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Mastery of Student Concepts in Physics Learning: Analysis of student learning outcomes based on teacher treatment after using the Discovery Learning Model

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Abstrak

Penelitian ini bertujuan untuk mengetahui pengaruh model pembelajaran *discovery learning* terhadap penguasaan konsep materi suhu dan kalor. Penelitian ini menggunakan jenis penelitian kuantitatif dengan desain quasi eksperimen menggunakan *Posttest Only Control Group Design.* Populasi dari penelitian ini adalah kelas X tahun ajaran 2023/2024 di SMK Negeri 09 Muaro Jambi. Pengambilan sampel menggunakan teknik *purposive sampling* sehingga didapat 2 kelas yaitu kelas eksperimen yang berjumlah 18 siswa dan kelas kontrol yang berjumlah 18 siswa. Kedua kelas diberi soal tes berupa *posttest* berbentuk pilihan ganda yang berjumlah 5 butir soal. Berdasarkan tes dan analisis data diperoleh nilai rata-rata pada kelas eksperimen sebesar 70,00 dengan standar deviasi 19,70 dan nilai rata-rata kelas kontrol sebesar 58,89 dengan standar deviasi 24,22. Dari hasil diatas diperoleh bahwa penguasaan konsep yang menggunakan model *discovery learning* lebih baik dari pada penguasaan konsep tanpa menggunakan model pembelajaran. Dapat disimpulkan bahwa model pembelajaran *discovery learning* berpengaruh terhadap penguasaan konsep siswa pada materi suhu dan kalor. Hal ini disebabkan karena pembelajaran dengan menggunakan model pembelajaran *discovery learning* dapat meningkatkan keaktifan siswa dalam belajar khususnya materi suhu dan kalor.

Kata Kunci: *discovery learning, penguasaan konsep, suhu dan kalor*

Abstract

This research aims to determine the effect of the discovery learning model on mastery of the concept of temperature and heat material. This research uses a quantitative type of research with a quasi-experimental design using Posttest Only Control Group Design. The population of this research is class X for the 2023/2024 academic year at SMK Negeri 09 Muaro Jambi. Sampling used a purposive sampling technique to obtain 2 classes, namely the experimental class with 18 students and the control class with 18 students. Both classes were given test questions in the form of a multiple choice posttest consisting of 5 questions. Based on tests and data analysis, the average score for the experimental class was 70.00 with a standard deviation of 19.70 and the average score for the control class was 58.00 with a standard deviation of 24.22. From the results above, it is found that mastery of concepts using the discovery learning model is better than mastery of concepts without using a learning model. It can be concluded that the discovery learning model influences students' mastery of concepts in temperature and heat material. This is because learning using the discovery learning model can increase students' activeness in learning, especially temperature and heat material.

Keywords*: discovery learning, mastery of concepts, temperature and heat*

Introduction

Physics is a subject taught at the Senior High School (SMA) level. Physics is a subject that studies natural phenomena accompanied by mathematical experiments and measurements (Krause et al., 2020). In school, physics is the subject most avoided and feared by students because it requires a high level of understanding to learn it (Meiliani et al., 2021; Putra et al., 2021; Reyza et al., 2022). Students' fear of physics subjects is caused by the material of physics subjects itself (Rozal et al., 2021; Sulman, 2012, 2019; Sulman, Sutopo, et al., 2021). Many students think that some of the material in physics subjects contains many formulas that are difficult to understand and questions that are difficult to solve (Sulman et al., 2020; Sulman, Tanti, et al., 2021; Sulman, Yuliati, Kusairi, et al., 2022). Students also think that physics has complex problems that are difficult to solve. So physics is avoided more than other subjects (Drozd, 2010). Students avoid physics subjects because many think this subject is very difficult to understand and digest. So that students' motivation to study physics decreases. Motivation has a very important role in increasing student curiosity and learning outcomes (Zakwandi et al., 2022; Zandvakili et al., 2019; Zeidler & Nichols, 2009; Zhang & Zhang, 2018; Zhao et al., 2021).

Physics material that is still considered difficult by some students is temperature and heat. Temperature and heat are materials that have abstract concepts but real events (Ornek et al., 2008). The most common mistake students make in studying physics when studying temperature and heat material is the frequent occurrence of misconceptions. Misconceptions occur because in the material of temperature and heat there are many concepts that are difficult to understand so that students experience misconceptions. Misconceptions are errors in interpreting and connecting one concept with other concepts (De Berg, 2008). Misconceptions or conceptual errors that often occur in studying temperature and heat material include students having difficulty distinguishing between temperature and heat. This misconception or conceptual error is one of the factors causing students' low mastery of concepts (Zeidler & Nichols, 2009).

