based on the results of research and discussion, it can be concluded that the average value of students' critical thinking skills on straight motion material with the Scientific Inquiry model was 60.02 and included in the sufficient category. Where the average percentage of students' critical thinking skills scores for each indicator, the lowest indicator obtained is to give a simple explanation, and the highest is to make strategies and tactics.

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