ANALYSIS OF CONCEPTS UNDERSTANDING AND STUDENTS' ATTITUDES TOWARDS LEARNING PHYSICS IN PARABOLIC MOTION

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ABSTRACT

Understanding the concepts and attitudes of students is one of the essential things in learning. Based on previous researchers' research, many students have low conceptual understanding or high misconceptions. In addition, students' attitudes towards learning physics are also considered less good. This study aims to determine: 1) students' conceptual understanding of the parabolic motion material, 2) students' attitudes towards learning physics, and 3) the relationship between conceptual understanding and student attitudes towards learning physics. This study used a quantitative descriptive method with a sample of 81 students from 3 senior high schools. The research instrument was in the form of a four-tier multiple-choice concept test about parabolic motion and a questionnaire about students' attitudes towards learning physics. The results showed that students experienced more misconceptions and student attitude questionnaire showed that the indicators of student social implications had the highest percentage and pleasure in learning physics had the lowest percentage. The relationship of understanding of concept with te attitude of the student using product moment show a medium correlation and weak correlation with a positive relation of meaning that if the student's attitude rose then the understanding of the concept of student will also rise or increase as well as otherwise.

I. INTRODUCTION

Education is one of the tools needed to support human progress. In realizing quality education, it is necessary to improve the curriculum from the 2006 curriculum to the 2013 curriculum. The 2013 curriculum requires students to be more active, independent and competent in learning [1]. This means that the 2013 curriculum is expected to be a guide in preparing learning in schools, especially in learning physics. The purpose of learning physics according to the 2013 curriculum is to equip students with the ability to understand concepts, principles of physics, thinking skills and self-confidence that can help students develop science and technology in the face of the times [2,3,4].

Physics is one of the science subjects that plays an important role in the development of science and technology [5]. The object of the study of physics is about nature, be it how nature works, natural phenomena, natural interactions and changes that occur in it [1,2,4,6]. Given the importance of the role of physics, it is necessary to teach physics subjects from the start of students at the junior high school level. To understand physics broadly, you must start by understanding the basic concepts in physics lessons [7].

Understanding the concept of physics is the level of students' ability to re-express the concepts and principles of physics [4]. Good concept understanding is not just memorizing formulas but also understanding existing concepts, solving and finding solutions, and using these concepts in everyday life [8]. So it can be concluded that concept understanding is the ability of students to express concepts and principles from one form to another and be able to apply these concepts in solving problems that exist in everyday life.

The level of concept understanding can determine student success in learning [7]. However, because of the large amount of abstract physics material, it is difficult for teachers to explain the material to students [9]. In addition, teachers still tend to explain concepts and formulas to students without actively involving students in finding these concepts [4]. So that some students do not understand the concept and tend to have misconceptions.

Misconceptions are natural in physics. Misconceptions do not only occur in students, even teachers and prospective teachers often experience misconceptions [10]. In physics, it is very difficult to avoid misconceptions because misconceptions occur when interacting with the environment and growing concepts that are in accordance with their intuition and common sense which are often not in accordance with scientific concepts [9]. Misconceptions are errors in understanding concepts or concepts that are not in accordance with scientific concepts as scientists think [11].

Many misconceptions can hinder learning. According to Wandersee, Mintzes, and Novak, 1994, all fields of physics are almost a misconception. Of the 700 studies on misconceptions, there are 300 studies of mechanics, 159 studies of electricity, 70 studies of heat, optics, and the properties of matter, 35 studies of earth and space, and 10 studies of modern physics [12]. According to Gourlay [13], in his study he found that most students experienced misconceptions in mapping physics concepts.

Many factors are the cause of misconceptions and low understanding of concepts in students. misconceptions can be caused by teacher-centered learning [anori], and not yet fully using a learning model that is in accordance with the 2013 curriculum [14]. One of the factors causing misunderstanding and low understanding of concepts in students is textbooks, learning contexts, teaching methods by educators and factors from the students themselves [15]. In addition, there are other factors that can cause misconceptions, namely the individual himself (a factor in students) which can be influenced by attitudes, interests, motivation and desire to learn.

