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Correlation of Concept Understanding and Students' Attitudes towards Learning Physics on the Material of Temperature and Heat in Class XI

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ABSTRACT
Learning physics in high school has a goal students can master physics concepts and have a confident attitude. Currently, students' comprehension of concepts is still lacking, considering the mindsets and attitudes of students who have not demonstrated a positive approach toward learning physics. It is necessary to analyze the students' conceptual comprehension, attitudes toward studying physics, and the link between conceptual understanding and student attitudes. This research includes descriptive research with a qualitative approach. The population of this study is all students of class XII MIPA SMAN Batusangkar and a sample of 172 students. This study used a purposive sampling technique. The instruments used are four tier multiplechoice diagnostic tests and attitude questionnaires. Overall, the research result at SMAN Batusangkar discovered that pupils' conceptual grasp was still lacking, so there is a misconception of 41.28% on the material of temperature and heat. Students' attitudes towards learning physics as a whole, they have shown a good attitude towards learning physics, which is in the good category of 68.92%. Concept understanding and students' attitudes towards learning physics have a moderate relationship. Correlation concepts understanding with student attitudes shows that student attitudes can influence concepts understanding, causing unsatisfactory physics learning outcomes.

INTRODUCTION

Education is an essential factor that plays a role in building a nation. Education must develop students' abilities and shape the character and civilization of a dignified nation to educate the life of the community, country, and state. The government has made various efforts and changes to improve student competence by continuously improving and evaluating the curriculum and learning models that are applied. The curriculum serves as a guide to the success or failure of education itself. Students

will expect to give the best results in the learning process to achieve quality education. The 2013 curriculum requires students to be more active, independent, and competent in learning. In facing 21st-century learning, students also need to be equipped with learning skills, literacy, and life skills [1]. Learning physics as a part of science also requires students to be active per the demands of the curriculum [2].

Learning physics in high school has several objectives. One of which is that students can master the concepts and principles of physics and have the skills to develop knowledge and self-confidence that can be used as provisions to continue education at a higher level build science and technology. Physics has a significant role in supporting the development of science and technology [3]. Physics is seen as essential to be taught as a subject in schools because physics is a subject that can foster students' thinking skills that are useful for solving problems in everyday life. Physics can also equip students with the knowledge, understanding, and abilities required to enter higher education levels.

Concept understanding is the ability of students to understand a concept about everyday phenomena based on experience and observations, which will then link to concepts that previously existed in them. Analyzing student initial understanding of concepts is necessary to prevent student errors. Many conceptual errors occur because of several factors, including factors in students, both students' attitudes or problems in learning interest, and in the process of developing students' cognitive structures.

Attitude is a view or feeling accompanied by a tendency to act towards particular objects [4]. Students are essential in learning, especially in physics lessons [4]. Students' attitude towards learning physics refers to students' feeling of pleasure or interest in studying physics subjects [5]. Students who have difficulty in physics subject matter, causing students don’t to be interested in a career in physics. Many students think that physics is boring and that pursuing a career in physics is a difficult job. In certain areas of physics, the decline in interest in physics worldwide is evident from the large number of researchers who have conducted studies to estimate student attitudes towards physics in secondary schools and universities [6]. Therefore, determining students' attitudes towards a subject is essential to improving students' understanding of concepts in that subject.

The reality on the ground today is still not as expected. However, various efforts will improve students' conceptual understanding, and schools still have not shown an optimal increase in student's conceptual understanding. Based on observations, the results of the final semester exams for students of class XI MIPA at one of the SMAN Batusangkar, namely SMAN 1 Batusangkar. Students will fixate on formulas and calculations compared to material concepts in the learning process so that conceptual understanding is still relatively low. The problem of misconceptions and insufficient knowledge of concepts is quite common in schools. In Mufit's research, students also experienced incomplete conceptual understanding, so students had difficulty solving physics concept questions even though they understand the topic in question [7].