Low mastery of concepts can be caused by teachers still focusing students on memorizing formulas and concepts only but not understanding the concepts being studied (Sulman, Yuliati, Purnama, et al., 2022; Zb et al., 2020; Zb, Novalian, Ananda, et al., 2021; Zb, Novalian, Rozal, et al., 2021). Temperature and heat material is material that must be studied by understanding the concepts, not just memorizing them (Docktor & Mestre, 2014). Low mastery of concepts is also caused by teachers still using learning models that are not appropriate to the material being studied. In the learning process, learning only focuses on the teacher (teacher centered) not on the students (Thomaz et al., 1995). Mastery of concepts should be the most important factor in improving student learning outcomes (Meiliani et al., 2021; Sulman, Yuliati, Kusairi, et al., 2022; Zb, Setiawan, Rozal, et al., 2021). Students who have good concept mastery will also have good learning outcomes (Chu et al., 2012). However, learning like this cannot improve students' mastery of concepts. Mastery of concepts can be improved by innovating learning models that can improve students' critical thinking abilities (Reyza et al., 2022; Sulman, Yuliati, Kusairi, et al., 2022; Sulman, Yuliati, Purnama, et al., 2022). One learning model that can be used is the discovery learning model.

The discovery learning model is a learning model that can improve students' mastery of concepts. Many researchers use the discovery learning model to improve students' mastery of concepts and ability to solve problems (Darling-Hammond et al., 2020). This learning model supports students to discover various concepts through observation and experimentation in order to build students' scientific attitudes (Misbah et al., 2022; Nehru

et al., 2022; Yusuf et al., 2022; Zakwandi et al., 2022). The discovery learning model requires students to discover their own knowledge through searching, discussion and trying activities (Acuña et al., 1995). The use of the discovery learning model requires students to be more active in seeking and investigating knowledge (Chusni et al., 2020; Nurulhidayah et al., 2020) so that the knowledge gained is more meaningful and long-lasting (Sit et al., 2020; Vuztasari et al. ., 2023). This discovery learning learning model is supported by several studies which say that this model is good to apply because it has a positive influence on students' critical thinking abilities (Sit et al., 2020). Students who have good critical thinking skills will also have good control of concepts (Chu et al., 2012).

This learning model is expected to improve students' mastery of concepts and learning outcomes (Reyza et al., 2022; Sulman et al., 2023; Sulman, Yuliati, Kusairi, et al., 2022). In accordance with several studies that have been conducted which say that the discovery learning model has an effect on students' mastery of concepts as evidenced by the increase in the average score of students who use the discovery learning model compared to students who use conventional learning models (Sit et al., 2020) . Based on the explanation above, researchers are interested in conducting research on the Influence of the Discovery Learning Model on Mastery of the Material Concepts of Temperature and Heat.

Method

This research was carried out at SMK Negeri 09 Muaro Jambi. The subject of this research is class X for the 2023/2024 academic year. This research aims to see the influence of the learning model on students' mastery of concepts in temperature and heat material. This research uses a type of research in the form of quantitative research. The design used in this research is a quasi-experimental research design. A quasi-experimental research design is a research design used to look for the effect of treatment on others under controlled conditions (Creswell, 2012). The quasi-experimental research design used was Posttest Only Control Group Design. This posttest will be given to students to see students' mastery of concepts in temperature and heat material. This research used 2 class groups, consisting of a control class group and an experimental class group. The control class was not given any treatment and the experimental class was given treatment (X) using the discovery learning model. This research was conducted to determine the effect of a treatment on students' mastery of concepts in the control class and experimental class. For more details, see Table 1 below:

Table 1. Research Design

Group	Treatment (X)	*Posttest*
R_1	X	Q_1
R_2		Q_2

Information:
R_1 : Experimental class
R_2 : Control class
X : The treatment uses discovery learning
Q_1 : Experimental class posttest results
Q_2 : Control class posttest results

This research has 2 variables, namely the independent variable and the dependent variable. The independent variable in this research is the discovery learning model and the dependent variable is concept mastery. The population of this study was class 10 at SMK Negeri 09 Muaro Jambi. Sampling in this study used a purposive sampling technique because the data obtained was normally distributed and homogeneous. There was one class as a control class without treatment with a total of 18 students and one experimental class given a treatment (X) using the discovery learning model with a total of 21 students.