Attitude is one aspect that affects students' understanding of concepts. attitude will affect motivation which in turn affects learning. Attitude is also defined as an individual's response to a stimulus object in the environment. Attitude responses to the environment can be positive or negative [16] Thus, students' attitudes towards a subject will direct the performance of that subject. A positive attitude will stimulate students to try and lead to high achievement in subjects [16]. A positive attitude is seen when students actively ask and answer questions during class discussions, are enthusiastic during learning, and there is interaction between teachers and students. Negative attitudes towards certain subjects make learning difficult. Negative attitudes can be seen when students are not active in learning, remain silent during the learning process and talk to their next door friend during learning.

The good and bad attitude of students towards learning achievement has an impact on student learning outcomes. It is important to foster a positive attitude of students so that the quality of learning will increase, achievement in learning and desire for a career in physics. The positive attitude of students can be in the form of increasing interest in learning physics, the social implications of physics, enjoying learning physics, adopting a scientific attitude and many more. Students who are able to apply a positive attitude will easily understand physics learning and feel that physics is a fun learning. However, the results showed that students' attitudes toward learning physics were not good enough. This can be seen in the research of Nurdin & Ling [17] which states that science subjects are difficult and complex, learning physics is only for students who quickly understand physics. In addition, learning physics is considered heavy, because it is related to mathematics which requires calculation analysis [18].

Based on the results of the literature study described, students' conceptual understanding tends to be low, misconceptions high and attitudes are not good for learning physics, researchers conducted research at senior high school in Pariaman City, to determine understanding of concepts and students' attitudes towards learning physics. Based on the teaching practice activities carried out in the field, it was shown that students did not understand the concepts and attitudes of students who were not good at learning physics. This study aims to analyze: 1) students' conceptual understanding of the parabolic motion material, 2) students' attitudes towards learning physics, and 3) the relationship between understanding concepts and students' attitudes towards learning physics.

II. METHOD

The type of research used is descriptive quantitative research. The population of this research is all students of class X MIPA at senior high school in Pariaman City. Sampling use purposive sampling technique by

considering schools with 3 categories, namely high, medium and low schools based on school accreditation. Each school is taken one representative class with consideration of the highest average physics score in the school. The number of samples in this study as many as 81 people.

In this study, there were two instruments, a parabolic motion concept test of the type of four tier multiple choice test and a questionnaire of students' attitudes towards learning physics. The four-tier multiple choice test in the form of parabolic motion concept questions consists of 10 questions adopted from Herawati [14], which have been declared valid and reliable. Students' attitude data, was obtained by giving a questionnaire test adopted from the modified CLASS (Colorado Learning Attitude about Science Survey). The scoring uses a Likert scale measurement. The Likert scale model consists of Strongly Agree (SS), Agree (S), Moderately Agree (CS), Disagree (TS), Strongly Disagree (STS). The scores for each category are described in Table 1 the following:

Table 1. Score Alternative Answers

No	Symbol	Description	Score
1.	SS	Strongly Agree	5
2.	S	Agree	4
3.	CS	Just Agree	3
4.	TS	Do Not Agree	2
5.	STS	Strongly disagree	1

For data analysis of student attitude using the analysis formulated as follow

$$\text{Index Formula}\% = \frac{\text{total score acquisition}}{\text{max score}} \times 100 \qquad (1)$$

After calculating average percentage of the questionnaire for each statement, it is categorized according to the qualifications of Table 2:

Table 2. Interpretation of Questionnaire Score

No	Percentage	Criteria
1.	0 – 20	Very Bad
2.	21 – 40	Bad
3.	41 – 60	Enough
4.	61 – 80	Well
5.	81 – 100	Very Good

