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Reducing the quantity of students who have misconceptions about archimedes' law material using the Children Learning in Science (CLIS) model

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Abstract

This research aims to determine the decrease in the quantity of students who have misconceptions about Archimedes' law material after the CLIS learning model has been implemented, determine student responses to the CLIS learning model that has been implemented, and determine the implementation of learning activities using the CLIS model. The research was carried out using quantitative methods. The population in this research was all students of class XI IPA MAN 1 Singkawang. The data in the research was obtained by giving sheets to the students. The instruments used were a TTT sheet consisting of 10 questions, a student response sheet with 9 questions, an observation sheet on the implementation of the CLIS learning model. Based on the results of the analysis of students' misconceptions, the highest decrease was in the concept "Objects sink in water because objects are heavier than water" namely 64.2% in the medium category. Student response to the CLIS learning model was 85% in the positive category. The implementation of the CLIS learning model is 100% with all activities carried out in the category. Therefore, it can be concluded that implementing CLIS can reduce the quantity of students who have misconceptions.

Keywords: CLIS; misconceptions; decreasing the quantity of students with misconceptions

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INTRODUCTION

Learning physics is essentially not a collection of facts and principles, but rather emphasizes students searching for, finding and analyzing the facts and principles obtained. Physics learning will be more effective if students are given direct experience to construct their own knowledge. In the 2013 curriculum, students are the ones who become more active, creative while the teacher is only a motivator and facilitator (Sumarli, 2018). Physics is studied at school to make it easier for students to be able to master and understand physics concepts or theories and develop abilities and skills (Murdani et al, 2018). Physics learning can train various skills that provide direct experience for students in constructing their own knowledge (Sumarli et al., 2018). The aim of learning physics as stated in the 2013 curriculum

framework is that students can master concepts and principles and have the skills to develop knowledge and self-confidence as a provision to continue their education at a higher level and develop science and technology (Kemendikbud, 2014). Based on these learning objectives, physics learning must be able to train students' abilities in mastering physics concepts and principles. Lack of mastery of concepts possessed by students and incomplete understanding received by students obtained from incorrect or incomplete information is one of the misconceptions (Suparno, 2013).

According to research by (Dewi et al., 2016), students still experience misconceptions about Archimedes' Law, especially to determine the states of floating, drifting and sinking. The biggest forms of misconceptions experienced by students include 1) Heavy objects will definitely sink 2) Hollow objects always float 3) Objects made of something hard will definitely sink 4) The amount of water affects the state of floating, floating and sinking. Apart from that, based on research by (A. Lestari, 2022), there were several student misconceptions regarding Archimedes' law material, more than 50% of students thought that type does not affect the weight of objects in the fluid and that the upward force is smaller than the weight of the ship so the ship floats.

Pre-research results also show that students still often experience misconceptions about the material of Archimedes' law. This is proven by the test results where students still experience many misconceptions in the material about buoyancy, namely 68.8%, while in the material about floating, floating and sinking objects, students' misconceptions are 75%. The number of students who have misconceptions is thought to be related to the learning process that occurs. This can be seen during learning, most students do not pay attention to the material explained by the teacher but are busy with themselves, sleeping around and chatting with their classmates. When the teacher asked the students just kept quiet. This clearly illustrates that students are not active in learning. The learning that occurs is also more centered on the teacher. The teacher only explains the material, gives practice questions, assignments, and during learning never does practical work. Learning like this clearly makes students only learn by rote, which over time the memorization process will fade if it is not memorized again so that students often experience misconceptions.

This shows that learning concepts is not memorizing concepts but is a process of connecting initial concepts with new concepts so that the desired final concept is obtained (P. A. S. Lestari et al., 2015). According to(Suparno, 2005), in general the steps that can be taken to overcome misconceptions are: 1) Revealing student misconceptions, 2) finding the causes of misconceptions, 3) finding appropriate solutions to overcome these misconceptions.

In this research, researchers chose the third step to overcome misconceptions. In this research, researchers used the Children Learning in Science (CLIS) learning model. The CLIS learning model is a learning model that seeks to develop students' ideas or concepts about a particular problem in learning and reconstruct it based on the results of observations or experiments (Rahayu, 2015). The CLIS learning model can reduce the number of students who have misconceptions (Fitria, 2022). This research aims to determine the decrease in the quantity of students who have misconceptions about Archimedes' law material after the CLIS learning model has been implemented, determine student responses to the CLIS learning model that has been implemented, and determine the implementation of learning activities using the CLIS model.