In Mufit's follow-up research, students' comprehension of concepts is also low, and misconceptions occur in students; this will cause the implementation of learning in schools that are still *teacher centered learning* so that students don’t active in the learning process [2]. One of the materials whose students' comprehension of concepts is still lacking and misconceptions often occur is on the material of temperature and heat. Must overcome this misconception problem to avoid later interfering with the learning process [8]. In Astalini's research, students' attitudes have shown a good attitude. However, some students still have a reasonably good attitude towards studying physics, causing students to be less motivation in expanding physics study time [9].

Based on the results of research conducted by Capriconia, it was found that students' understanding of the concept of straight motion still tends to be low. Understanding physics concepts is very important in the process of solving physics problems, because low understanding can cause misconceptions in students. Apart from that, students' attitudes towards studying physics also influence their success in

understanding physics concepts. Students' positive attitudes towards learning physics have been proven to improve their learning achievement [10].

In the context of physics learning, students' understanding of concepts and attitudes are interconnected and play an important role in improving learning outcomes. Good understanding will help students overcome difficulties in understanding physics material, while a positive attitude towards learning will provide additional motivation for students to learn better. Therefore, it is important for educators to pay attention to and develop these two aspects together in order to increase the effectiveness of physics learning.

This research aims to determine the correlation between students' conceptual understanding and students' attitudes towards learning physics on temperature and heat. The results of this research can be used as material for consideration by teachers to determine the level of student understanding and student attitudes and determine appropriate learning models and methods in delivering temperature and heat material. Based on problems in the field, researchers are interested in conducting research with the title "Correlation of Students' Understanding of Concepts and Attitudes towards Physics Learning on Temperature and Heat Material in Class XI SMA N Batusangkar".

METHOD

The research method employed was a descriptive study using a quantitative approach. This study has a population of all class XII MIPA SMAN Batusangkar, namely 341 students. This research used a technique known as purposive sampling.To determine how many class samples are used by each school, referring to the table from Isaac & Michael with a significance level of 5% so that the total sample size is 172 people consisting of 73 students from SMAN 1 Batusangkar, 52 students from SMAN 2 Batusangkar, and 47 students from SMAN 3 Batusangkar.

In this study, the four-tier multiple-choice diagnostic test instrument was to understand students' concepts analyzed by quantitative analysis, and attitude questionnaires to see students' attitudes towards learning physics were analyzed using a Likert scale. In the attitude questionnaire, the researcher uses indicators adopted from the *Colorado Learning Attitudes about Science Survey* (CLASS), modified to guide preparing questions or statements in the instrument to be tested. The data analysis technique to determine the relationship between conceptual understanding and student attitudes is the Pearson correlation test with the help of SPSS ver 25.0.

Data analysis for the instruments in this study can be seen in the following description:

Concept Understanding Test Data Analysis.
The data analysis technique used to analyze the concept test data is the quantitative analysis technique. Quantitative analysis techniques are used to manage and interpret data in the form of numbers or those that are systematic. Scoring is given by giving a score of 1 for the correct answer choice or choice of reason, and a score of 0 is given for the answer choice and the wrong reason choice [11]. The confidence level is high if you choose the sure option by providing a score of 1, and the confidence level is low if you select the unsure option by giving a score of 0.

Based on the data analysis, the level of students' comprehension of concepts with the criteria of understanding, not understanding, or misconceptions can be grouped into several categories as follows: 1) $0\ \% \leq P < 30\ \%$ is low criteria, 2) $30\ \% \leq P < 60\ \%$ is medium criteria, and 3) $60\ \% \leq P \leq 100\ \%$ is high criteria (Category of Concept Understanding Level) [12].

The interpretation of the concept test results or four-tier multiple-choice test is used to classify students according to the criteria for understanding, not understanding, or misconceptions. The interpretation results are made in tabular form, containing the answer column, the confidence level in the answers, the reasons, the level of confidence in the reasons, and the criteria.

The *four-tier multiplechoice* diagnostic test interpretation guidelines used were adopted from Fariyani's research [11]. There are 16 possible student criteria, as presented in Table 1.