The student's concept value data is obtained by analysis using the formula:

$$NA = \frac{\Sigma answer\ score + reason\ score}{overral\ max\ score} \times 100 \qquad (2)$$

The determination of the score, both the answer score,and the reason score, are each given 1 point. If the answer is correct, 1 point is given and if the answer is incorrect, 0 points are given, as well as if the reason is correct, the student's reasoning is given 1 point and if the reason is wrong, 0 points are given. So that from 1 concept question has 2 points if both the answer and the reason are correct. Conceptual understanding analysis was carried out manually based on a combination of answers to the four-tier test which, were grouped into 3:Understanding Concepts (SU), Misconceptions (M) and Not Understanding Concepts (NU). The technical analysis of the combination of answers used in this study can be see in Table 3:

Table 3. Interpretation of Four-Tier Multiple Choice Results

Criteria	Answer	confidence	Reason	confidence
Understanding Concepts (SU)	True	High	True	High
Misconception (M)	True	Low	False	High
	True	High	False	High
	False	High	True	Low
	False	High	True	High
	False	High	False	Low
	False	Low	False	High
Don't	True	Low	True	Low
Understand	True	High	True	Low
the Concept	True	Low	True	High

(NU)	True	Low	False	Low
	False	Low	True	Low
	False	Low	False	Low
	True	High	False	Low

Based on Table 3, there are 3, possible answers to the categories of students in answering questions, namely understanding concepts, misconceptions, and not understanding concepts. The results identification of answers to the category of understanding of students' concepts are processed in the form of percentages using the equation:

$$P = \frac{f}{n} x 100\% \qquad (3)$$

Information:

P = percentage (% group)

F = the number of each group

N = total number of students

Furthermore, the data is described based on the category of understanding of the concept which can be known in the following Table 4:

Table 4. Categories of Students' Concept Understanding Level Percentage

No	Percentage(%)	Category
1.	0 - 30	Low
2.	31 - 60	Medium
3.	61 - 100	High

The relationship between students' attitudes towards learning physics and students' understanding of concepts can be known by using correlation analysis. This correlation analysis using the Pearson Product Moment correlation. In the Pearson Product Moment correlation, the score of the results of the questionnaire analysis is need as the independent variable (X) and the score of the concept test results as the dependent variable (Y). In the Pearson Product Moment correlation test, a significance level of 5% is use. The formula used in the Pearson Product Moment correlation is as follows:

$$r_{xy=} \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{\{N \sum X^2 - (\sum X)^2\} \ \{N \sum Y^2 - (\sum Y)^2\}}} \qquad (4)$$

Information:

R_{xy}= R Pearson Correlation Coefficient

N = Number of Samples

X = Independent Variable

Y = Bound Variable

Interpretation of the correlation coefficient that is found to be large or small, it can guided by the Table 5.

Table 5. Criteria of Pearson Correlation

No	Value Interval	Description
1.	0,00	No correlation
2.	0,00-0,20	Very weak correlation
3.	0,20-0,40	Weak but sure correlation
4.	0,40-0,70	Medium correlation
5.	0,70-0,90	Strong correlation
6.	0,90-1,00	Very strong correlation
7.	1,00	Perfect correlation

III. RESULTS AND DISCUSSION

A. *Understanding of Students Concepts*

Overall regarding students' understanding of physics concepts for schools in the high, medium, and low categories, the results showed that there were students' misconceptions about the parabolic motion material higher compared to understanding concepts or not understanding the concepts described in Figure 1.
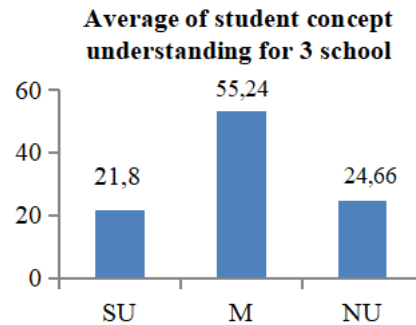
Average of student concept understanding for 3 school

Fig. 1. Average Level of Student Concept Understanding on Parabolic Motion Material.