METHODS

The research was conducted using quantitative methods. The research design used One-Group Pretest Posttest Design, namely a research design that has three stages, namely pretest, treatment and posttest. The population in this study were 30 students of class XI IPA MAN 1 Singkawang. This research uses a purposive sampling technique. In this study, the instrument used was a TTT sheet on Archimedes' Law for class chosen to find out students who experience misconceptions and students who have scientific concepts. student response sheets to the CLIS model and observation sheets on the implementation of the CLIS learning model.

Determining the reduction in the quantity of students with misconceptions uses the formula for reducing the quantity of misconceptions adopted from the normalized gain developed by Kurniawan (2016).

$$DQM = \frac{\%Pretest - \%posttest}{\%Pretest - \%ideal} \times 100 \quad (1)$$

Table 1. Categories for Reducing Misconceptions

Mark	Category
70 < DQM ≤ 100	High
30 < DQM ≤ 70	Medium
0 < DQM ≤ 30	Low

To calculate the percentage of implementation of the learning model, you can use the equation from (Hermansyah, 2014).

$$PKM = \frac{Number\ of\ activities\ carried\ out}{Total\ number\ of\ activities} \times 100\% \quad (2)$$

Table 2. Categories of learning feasibility

Mark	Category
100	All activities were carried out
76< KM < 100	Almost all activities were carried out
51 < KM ≤ 75	Most of the activities were carried out
KM = 50	Half of the activities have been carried out
26 < KM < 50	Almost half of the activities have been carried out
0 < KM ≤ 25	A small number of activities were carried out
KM = 0	Not a single activity was carried out

The calculation for the percentage of student responses can be seen in the equation

$$T = \frac{J}{N} x\ 100\% \quad (3)$$

Table 3. Categories of Student Response Percentages

Category Percentage	Category
66%<T≤100%	Positive
33%<T≤66%	Neutral
0%≤T≤33%	Negative

RESULTS AND DISCUSSION

Research Result

Implementation Research

This research was carried out on 18 July - 25 July 2019 at one of the State High Schools in the city of Singkawang. The pretest was carried out on July 18 2019 and the posttest was carried out on July 25 2019.

The implementation of the Children Learning in Science (CLIS) learning model was carried out in 2 meetings (4 x 40 minutes). Learning activities are carried out in the classroom with researchers acting as teachers. Before the CLIS learning model was implemented, the research sample was given a pretest to determine the quantity of students who had misconceptions about Archimedes' law using the Three Tier-Test (TTT) which consisted of 10 questions.

The learning stages in this research consist of five stages, namely the orientation stage, at this stage the teacher motivates students by showing video demonstrations. The second stage is generating students' ideas based on the questions in the LKS. The third stage is the stage of reorganizing ideas, at this stage students are divided into small groups, students exchange ideas and look for scientific concepts from the material studied in books or other relevant sources. Students are then given the opportunity to carry out experiments according to the video demonstration that has been shown. The fourth stage is the application of ideas, students are asked to answer the questions on the worksheet in accordance with scientific concepts that have been developed through experiments. The fifth stage is strengthening ideas, namely the concepts that students have acquired are given feedback by the teacher to strengthen their scientific concepts, so that it is hoped that students whose concepts are not scientific will become aware and change their concepts into scientific concepts.

To determine the decrease in the quantity of students who have misconceptions about Archimedes' law, a posttest was carried out, namely by giving questions in the form of a Three Tier-Test (TTT) and were the same as the questions given during the pretest. Analysis of posttest and pretest results focused on reducing the quantity of students who had misconceptions about each concept.

Data Description

To facilitate analysis and discussion of research results, the distribution of misconceptions and scientific conceptions in each question about Archimedes' law is given a concept number to represent the scientific conception of that concept, so that it can be discussed according to the concept number that has been determined as in Table 4.