Table 1. Interpretation of Four-Tier Multiple-Choice Diagnostic Test Results [10]

Criteria	Answer	Confidence Answer	Reason	Confidence Reason
Understand	True	High	True	High
Don't Understand	True	High	True	Low
	True	High	False	Low
	True	Low	True	High
	True	Low	True	Low
	True	Low	False	Low
	False	Low	True	Low
	False	Low	True	High
	False	Low	False	Low
Misconseption	True	High	False	High
	True	Low	False	High
	False	High	True	High
	False	High	True	Low
	False	High	False	High
	False	High	False	Low
	False	Low	False	High

Attitude Questionnaire Data Analysis.
Data analysis will be executed by using a Likert scale. The Likert scale measures attitudes, opinions, and perceptions of a pupil or group of pupil about social phenomena. This study used the Likert scale to measure attitudes and perceptions towards learning physics. Calculation of Likert scale value as follows : 1) STS symbol means Strongly Disagree with 1 score, 2) TS symbol means Disagree with 2 score, 3) CS symbol means Quite Agree with 3 score, 4) S symbol means Agree with 4 score, and 5) SS symbol means Strongly Agree with 5 score [13].

Based on student answers filled in according to the Likert, we will obtain the total score. The total score obtained is entered into a formula whose measurement is determined by:

$$Score\ Percentage = \frac{score\ total}{maximal\ score} x100 \quad (1)$$

Interpretation Criteria for Attitude Questionnaire Score Results are, 1) Score 0-20% is very bad criteria, 2) Score 21-40% is bad criteria, 3) Score 41-60% is enough criteria, 4) Score 61-80% is good criteria, 5) Score 81-100% is very good criteria [14].

Data Analysis for Correlation of Concept Understanding and Attitudes to Learning Physics.
The Pearson correlation test uses the data analysis technique to determine the relationship between conceptual understanding and student attitudes. Product moment correlation to test the hypothesis of the relationship between one independent variable and one dependent [13].

After collecting the research data through concept tests, and questionnaires, the researchers will analyze the data. After obtaining the results of the analysis of the concept test and the results of the questionnaire analysis, the researchers conducted a correlation test analysis of the results of the two analyzes using *Pearson's product moment* through the SPSS 25.0 program by entering the scores of the questionnaire analysis results as the independent variable (variable X).

The relationship/correlation between these variables can be seen closely by using the correlation

coefficient value as a benchmark. Guidelines for Providing Interpretation of Correlation Coefficients : 1) 0,800 – 1,000 is very strong relationship level, 2) 0,600 – 0,799 is strong relationship level, 3) 0,400 – 0,599 is enough relationship level 4) 0,200 – 0,399 is low relationship level, and 5) 0,000 – 0,199 is very low relationship level [13].

RESULTS AND DISCUSSIONS

Concept Understanding

The data obtained from the four-tier multiple-choice diagnostic test results will be interpreted into a table. The field test sample was 172 students in three schools in SMAN Batusangkar grouped with the criteria of understanding, not understanding, or misconceptions. The recapitulation of the results of grouping all students who experience misconceptions, do not understand and understand concepts at SMA N Batusangkar is presented in Table 2.

Table 2. Results of Analysis of Concept Understanding at SMA N Batusangkar.

Name of School	Category		
	Misconception (%)	Do not understand the concept (%)	Understand the concept (%)
SMA A	38,09	25,53	36,38
SMA B	40,89	20,82	38,29
SMA C	44,71	23,08	32,21
Average	41,28	22,79	35,93

According to the information in the table, the overall results of the research for understanding the concepts of SMA N Batusangkar students are still low, so there is a misconception of 41,28% but still in the moderate category, not understanding the concept of 22,79% in the low category, and understand the concept of 35,93% in the medium category.