The low understanding of students' concepts and misconceptions is shown from concept test results given to 81 students at senior high school at three different school levels with high, medium and low categories. The data analysis results from the three schools showed low concept understanding with a percentage of 21.8% and students' misconceptions with a moderate percentage of 55.24%, and 24.66% did not understand the concept even though the material tested had been studied previously. In schools with a high category, who found problems in understanding the concept and schools in the medium or low category.

The lowest concept understanding found in question number 4, wherein question no. 4 is the indicator of the problem inferring the magnitude of the speed on the x-axis. On the problem known, someone's image is playing golf forming a path like a Figure 2.
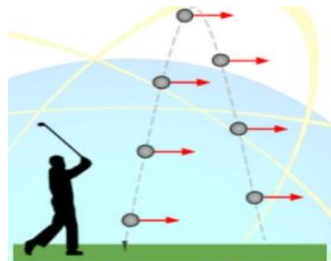

Fig. 2. People Playing Golf.

If the red arrow is a vector velocity symbol, then give a conclusion. Many students answered with wrong answers, namely the average answer with answer A, namely the speed on the horizontal axis is greater than the speed on the vertical axis, B, namely the speed on the horizontal axis is smaller than the speed on the vertical axis, and E, namely the speed on the horizontal axis is the same. with speed on the vertical axis. Only a few students answered correctly with the answer C, namely the speed on the horizontal axis remains. Likewise with the reason, many students answered incorrectly. Only a few students answered E. The acceleration on the horizontal axis is zero. In this question, most of the students filled out answers and reasons with a high level of confidence, namely sure and very sure. So many students have misconceptions. In the matter of parabolic motion, we know that the velocity on the x-axis is constant because the motion of the x-axis is not affected by the acceleration of the object. However, many students think that the x-axis velocity in parabolic motion always changes because it is influenced by the acceleration of gravity.

In addition to number 4, also in question number 9 about calculating the furthest distance, the ball can reach. The problem presented a case of a ball thrown at a certain speed with Figure 3.
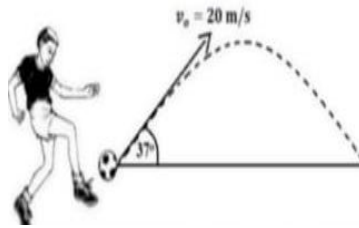
Fig. 3. People Kicking the Ball

Students are ask to determine the horizontal distance that the ball can reach. In this question, many students answered with wrong answers, namely B. 1.6 m and D. 16 m. Only a small number of students answered with an answer of E.38.4m. The error in this answer also affects the error in reasons given. The reasons for the answers given by some students answered incorrectly, namely C. The horizontal distance is reached when the maximum height is reach and A. The maximum horizontal distance is affected by the acceleration of gravity. Only a few students answered correctly with the reason D. The maximum horizontal distance is the maximum distance reach by the object, which is proportional to the square of the object's velocity. For schools in the middle and low categories, they generally answered incorrect, however for high school categories, almost all of them answered correctly for reasons of answer questions, but still many students were wrong in filling out the correct answers. Overall the three schools generally answered with high confidence, namely sure and very sure for the level of confidence in the answers and reasons, so that there was a high level of misconception in school in the high, medium, and low categories of schools.

Most of the motion phenomena, both parabolic motion, straight motion, circular motion, etc. In everyday life are difficult to observe and measure, so that it can lead to misconceptions for students. Conceptual misunderstandings are caused by a combination of prior knowledge obtained from interaction with the environment, so that students have different initial knowledge or concepts from expert concepts before entering formal school. Generally in school teachers still carryout teacher-centered learning. Teacher more to provide material exposure to student, very few discussion activities and presentations, experimental activities are rarely done [20]. Such learning causes less trained ability of student analysis so that the student has difficulty in solving physics problems. The difficulties experienced by student with respect to inability in implementing the scientific reaction skill needed to explain concept. According to Delvia [21], there are about 81% students difficulty solving the problems of physics even though it already knows the concept of the problem.