Table 4. Distribution of Misconceptions and Scientific Concepts in Questions

Concept Number	Questions	Misconceptions	Scientific Concepts
1	1 and 7	The weight of an object in water and in air is the same	The weight of objects in air and in water is different. It is lighter in water because there is a lifting force acting on the object
2	2, 6 and 8	A sinking object has a density less than the density of water, and an object floats if the density of water is less than the density of the object	A sinking object has a density greater than the density of water, and an object floats if the density of water is greater than the density of the object

Concept Number	Questions	Misconceptions	Scientific Concepts
3	3 and 5	Increasing the volume of water will cause sinking objects to float	Objects sink because the density of the object is greater than the density of water and a sinking object cannot float if the outer cross-section of the object is not enlarged
4	4	Reducing the volume of water will cause floating objects to sink	Objects float because the density of the object is less than the density of water and floating objects will remain floating if no weight is added to them.
5	9	Objects sink in water because objects are heavier than water	Objects sink in water because the density of the object is greater than the density of water
6	10	Shocks cause floating objects to sink	Floating objects will remain floating if no weight is added to them

The results of the analysis of students' answers during the pretest and posttest used Three Tier-Test analysis. Students are grouped into several categories, including Scientific Concepts (SC), Misconceptions (M), Lucky Guesses (LG), Guesses (G), Lack of Knowledge (LOK). Percentage of TTT analysis results during pretest and posttest as in Table 5.

Table 5. Percentage of TTT Analysis

Decision TTT	Questions	Number Concepts					
		1	2	3	4	5	6
Scientific Concepts (SC)	Pre Test	36,7%	33,3%	21.7%	20%	30%	3,3%
	Post Test	56,7%	56,6%	46,7%	50%	50%	43,3%
Misconceptions (M)	Pre Test	56,7%	38%	53,3%	50%	46,7%	70%
	Post Test	28,3%	39%	36,7%	23%	16,7%	46,7%
Lucky Guess (LG)	Pre Test	6,7%	10%	8,3%	16,7%	0%	6,7%
	Post Test	3,3%	4,4%	8,3%	10%	0%	3,3%
Guess (G)	Pre Test	10%	8,9%	8,3%	6,7%	10%	3.3%
	Post Test	10%	6,7%	3,3%	13,3%	3,3%	0%
Lack Of Knowledge (LOK)	Pre Test	8,3%	8,9%	8,3%	6,7%	13,3%	16,7%
	Post Test	1,7%	3,3%	5%	3.3%	0%	6,7%

Based on the data in Table 5, the percentage of students who experienced misconceptions during the pretest and posttest decreased in five concept numbers, namely concept numbers 1, 3, 4, 5 and 6, but there was an increase in one concept number, namely concept 2.

Analysis of Decreasing the Quantity of Students with Misconceptions (DQM)

After the students' pretest and posttest results are analyzed using TTT analysis, the decrease in the quantity of students who have misconceptions about each concept can be analyzed. Analysis data on the decrease in the quantity of students with misconceptions is shown in Table 6.

Table 6. Analysis DQM

Concept Number	Percentage Of Misconceptions		DQM	Category
	Pretest	*Posttest*		
1	56,7%	28,3%	50%	Medium

Concept Number	Percentage Of Misconceptions		DQM	Category
	Pretest	*Posttest*		
2	38%	39%	-2,64%	Low
3	53,3%	36,7%	31,1%	Medium
4	50%	23%	54%	Medium
5	46,7%	16,7%	64,2%	Medium
6	70%	46,7%	33,2%	Medium

Based on the data in Table 6, the quantity of students with misconceptions decreased in the moderate category for concept numbers 1, 3, 4, 5, and 6 and increased for concept number 2.

Analysis of Student Responses

Student response sheets were given to students with the aim of knowing student responses to the application of the CLIS learning model to Archimedes' law material. Student responses were given to 30 students after implementing learning using the CLIS learning model by giving a mark (√) in the agree or disagree column for each statement. A recapitulation of student response test results is shown in Table 7.

Table 7. Recapitulation Results of Student Responses

No	Aspect	Response Percentage Student (%)	
		Agree	Disagree
1	CLIS		
	- CLIS learning is different from usual	96,7	3,3
	- Interest in CLIS learning	90	10
	- Interest in animation	80	20
2	Ability to predict problems		
	- Can predict problems	83,3	16,7
	- No difficulty when predicting	83,3	16,7
3	Problems in learning		
	- Predictions do not match the results Observation	86,7	13,3
	- Difficulty in explaining	70	30
4	Conceptual change		
	- Can improve predictions	93,3	6,67
	- Feel more confident improving predictions	83,3	16,7
	Average	85	

Table 7 shows that 96.7% of students stated that this learning was different from previous learning. There were 90% of students who stated they were interested in the learning model applied. As many as 80% of students stated they were interested in the animation displayed. There were 83.3% of students who felt more confident in improving their predictions after seeing the animation and students felt they had no difficulty in explaining predictions and observations and students could predict the answers to problems given by the teacher that were the same as students' understanding. As many as 86.7% of students felt that their predictions were not the same as observations. There are 70% of students who have difficulty predicting the answer to the problem the teacher gives. As many as 93.3% of students

were able to improve their predictions after making observations. The average of the student response analysis was 85% in the positive category.