The results of grouping analysis of students who understand the concept can be seen in Figure 1

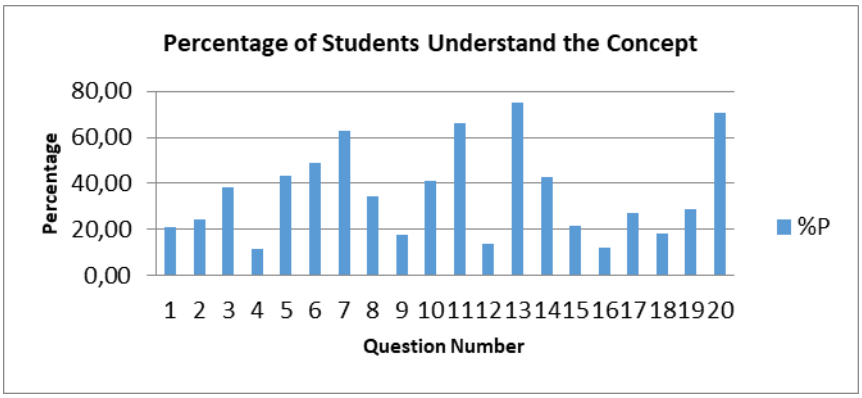


Fig 1. *Grouping Students Understanding the Concept of Each Question*

Figure 1. shows students' understanding of each item in the high, medium and low categories. The average acquisition of students who understand the concept of each item in the low category is 18.81%. Understanding of concepts in this low category occurs in 10 items, namely numbers 1, 2, 4, 9, 12, 15, 16, 17, 18, 19. The indicator for question number 4 is: Using the thermometer calibration equation on the Celsius scale with any scale. On this question, 68.02% of students experienced misconceptions, and on this question, students experienced the lowest understanding of the concept at 11.63%. Most students still make mistakes in answering the reasons for the answers to the third level questions, which makes many students experience misconceptions about these questions. This error occurred due to students not being careful in reading the answer items on the third level questions.

Students who understand the concept in each item in the moderate category occur in 6 items, namely on questions number 3, 5, 6, 8, 10, 14 with an average of 41.58 % . The indicator for question number 6 is: Analyzing the factors that cause expansion in an object. In this question, 48.84% of students understand the concept that a bimetallic chip has 2 (two) different types of metal in the unit of a bimetallic chip, because it consists of 2 (two) types of metal, the coefficient of linear expansion of the two types of metal is different so that when When heated, it bends towards the metal which has a smaller coefficient of linear expansion. Meanwhile, when cooled, the bimetallic piece will bend towards the opposite metal, namely the metal that has a greater coefficient of linear expansion.

In question number 7, 11, 13 and 20 students understand the highest concept of 69.81%. The indicator for question number 11 is: Shows factors that influence the heat capacity value of a substance. In this question, students experienced a concept understanding of 66.28% in the high category. This means that it can be concluded that students understand the concept that the factors that influence the value of the heat capacity of an object are density, volume and specific heat.

The percentage of students understanding the highest concept with the high category in question number 13 with indicators describing the process of changing the state of matter is 81.19%. While the percentage of students who understand the lowest concept with the low category in question number 4 with the indicator determining the boiling point of water is 10.89%.

Based on the graphic data, the highest percentage of students understanding the concept in question number 13 is 81,19% and the lowest understanding of the concept in question number 4 is 10.89%. Misconceptions in the high category also occur in question number 4 with an average of 66.34%.

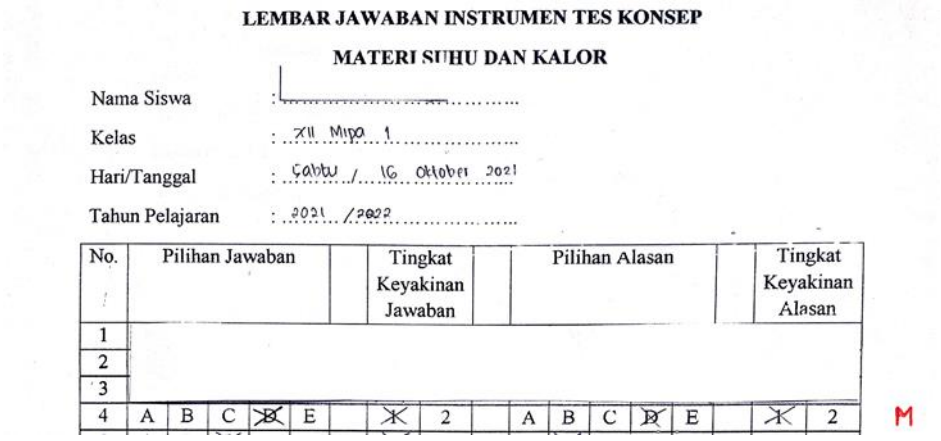
4. Termometer X dirancang dapat mengukur air membeku pada skala -20 dan air mendidih pada skala 140. Jika suatu benda diukur dengan termometer Celcius menunjukkan nilai 45°C, maka tentukan nilai yang ditunjuk saat diukur dengan termometer X…
   a. -52°
   b. -92°
   c. 52°
   d. 72°
   e. 92°