According to Pratama [12], as many as 60% of the problems that cause misconceptions are the conventional way of teaching teachers or the lecture method. The use of this conventional/lecture method makes learning that occurs only in one direction, lack of interaction between students, so that it does not open up opportunities for students to find new ideas, so that learning boring, students' creativity and scientific potential are limited [20]. In addition, the low level of understanding of the concept of the student according to research Fadhilah [22] is caused by the lack of implementing learning model that support the capability of student critical thinking, teaching materials especially LKS rarely used and literacy student are still limited to reading, counting and writing.

Another factor causing the low understanding of students' concepts is the student's learning atmosphere. Since the outbreak of the Covid-19 case, the Ministry of Education and Culture decided to carry out online learning. Online learning is adapt to the conditions and situations of each student, including in terms of access gaps/learning facilities at home. Learning facilities in online situations are only limited to use mobile media using the online method through whatsapp groups. Usually the teacher provides learning in the form of videos from YouTube that are adapted to the material being studied as a means for students to understand learning. the media and learning facilities used are limited to IT-based teaching materials widely used in schools, only green audio material (75%), multimedia, animation, E-books etc Phet simulations are still lacking [4].

The thing that can be done to overcome the low understanding of concept is the discussion of phenomenon of physics phenomena that can stimulate student, using the cognitive conflict learning model through the application of real experimental video analysis, teaching material, LKS, and others [22].

B. Students' Attitudes towards Learning Physics

Student attitude data obtain from distributing questionnaires to students. In general, the highest student attitudes found in the social implications indicator of physics. The lowest student's attitudes were in the pleasure indicator in studying physics, as described in Figure 4.

**Average of student concept
understanding for 3 school**
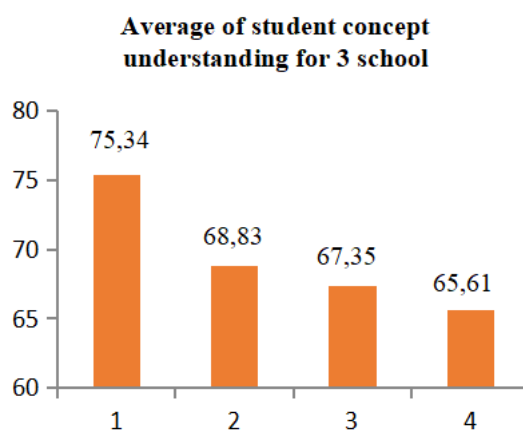
Information:

1. Social implications of physics
2. Interest in increasing the time to study physics
3. Adopt a scientific attitude
4. Fun in studying physics

Fig. 4. Average Student Attitudes towards Learning Physics

The students' attitudes towards learning physics are on average in 3 different categories: schools with 3 high categories, medium categories and low categories. Overall, the average of the three schools for each attitude indicator showed a good attitude. The average percentage of the three schools is the highest on the indicator of the social implications of physics with an average percentage of 75.34%, and the lowest percentage is on the arrow of pleasure in studying physics with an average rate of 65.61%. This means that students have enough awareness in knowing the relationships and relationships of physics and the use of physics in everyday life.

The indicators of the social implications of physics in the three schools have a percentage of >70% with a good category. Most of the students gave an assessed of moderately agree, agree, and strongly agree. This research shows that SMAN Kota Pariaman is categorize as good with many students who apply physics in daily. The social implications of physics describe the influence of physics on social life. Who can also feels its applications in learning discussion activities. Students' social abilities will see when working together compared to themselves [23].

Who found the indicator of interest in increasing the time to study physics at the three schools to be more than > 65% with a good category attitude. Interest in increasing study time can interpret as a form of student preference in studying physics so that students use a lot of free time to study physics more deeply. Study time refers to a certain time that students set for themselves to study to acquire knowledge. With lots of time to study physics, positively impact on student achievement and learning outcomes [23].