Results of Learning Model Implementation Analysis

The implementation of the CLIS learning model is carried out by observers who observe learning activities using the CLIS learning model during the initial treatment process until the final treatment. The implementation of learning activities carried out by teachers and students can be seen in Table 8.

Table 8. Keterlaksanaan Model Pembelajaran CLIS

Meeting	Teacher Activities		Student Activities	
	Percentage (%)	Category	Percentage (%)	Category
1	100	All activities were carried out	100%	All activities were carried out
2	100	All activities were carried out	100%	All activities were carried out

Based on data on the implementation of the CLIS learning model in Table 8, learning activities using the CLIS model carried out at meetings 1 and 2 have all activities implemented in the category.

Discussion

Decrease in the quantity of students who have misconceptions

The results of the TTT analysis showed that there was a decrease in the quantity of students who had misconceptions about concepts number 1, 3, 4, 5, and 6 in the medium category. As an example of the scientific conception in concept 1, according to this concept, the weight of objects in water and in air is different because in water objects experience a lifting force so that the weight of objects in water seems to decrease. According to students' misconceptions, based on students' answers, it is stated that the weight of objects in air and in water is the same because the gravitational force of objects in water and in air is the same so the weight of objects is the same. This happens because students are not yet familiar with the learning being applied. Students' unfamiliarity with this learning can be seen from the results of students stating that CLIS learning is different from usual learning.

According to(Hikmat et al., 2014), a decrease in the quantity of misconceptions indicates a change from wrong conceptions to correct conceptions that are in accordance with the conceptions of experts or scientists. This change in conception cannot be separated from the effective role of experimentation. The teacher's goal in conducting experiments is so that students who do not understand the concept and are only guessing will be able to get the actual concept through experiments so that students can change their initial, incorrect concept into a scientific concept. Learning related to misconceptions should be learning that can cause cognitive conflict. At this stage the teacher gives guiding questions which can cause cognitive conflict in students, so that students who initially have misconceptions can change their initial concepts to be in accordance with scientific concepts, while students who initially have scientific concepts will maintain their initial concepts. The stage of the CLIS model that can show students' conceptual changes is the Rearrangement of Ideas stage, where students are asked to look for scientific concepts from the material that has been shown through video demonstrations. These results were confirmed by (Fitria, 2022), that there were differences before and after the implementation of the Children Learning in Science (CLIS) learning model on students' Physics learning outcomes. Learning outcomes using the Children Learning in Science (CLIS) learning model are higher than previous methods/models by being able to increase students' completeness or learning outcomes. This increase proves that learning using the Children Learning in Science (CLIS) learning model can improve student learning achievement

In concept number 2, the percentage of students with misconceptions increased. The scientific concept in concept number 2 is that an object sinks if the density of the object is greater than the density of water, and an object floats if the density of water is less than the density of the object. So density affects objects that float, float and sink. According to students' misconceptions, it can be seen from the students' answers which state that objects sink because the density of the object is smaller than the density of water and if the density of the object is greater then the object will float.

Excerpts of students' answers with misconceptions about concept number 2 can be seen in Figures 1 and 2.