   Tingkat keyakinan terhadap pilihan jawaban:
   1. Yakin
   2. Tidak yakin

   Alasan terhadap pilihan jawaban:
   a. $\frac{Tx-Xb}{Xa+Xb}=\frac{Tc-Cb}{Ca+Cb}$
   b. $\frac{Tx+Xb}{Xa-Xb}=\frac{Tc+Cb}{Ca-Cb}$
   c. $\frac{Tx-Xb}{Xa-Xb}=\frac{Tc-Cb}{Ca-Cb}$
   d. $\frac{Tx+Xb}{Xa+Xb}=\frac{Tc+Cb}{Ca+Cb}$
   e. $\frac{Tx-Xb}{Xa+Xb}=\frac{Tc+Cb}{Ca-Cb}$

   Tingkat keyakinan terhadap pilihan alasan:
   1. Yakin
   2. Tidak yakin

Fig 2. *Question number 4 the four-tier multiple-choice diagnostic test instrument*



LEMBAR JAWABAN INSTRUMEN TES KONSEP

MATERI SUHU DAN KALOR

Nama Siswa : .....

Kelas : XII Mipa 1

Hari/Tanggal : Sabtu / 16 Oktober 2021

Tahun Pelajaran : 2021 / 2022

No.	Pilihan Jawaban		Tingkat Keyakinan Jawaban		Pilihan Alasan		Tingkat Keyakinan Alasan
1							
2							
3							
4	A B C ~~D~~ E		~~X~~ 2		A B C ~~D~~ E		~~X~~ 2

M

Fig 3. *Students' answers in the category of misconceptions*

Based on the picture above with item number 4 presented the indicators for question number 4 are : using the thermometer calibration equation on the Celcius scale with an arbitrary scale. In this question, 68.02% of students exprerienced misconceptions, and students experienced the lowest conceptual understanding of 11.63%. Most students are still many who are wrong in answering the reasons for answers at the third level of questions so that many students experience misconceptions about these questions. This error occured as a result of students not being careful in reading the answer items on the third level questions.

The results obtained from the four-tier multiple-choice diagnostic test instrument; namely, students' comprehension of concepts, are low so that misconceptions occur, which occupy the highest position of 41.28% among other categories. The number of questions tested to students was 20 questions. The students experienced the most heightened concept understanding in indicator question number 13 about describing the process of changing the form of substances totaling 129 students with a percentage of understanding concepts of 75,00%. At the same time, the category of understanding the lowest concept occurs in the indicator of question number 4, which is determining the boiling point of water with several 20 students at 11,63%.

Based on the results of the analysis of the understanding of the concept of each school based on the high, medium, and low categories obtained the result, namely for schools in the high category, SMAN A, there was a misconception of 38,09%. This is lower than the middle school category, namely SMA B with a misconception of 40,99%, and the low category school, namely SMA C, with a misconception of 44,71%. Overall, the study results for understanding students' concepts at SMAN Batusangkar showed that students had misconceptions. Students experience misconceptions in choosing answers by 41,28% of all the questions tested. Misconceptions occur because students are very sure of the answers they think are correct. In addition to experiencing misconceptions, students also experience understanding concepts by 35,93% and not understanding concepts by 22,79%.

According to Fauziah, the cause low students' comprehension of concepts is caused by *Teacher Centered learning* [15]. The low students' comprehension of concepts and misconceptions, among others, are caused by learning in schools that have'nt involved pupils in finding concepts or constructing knowledge [9]. Low concept understanding and students' misconceptions are caused by many factors, including not involving students in concept discovery in physics learning [16]. Another factor is that students' curiosity is very lacking, resulting in misconceptions in students and low levels of conceptual understanding, especially in physics lessons [17]. In addition, the cause of low student concept understanding is the lack of application of learning models that support students' critical thinking skills materials teaching, especially LKS which are rarely used, and student literacy is still low in reading, counting, and writing [18].