The instrument used to collect data in this research is a posttest in the form of

multiple choice questions to measure mastery of the concept of temperature and heat material with a total of 5 questions. This test was given to the control class without treatment and the experimental class which was given treatment using the discovery learning model, then the results data will be compared to get the results whether there is an influence of the discovery learning model on mastery of the concepts of temperature and heat. Data taken from the control class and experimental class are in the form of final scores (posttest) for mastery of the concepts of temperature and heat. From the analyzed data, values will be obtained in the form of an average concept mastery value, maximum value, minimum value and standard deviation value which are used to see students' concept mastery in temperature and heat material.

Results and Discussion

Students' mastery of concepts is measured using a posttest using multiple choice questions consisting of 5 questions. This test is carried out to see the effect of a treatment. Which is divided into 2 class groups, namely the control class without treatment and the experimental class which is given treatment, namely using the discovery learning learning model. The results obtained from the test regarding students' mastery of concepts showed that the average mastery of students' concepts in temperature and heat material in the experimental class was with an average score of 70.00 and the control class had an average score of 58.89. For the maximum score in the experimental class, the score was 100 and the control class was 80 and for the minimum score in the experimental class, the score was 40 and the control class was 20. The standard deviation in the experimental class was 20.00 and the control class was 24.22. . These results indicate that students' mastery of the concept of temperature and heat material in the experimental class is different from students' mastery of the concept of temperature and heat material in the control class. For more clarity, see Table 2 below:

Table 2. Description of Concept Mastery Value Analysis Results

Experimental Class	Average value	70,00
	Maximum value	100
	Minimum Value	40
	Standar deviasi	19,70
Control Class	Average value	58,89
	Maximum value	80
	Minimum Value	20
	Standar deviasi	24,22

In accordance with Table 2 above, it shows that the experimental class and control class mastery of concepts have different concept mastery from the control class with a difference in average value of 6.11. So that students' mastery of concepts regarding temperature and heat in the experimental class is higher than students' mastery of concepts in the control class. It is proven that the discovery learning model has a positive effect on students' mastery of concepts in temperature and heat material.

In this study, prerequisite tests were used, namely the normality test. The normality test is used to determine whether the data is normally distributed or not. The t-test was used to determine the significant difference between the posttest scores of the experimental class which were given treatment using the discovery learning model and the posttest scores of the control class which were not given any treatment.

The normality test is used to determine the distribution of data. The normality test is very important to use because we can see whether the data that occurs at the beginning before a treatment is carried out is in a normal distribution, or whether the data to be observed does not have a large enough gap between one individual and another, so that the data drawn later can be used. generalized into a conclusion, so that normality analysis will show whether the data is normally

distributed or not. Good data is data that has a normal distribution. The normality test used in both class groups, namely the experimental class and the control class, uses the Kolmogrov Smirnov test with a significance level of 0.05. Normally distributed data has a significance value > 0.05. The normality test was carried out using software in the form of the SPSS application. For more details, see Table 3 below.

Table 3. Normality Test Results

	Kolmogorov-Smirnov[3]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Experimental Class	.194	18	0.071	.893	18	.043
Control Class	.197	18	0.063	.901	18	.060

From Table 3 above, the results show that the significance value in the experimental class is 0.071 and the significance value is 0.071>0.05, so the data is normally distributed. And for the control class, the significance value was 0.063 and the significance value was 0.063>0.05, so the data was normally distributed. It can be concluded that the experimental class and control class have normally distributed data.

In the learning process, teachers often use learning models that make students less active in learning. Teachers should use learning models that are able to encourage students to be more active in learning so that learning can run more effectively (Sit et al., 2020; Acuña et al., 1995). One of the learning models that can encourage students to be more active is the discovery learning model. Discovery learning is a learning model that guides students to discover their own knowledge through searching, discussion and trying activities so that students become more active in learning (Sit et al., 2020). This learning model is used to measure students' mastery of concepts in temperature and heat material. To determine the effect of the discovery learning model on students' mastery of concepts in temperature and heat material, they were given a test in the form of a multiple choice posttest with a total of 5 questions. This question was given to 2 class groups, namely the control class without any treatment and the experimental class which was given treatment using the discovery learning model. After being given a test in the form of a posttest in the form of multiple choices, data analysis was then carried out. Multiple choice questions are questions that researchers consider capable of providing varied answers so that students are truly able to master the learning outcomes or the most correct answers according to their understanding of the concepts (Amelia & Amelia, 2023; Firman & Efendi, 2023; Hidayati et al., 2023; Imawan et al., 2023). Basically, good test questions are able to provide a definite picture of what is being observed and is being done, so that they are truly able to analyze students' abilities according to the indicators being reviewed.