In the indicators adoption of scientific attitudes of students, in the three schools, more than > 65% were found with attitudes in the good category. In the indicator of the adoption of scientific attitude, students talk about scientific behavior in studying physics. Scientific attitude has three basic components: belief, feeling, and action. The three components are applied using scientific methods to form an active attitude, and have critical, structured, independent, and logical thinking. For example, when conducting experiments, it is necessary to look for information proven to be true so that the knowledge obtained is more conceptual [23, 24].

The indicators of enjoyment in learning physics at the three schools have a good category with an average of >60%. Shows that students quite enjoy learning physics. Indicators of fun in learning physics will affect students' interest in studying physics. Feelings of pleasure will cause students to behave well during learning, do assignments, have a high sense of enthusiasm and curiosity. The attitude of students who are happy with physics will impact the results of learning physics. If students enjoy learning physics, the results of studying physics will also be good [24].

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C. Correlation Between Student Attitudes Toward Learning Physics with Understanding of Student Concept.

The relationship of student attitudes and understanding of the concept of student obtained by using product-moment correlation, so obtained the following result:

Table 6. Pearson Product Moment (PPM) Correlation Test Results in the Three Sample Classes

Sample	Total	R	Description
High Category school	31	0,3469	Weak correlation
Medium Category school	30	0,3059	Weak correlation
Low Category school	20	0,430	Medium correlation

Based on Table 6, it found that the magnitude of *rxy* each shows that the two variables are correlated, or there is a relationship between student attitudes with the understanding of student concepts. Based on the Pearson correlation value criteria, the two correlated variables or student attitudes have a relationship with students' conceptual understanding. The r-value shows the numbers 0.3469 and 0.3059, which means that the two variables have a weak correlation. While the value of r shows the number 0.43 which, means the two variables have a moderate correlation. The two correlations show a relationship with the direction of the positive relationship. The direction of a positive relationship means that if the value of a variable increase, the value of another variable will increase. It means that students' understanding of concepts and attitudes towards learning physics have a close relationship. If students' attitudes towards learning physics are good, then the value of concept data will be high.

In low category schools, students' understanding of concepts and attitudes towards learning physics have a moderate relationship, while in high and medium categories schools have a weak relationship. This happened possibly due to online learning during the covid19 pandemic, which affected students' understanding of concepts and attitudes towards studying physics. One of the dominant factors that influence online learning is students' readiness to receive and send information, especially in discussing content or concepts that are difficult to understand [25]. Even during the COVID-19 pandemic, students still want learning that involves them actively in learning [4].

IV. CONCLUSION

Based on the results of the study and discussion, we can conclude that understanding of high school physics concepts on parabolic motion at Pariaman City is still in the low category while students' misconceptions are in the medium category. In general, students' misconceptions are higher than understanding concepts and not understanding concepts. This means that many students still misunderstand the concepts in the parabolic motion. This can happen maybe because schools in the 2020/2021 school year are still carried out online, so there are many limitations in carrying out learning both from methods, learning models, explanations from teachers, which cause all of the expected competencies not to achieve. In addition, online learning causes a reduced sense of enthusiasm for learning, reduced desire to learn, and a sense of pleasure to learn, which may affect learning.

In students' attitude towards studying physics at senior high school, each attitude indicator shows a good attitude, with the highest percentage of indicators being on the social implications of physics and the lowest percentage on indicators of fun learning physics. However, the overall category is good. Between understanding the concept and students' attitudes have a significant or correlated relationship. Means that students' attitudes and students' understanding of concepts influence each other. If the student's attitude towards learning physics is good, then the understanding of the concept is also high. In this case, although the student's attitude is good, understanding the concept is still low. This is due to the low understanding of concepts not only influenced by student attitudes, but many other thing can influence such as motivation, interests, talents, teaching methods, learning atmosphere, learning facilities and much more.

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