The highest source of misconceptions comes from the students themselves. Students express

knowledge from their minds. The misconceptions revealed using the four tier multiple choice diagnostic test instrument can be a note for teachers in carrying out physics learning, especially on temperature and heat material. With a diagnostic test for understanding concepts like this, teachers can immediately improve students who have misconceptions and don't understand concepts. Diagnostic tests can diagnose deeper levels of student understanding and identify the causes of misconceptions in students [19].

Student Attitude.
The data obtained from the student questionnaires be grouped into attitude indicators consisting of the social implications of physics, interest in increasing study time physics, adoption of scientific attitudes, and enjoyment in learning physics.

The summary of the analysis results for student questionnaires at SMA N Batusangkar is present in Table 3.

Table 3.SMAN Batusangkar Student Questionnaire Analysis Results.

Name of School	Attitude Indicator			
	Social Implications of Physics (%)	**Interest in Increasing Study Time Physics (%)**	**Adoption of Scientific Attitude (%)**	**Enjoyment in Learning Physics (%)**
SMA A	78,21	66,21	73,87	68,60
SMA B	75,18	65,21	73,37	66,36
SMA C	74,15	65,19	73,31	65,42
Average	75,70	65,48	73,49	66,69
Criteria	Good	Good	Good	Good

Based on Table 3, overall, the research results for student attitudes at SMA N Batusangkar have shown a good attitude for each attitude indicator. The most significant percentage of the first attitude indicator is the social implications of physics, with a rate of 75,70%..

According to the findings of the analysis, students' attitudes about learning physics in high school categories, namely SMA A, schools in the medium category, namely SMA B, and schools with low categories, namely SMA C, are good for all indicators. Overall, students' attitudes have shown a good attitude towards studying physics. The attitudes of students who show good categories can be seen from the discussion of the following attitude indicators: The highest attitude indicator, namely the social implications of physics as much as 75,70%, results with students' attitudes with good criteria, this means that students feel the implications of physics in their social life, the role of physical science in technological progress, and the good implications for their social life. According to Rosdianto, physics concepts and principles are widely applied to life and contribute significantly to development and life in this era. Therefore, the concept of physics should also be linked in everyday life so that students cannot imagine abstract concepts in reality [20]. In addition, Kaniawati also explains that concepts have an essential role in learning as a foundation in studying natural phenomena [21].

The lowest indicator is the interest in increasing study time physics of 65,48% of students' attitudes with good criteria. This implies that it is well-known that when students graduate high school, they study physics at home, either alone or in groups, and seek friends for help with the topics they don't understand. Students who have free time and are interested in filling it with studying physics have a curiosity and curiosity to research physics more deeply. Students show this positive attitude, but it is different from a negative attitude. Students who have unfavorable attitudes will not spend their time studying these subjects. The attitude of students' interest in spending time in physics can make students serious about studying physics [20].

Correlation of Concept Understanding and Attitudes to Learning Physics.
The correlation or the link between conceptual understanding and student attitudes toward learning

physics can be obtained by using product-moment correlation utilizing the SPSS 25.00.The correlation between understanding concepts and student attitudes for the three schools is as follows.

Table 4. Correlation between understanding concepts and attitudes of SMAN Batusangkar

Name of School	Value Significance	Value Correlation	Description
SMA A	0.000	.534**	Medium
SMA B	0.000	.472**	Medium
SMA C	0.005	.382**	Low

Table 4 shows the significance values obtained are 0.000 and 0.005, which means a correlation between the concept understanding variable and the student attitude variable because the variable is declared to correlate if the significance value is < 0.05. The value of the correlation coefficient is high school categories, namely SMA A has a value of r = 0.534, which means that the correlation between the variables of understanding the concept and the variable of student attitudes is sufficient or moderate. The correlation between understanding concepts and attitudes of students in the medium category school, namely SMA B, has a value of r = 0.472, which means that the correlation is moderate. In contrast, for the low category school, namely SMA C, the value of r = 382 means that the correlation is low.

