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Research Paper

Effectiveness of Learning Devices Based on Conceptual Change Model to Improve Concept Mastery of Students in the Gas Kinetic Theory Material

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Abstract: This study aims to determine the effectiveness of learning devices based on conceptual change model to improve concept mastery of students in the gas kinetic theory material. The learning device was developed with a 4D model which includes the stages of define, design, develop, and disseminate. The tools developed are syllabus, lesson plans, student worksheets, and concept mastery test instruments. The research data was obtained from the results of a limited trial of 27 students of eleventh-grade MIPA 1 at SMAN 1 Kediri. The data analysis technique used in this research is data analysis using n-gain. Based on the results of the n-gain analysis, a score of 0.60 was obtained in the medium category for all students. The n-gain analysis of each student resulted in 18.51% of students experiencing a high level of concept mastery, 70.37% of students experiencing a moderate level of concept mastery, and 11.11% of students experiencing a level of mastery with low criteria. These results indicate that the learning devices based on the conceptual change model are effective to improve concept mastery of students in the gas kinetic theory material.

Keywords: Conceptual change model; Concept mastery; Learning devices.

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INTRODUCTION

Physics is a subject that can print the competencies needed by the times. This is because physics is a science to study the universe. Physics also aims to foster thinking skills that are useful for solving problems in everyday life (Aldi et al, 2022; Dewi et al, 2022). However, in reality, what happens in the learning process where some students often feel bored and have difficulty studying physics, so lessons tend to be ignored (Armiati et al, 2020). This is because the learning that takes place in schools is still very theoretical and does not apply the learning model that has been developed by many experts (Kartini et al, 2019; Yudiafarani et al, 2022). This is following the results of interviews and observations of researchers at SMAN 1 Kediri, learning is still not optimal. Students still view physics learning as only a collection of formulas that must be memorized so physics learning is considered difficult and less fun (Khasanah et al, 2019; Doyan et al, 2022). This makes students less able to understand the concept of physics (Muhaimin et al, 2015; Susilawati et al, 2022).

According to the Big Indonesian Dictionary, mastery is the understanding or ability to use knowledge, intelligence, and so on. While the concept is everything in the form of new meanings that can arise as a result of thinking, including definitions, understanding, special characteristics, nature, essence or content, and so on (Doyan et al, 2019; Turrahmah et al, 2019; Hajratun et al, 2022). So, mastery of concepts is the

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ability of students to understand the concepts of a learning material both in theory and its application in everyday life based on Bloom's cognitive aspects on aspects of knowledge, understanding, application, analysis, synthesis, and evaluation.

In the learning process, students are likely to be more likely to memorize the information obtained without trying to relate it to previously owned concepts (Nurmaya et al, 2021; Susilawati et al, 2021). Based on this opinion, it can be said that students tend to memorize more because the concepts received are not connected with the concepts they have previously (Hulwani et al, 2019; Hidayatin et al, 2022; Ichtiari et al, 2022). The tendency to memorize rather than understand causes learning to often result in misconceptions or misconceptions (Dewi et al, 2021; Hidayati et al, 2021; Susilawati et al, 2020).

A misconception is a condition in which a person has a conception of a concept that is different from the conception agreed upon by experts (Ibrahim et al, 2019). Based on the results of research conducted by Barawas et al (2020), many misconceptions are found in the Kinetic Theory of Gas material. This theory is a scientific theory of the properties of gases that explains the so-called macroscopic observable and measurable properties of gases. Macroscopic properties in terms of molecular composition and activity. In general, the kinetic theory of gases discusses the properties of ideal gases, ideal gas equations, pressure, and energy according to the kinetic gas theory, degrees of freedom, and the equipartition theorem (Haryadi, 2019).

Misconceptions that often occur in this material include students assuming that the number of molecules of a gas is proportional to the temperature of the gas, so that the higher the gas temperature, the more the number of gas molecules and vice versa. Students assume that internal energy is the total amount of kinetic energy of the molecules of a substance in a system, while thermal energy can be interpreted the same as bond energy. The terms that are known to students are not appropriate (experienced misconceptions) with existing scientific concepts. This misconception needs to be corrected so that it does not have an impact on understanding the materials that will be presented at the next meeting.

Improvements in the learning process can be done by choosing an appropriate learning model (Doyan et al, 2020; Gunawan et al, 2021; Harjono et al, 2021). One of the learning models that can help correct misconceptions is the conceptual change model. This model is a learning model that considers the prior knowledge that students have and how students relate this prior knowledge to new knowledge (Chi, 2010). The conceptual change model suggests creating dissatisfaction in the minds of students with alternative conceptions or what is called cognitive conflict followed by strengthening the status of scientific conceptions (Baser, 2016).