Students' mastery of concepts in temperature and heat material can be seen from the results of the answers to the posttest data. The average value, maximum value, minimum value and standard deviation of the experimental class and control class were obtained. The test results can be seen in Table 2 above so that the average score for students' mastery of concepts in temperature and heat material in the experimental class is 70.00 with a standard deviation of 19.70. Meanwhile, the average score for students' mastery of concepts in temperature and heat material in the control class was 58.89 with a standard deviation of 24.22. This shows the difference in the average value of students' concept mastery in temperature and heat material between the experimental class and the control class, where students' concept mastery in temperature and heat material in the experimental class using the discovery learning

learning model is higher than students' concept mastery in temperature and heat material. in the control class who were not given any treatment. For the maximum score obtained by students from the experimental class and control class, it can be seen again in Table 2 that the maximum score for students in the experimental class was 100 and the maximum score for students in the control class was 80. This shows that the maximum score for students in the class that was treated using the model Discovery learning, namely the experimental class, experienced an increase compared to the maximum score of students without treatment, namely the control class. Students' activeness in understanding learning material can increase students' interest in learning (Adha et al., 2023; Maya et al., 2023; Rusli et al., 2023; Sofna et al., 2023). Interest in learning will be the key to students' success in providing better and maximum learning results, this is because students' interest in learning will provide more encouragement to students, especially in learning and understanding knowledge so that students are encouraged to find out the truth from the knowledge information. given by the teacher.

The minimum score obtained by students can be seen in Table 2. The minimum score obtained by students in the experimental class was 40 and the control class obtained a score of 20. The low scores obtained by students could be caused by several factors such as students still not being able to understand the concepts. in temperature and heat material, students also cannot connect one concept with another concept, and in the learning process teachers still use conventional learning models so that students are less active in learning, so this causes students to get low grades. To improve students' low scores, teachers need to use learning models that are able to make students more active in the learning process (Sit et al., 2020). Active learning can also increase students' interest in learning to be better and more focused (Masalesi, 2022; Misbah et al., 2022; Nehru et al., 2022; Ramadhani & Nurita, 2022). Using learning models properly and regularly can produce better and more meaningful learning results. (Pramita & Putri, 2023; Roshita et al., 2023; Sapitri & Indriyati, 2023)

The learning model that is able to make students more active is the Discovery learning model. The Discovery Learning learning model has many advantages apart from making students more active in learning. This model is also able to make students understand concepts more quickly independently. students' abilities by using the discovery learning model will make students enthusiastic in understanding the material more deeply, students will try to connect theory with the reality that occurs in the field, which then during the lecture process students will become motivated and have more enthusiasm so that their learning outcomes will be better and maximum. Student abilities that are influenced by this learning model, apart from learning outcomes, are students' interest and motivation to learn, where students will be enthusiastic and more enthusiastic in the learning process, so that students' abilities will indirectly improve better. It cannot be denied that if the teacher has used an appropriate learning model, it will make the learning process run well and effectively so that the learning goals expected by the teacher can be achieved optimally.

This learning model is a learning model that involves students' mentality to discover knowledge by conducting observations, experiments and literature reviews (Sit et al., 2020; Acuña et al., 1995). From the results of the research above, the researcher conducted research on 2 classes, namely the experimental class and the control class. Where the experimental class is the class that is given treatment using the discovery learning model and the control class is given no treatment. The results of the research obtained data on the average value of concept mastery of students in the experimental class and control

class, where the average value of the experimental class was higher than the average value of the control class. It is proven that the discovery learning model has a great influence on students' mastery of concepts. By using this learning model students become more active in seeking and discovering their own knowledge. Learning is not only centered on the teacher but is more focused on the students. Student-focused learning can make students have better understanding and quality.

Conculusion

Based on the research results above, it can be concluded that the discovery learning model influences students' mastery of concepts in temperature and heat material. This is evidenced by the higher average value of students' concept mastery in the experimental class which was given treatment using the discovery learning learning model, namely 70.00 with a standard deviation of 19.70 compared to the control class which was not given treatment with an average value of 58.89 with a standard deviation of 24.22. By using the discovery learning model, students are more active in learning and are able to increase students' mastery of concepts. The researcher also suggests to readers and researchers in the future to be more careful about the research instruments used and also the analysis of students' characters so that the research is more focused. The researcher also suggests to readers and researchers in the future to be more careful about the research instruments used and also the analysis of students' characters so that the research is more focused. In the research that researchers have conducted there are several variables that are not observed but are very important, for example the detailed process of implementing the learning model, so that if the details of the use of the learning model can be known, it will be possible to carry out direct evaluation of the learning process that has been implemented, in other words, it is hoped that researchers in the future In the future, there will be more focus not only on learning outcomes but more on the process of implementing this discovery learning model.

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