The research data shows that the correlation between conceptual understanding and student attitudes in schools with a high category, namely SMA A, and in the medium category, namely SMA B, correlates with a moderate level of relationship. Students' attitudes in SMA A and SMA B towards studying physics are in a good category. However, students' comprehension of concepts is still lacking and is classified as a misconception. The correlation between conceptual understanding and student attitudes in schools with a low category, namely SMA C, correlates with a low level of relationship. Students' attitudes in SMA C towards learning physics are in a good category, but in understanding the concepts, students have, SMA C is still low compared to SMA A and SMA B.

Based on the results in the correlation analysis the link between conceptual understanding and student attitudes towards studying physics, students' understanding of concepts is influenced by students' attitudes towards learning physics, which can be seen from the students physics learning outcomes. According to Zainal, attitude is one-factor influencing learning outcomes. This means that the more positive/very positive the student attitudes towards studying physics is higher/very high the student's physics learning outcome. On the other hand, the more negative/very negative the students towards physics learning, the lower/very low students' physics learning outcomes [22]. Conceptual understanding and students' attitudes become an inseparable unit [23].

If the conceptual understanding test and student attitude questionnaire show that there are students whose attitudes towards learning physics can not correlate with the results of learning physics they get. This is because the student's attitude towards studying physics is in the negative category, and the results of learning physics are high. Students' negative attitude towards learning physics leads to the teacher's teaching and the lack of interaction and communication between teachers and students. Even though these students have negative attitudes towards learning physics, these students are still trying to learn physics so that students understand the concepts that cause the results of learning physics to be satisfactory.

CONCLUSION AND SUGGESTION

According to the information in the results of the research and discussion can be concluded that overall the results of the four-tier multiple-choice diagnostic test for understanding the concepts of SMAN Batusangkar students showed that students' conceptual understanding was still low, so they experienced misconceptions about temperature and heat material, but were still in the moderate category. The analysis results obtained from the student attitude questionnaire are that students'

attitudes towards studying physics at SMAN Batusangkar are already good for all indicators. Overall, students' attitudes have shown a good attitude towards learning physics, with the highest attitude indicator on the social implications of physics and the lowest indicator on increasing interest in studying physics. Conceptual understanding and student attitudes towards studying physics at SMAN Batusangkar have enough relationship level, so there is a positive and significant correlation the link between conceptual understanding and student attitudes. This shows that students' understanding of concepts can be influenced by students' attitudes, causing unsatisfactory physics learning outcomes. If students' understanding of concepts is high, then students' attitudes towards learning physics will be good.