Based on these considerations, a conceptual change model learning device was developed to improve students' mastery of the kinetic theory of gas concepts. This is done with the hope that teachers can apply it during the Covid-19 quarantine period or when the Covid-19 pandemic ends.

METHOD

This study aims to determine the effectiveness of learning devices based on conceptual change model to improve concept mastery of students in the gas kinetic theory material. The learning tools were developed using a 4D model which includes the stages of defining, planning, developing, and disseminating (Sugiyono, 2017). The research data was obtained from the results of a limited trial of 27 students of class eleven MIPA 1 at SMAN 1 Kediri. The research data were in the form of pretest and posttest. Furthermore, the effectiveness of the learning device was obtained from the results of pretest and post-test analysis using the N-gain test consisting of three categories, namely low ($0.00<g<0.30$), medium ($0.30\leq g<0.70$), and high ($0.70\leq g\leq 1.00$), (Doyan et al, 2020).

$$\mathrm{N-gain} < g \geq = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}} \qquad (1)$$

Where S_{post}=Posttest score, S_{pre}=Pretest score, S_{max}=Maximum score. The students' n-gain values that have been obtained are then converted into percentages using excel. The results of the average n-gain scores that are converted into percentages are then categorized based on the interpretation of the effectiveness of n-gain as shown in table 1. The learning tools developed are effectively used to improve students' mastery of concepts if the minimum n-gain value in the interpretation is quite effective.

Table 1. Interpretation of the Effectiveness of N-Gain (Yuninda et al, 2021)

Percentage (%)	Interpretation
< 40	Ineffective
40-50	Less effective
56-75	Effective enough
>76	Effective

RESULT AND DISCUSSION

This study aims to determine the effectiveness of learning devices based on conceptual change model to improve concept mastery of students in the gas kinetic theory material. The resulting learning tools are syllabus, lesson plans, student worksheets, and concept mastery instruments on gas kinetic theory material. The learning tools developed were designed using a 4D model with four stages, namely the define, design, develop, and disseminate stages.

Learning tools that have been declared feasible are then tested on a limited basis to determine the level of effectiveness. The effectiveness of the learning tools referred to in this study is the increasing mastery of students' concepts after being taught using the kinetic gas theory learning material based on the conceptual change model. Increased mastery of students' concepts can be seen from the analysis of the data obtained after the trial. The increase in mastery of concepts was analyzed using the n-gain test. The results of the n-gain concept understanding test for all students are shown in Table 2.

Table 2. The Results of the Analysis of the Average Mastery of Concepts

Pre-Test	Post-Test	N-*Gain*	Percentage	Criteria	Category
22.50	70.61	0.60	60.73%	Medium	Effective enough

Based on the table, it can be seen that the results of the analysis of the average pre-test and post-test scores using the N-gain test obtained the average pre-test score of 22.50 and post-test of 70.61. From this value, it can be seen that there is an increase in students' conceptual mastery after being given learning treatment by using the conceptual change model. In addition, the average n-gain result is 0.60 with a percentage of 60.73% so it is included in the medium criteria. Thus, it can be said that the conceptual change model learning tool is quite effective in increasing students' mastery of concepts.

Meanwhile, for the analysis of each student, different levels of mastery of concepts were obtained. Some experience a high, or medium level of concept mastery and some have a low level as shown in Table 3.

Table 3. Results of Analysis of Concept Mastery Criteria Using N-gain

N-gain Score	Criteria	Number of Students	Percentage
$g > 0.70$	High	5	18.51%
$0.30 \leq g \leq 0.70$	Medium	19	70.37%
$g < 0.30$	Low	3	11.11 %

Based on Table 3, it can be seen that there are 18.51% of all students who experience a level of mastery of concepts with high criteria, 70.37% of all students who experience a level of mastery of concepts with moderate criteria, and 11.11% of all participants. students who experience a level of mastery with low criteria.

Based on the results of the analysis above, it can be seen that the learning devices based on conceptual change model are effective to improve the concept mastery of students in the gas kinetic theory material. This is because the conceptual change model is a learning model that facilitates students to change their conceptions, through the generation and restructuring of the concepts that were brought before learning. In addition, this model is based on real constructivism which is based on thinking skills (Pebrianti et al, 2015).

CONCLUSION

The learning devices based on conceptual change model to improve concept mastery of students in the gas kinetic theory material have been successfully developed. Based on the results of the n-gain analysis, a score of 0.60 was obtained with a moderate category for all students. The n-gain analysis of each student resulted in 18.51% of all students experiencing a high level of concept mastery, 70.37% of all students experiencing a moderate level of concept mastery, and 11.11% of overall students who experience the level of mastery with low criteria. These results indicate that the learning devices based on conceptual change model are effective to improve concept mastery of students in the gas kinetic theory material.

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