REFERENCES

[1] Amran, A., Ananda, A., & Khairani, S. (2018, April). Effectiveness of integrated science instructional material on pressure in daily life theme to improve digital age literacy of students. In *Journal of Physics: Conference Series* (Vol. 1006, No. 1, p. 012031). IOP Publishing.
[2] Mufit, F., Hanum, S. A., & Fadhilah, A. (2020, March). Preliminary research in the development of physics teaching materials that integrate new literacy and disaster literacy. In *Journal of Physics: Conference Series* (Vol. 1481, No. 1, p. 012041). IOP Publishing.
[3] Mahpudin, A., & Puadi, E. F. W. (2018). Rancang bangun augmented reality (AR) Berbasis android untuk pengembangan media pembelajaran fisika. In *Prosiding Seminar Nasional & Internasional* (Vol. 1, No. 1).
[4] Kurniawan, D. A., Perdana, R., & Kurniawan, W. (2019). Identification attitudes of learners on physics subjects. *Journal of Educational Science and Technology (EST)*, *5*(1), 56-63.
[5] Agunbiade, E., Ngcoza, K., Jawahar, K., & Sewry, J. (2017). An exploratory study of the relationship between learners' attitudes towards learning science and characteristics of an afterschool science club. *African Journal of Research in Mathematics, Science and Technology Education*, *21*(3), 271-281.
[6] Mushinzimana, X., & de la Croix Sinaruguliye, J. (2016). Attitude of physics students towards Physics at College of Science and Technology–University of Rwanda. *Rwandan Journal of Education*, *3*(2), 1-10.
[7] Mufit, F. (2016). A study about understanding the concept of force and attitude towards learning physics on first-year students in the course of general physics; as preliminary investigation in development research.
[8] Puspitasari, R., & Mufit, F. (2021, April). Conditions of learning physics and students' understanding of the concept of motion during the covid-19 pandemic. In *Journal of Physics: Conference Series* (Vol. 1876, No. 1, p. 012045). IOP Publishing.
[9] Astalini, A., Kurniawan, D. A., & Sumaryanti, S. (2018). Sikap siswa terhadap pelajaran fisika di sman kabupaten Batanghari. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, *3*(2), 59-64.
[10] Capriconia, J., & Mufit, F. (2022). Analysis of concept understanding and students' attitudes towards learning physics in material of straight motion. *Jurnal Penelitian Pendidikan IPA*, *8*(3), 1453-1461.
[11] Fariyani, Q., & Rusilowati, A. (2015). Pengembangan four-tier diagnostic test untuk mengungkap miskonsepsi fisika siswa sma kelas x. *Journal of Innovative Science Education*, *4*(2).
[12] Suwarna, I. P. (2013). Analisis miskonsepsi siswa SMA Kelas X pada mata pelajaran Fisika melalui CRI (Certainty of Response Index) termodifikasi. *Jurnal Laporan Lemlit. UIN Syarif Hidayatullah Jakarta*.
[13] Sugiyono. (2012). *Metode Penelitian Pendidikan (Pendekatan Kuantitatif, Kualitatif, Dan R&D)*. Alfabeta.
[14] Riduwan. (2012). *Metode & Teknik Menyusun Proposal Penelitian*. Alfabeta.
[15] Fauziah, S., Mufit, F., Afrizon, R., & Hidayat, Z. (2021). Analysis of Concepts Understanding and Students' Attitudes Towards Learning Physics In Parabolic Motion At SMAN Kota Pariaman. *Pillar Of Physics Education*, *14*(3), 177-186.
[16] Pratama, V., Anggraini, S. F., Yusri, H., & Mufit, F. (2021). Disain dan validitas e-modul

interaktif berbasis konflik kognitif untuk remediasi miskonsepsi siswa pada konsep gaya. *Jurnal Eksakta Pendidikan (Jep)*, *5*(1), 68-76.
[17] Luthfi, I., Mufit, F., & Putri, M. R. N. (2021). Design of Physical Teaching Materials Based on Cognitive Conflict Learning in Direct Current Electricity Integrating Virtual Laboratory. *Pillar of Physics Education*, *14*(1), 37-46.
[18] Fadhilah, A., Mufit, F., & Asrizal, A. (2020). Analisis validitas dan praktikalitas lembar kerja siswa berbasis konflik kognitif pada materi gerak lurus dan gerak parabola. *Pillar of Physics Education*, *13*(1).
[19] Dirman, H. M., Mufit, F., & Festiyed, F. (2022). Review and comparison of four-tier multiple choice and five-tier multiple choice diagnostic tests to identify mastery of physics concepts. *Jurnal Penelitian Pendidikan IPA*, *8*(1), 1-12.
[20] Rosdianto, H. (2017). Students' Conceptual Understanding through Generative Learning Model in Topic "Light"'.*Jurnal Pendidikan Indonesia*, *6*(2), 259-262.
[21] Kaniawati, I. (2017). Pengaruh simulasi komputer terhadap peningkatan penguasaan konsep impuls-momentum siswa SMA. *Jurnal Pembelajaran Sains*, *1*(1), 24-26.
[22] Zainal, A. (2012). *Evaluasi Pembelajaran Prinsip, Teknik, Prosedur*. PT. Remaja Rosdakarya.
[23] Rizkita, N. I., & Mufit, F. (2022). Analisis Pemahaman Konsep dan Sikap Siswa Terhadap Belajar Fisika Pada Materi Hukum Newton Tentang Gerak. *Jurnal Eksakta Pendidikan (Jep)*, *6*(2), 233-242.