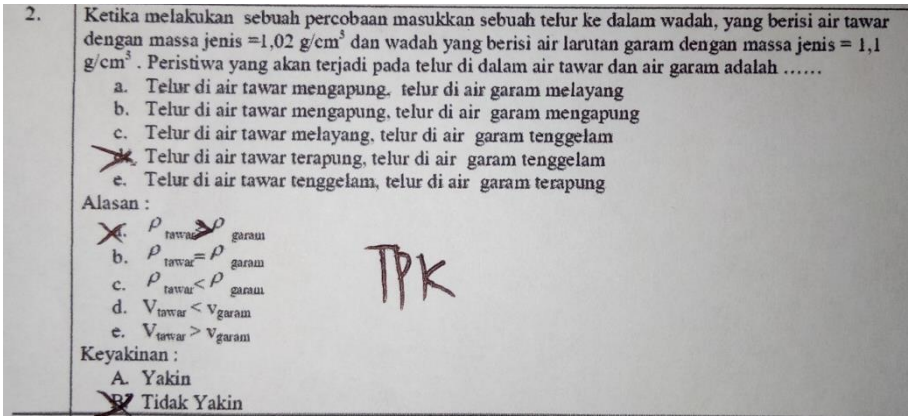
2. Ketika melakukan sebuah percobaan masukkan sebuah telur ke dalam wadah, yang berisi air tawar dengan massa jenis =1,02 g/cm³ dan wadah yang berisi air larutan garam dengan massa jenis = 1,1 g/cm³ . Peristiwa yang akan terjadi pada telur di dalam air tawar dan air garam adalah .....
a. Telur di air tawar mengapung, telur di air garam melayang
b. Telur di air tawar mengapung, telur di air garam mengapung
c. Telur di air tawar melayang, telur di air garam tenggelam
d. Telur di air tawar terapung, telur di air garam tenggelam
e. Telur di air tawar tenggelam, telur di air garam terapung
Alasan :
a. $\rho_{tawar} > \rho_{garam}$
b. $\rho_{tawar} = \rho_{garam}$
c. $\rho_{tawar} < \rho_{garam}$
d. $V_{tawar} < v_{garam}$
e. $V_{tawar} > v_{garam}$
Keyakinan :
A. Yakin
B. Tidak Yakin
TPK

Figure 1. Excerpt of student answers from pretest results

Based on Figure 1, the increase in misconceptions in concept number 2 can be seen in question number 2 that at the first level students answered the question the answer was wrong, at the second level students answered the reason for choosing the answer to the question was also wrong, at the third stage students answered that they were not sure about their confidence in filling in the question and the reasons . Through the TTT decision, students can be categorized as lacking knowledge.

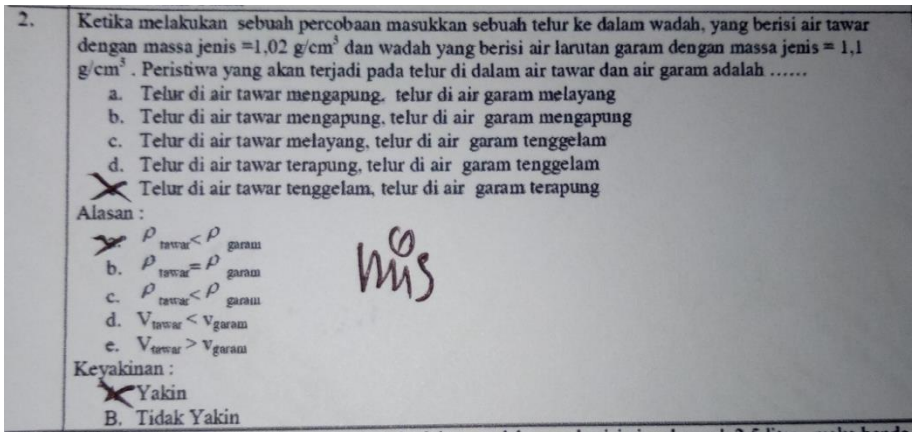
2. Ketika melakukan sebuah percobaan masukkan sebuah telur ke dalam wadah, yang berisi air tawar dengan massa jenis =1,02 g/cm³ dan wadah yang berisi air larutan garam dengan massa jenis = 1,1 g/cm³ . Peristiwa yang akan terjadi pada telur di dalam air tawar dan air garam adalah .....
a. Telur di air tawar mengapung, telur di air garam melayang
b. Telur di air tawar mengapung, telur di air garam mengapung
c. Telur di air tawar melayang, telur di air garam tenggelam
d. Telur di air tawar terapung, telur di air garam tenggelam
Telur di air tawar tenggelam, telur di air garam terapung
Alasan :
a. $\rho_{tawar} < \rho_{garam}$
b. $\rho_{tawar} = \rho_{garam}$
c. $\rho_{tawar} < \rho_{garam}$
d. $V_{tawar} < v_{garam}$
e. $V_{tawar} > v_{garam}$
Keyakinan :
Yakin
B. Tidak Yakin
MIS

Figure 2. Snippet of students' answers from the post test results

Based on Figure 2, after carrying out the treatment, students no longer lack knowledge, but students experience misconceptions, where students at the first level answer correctly but at the second level students answer incorrectly and at the third level, students answer that they are confident with the answer at the first level and second level.

However, the results of the decrease in students who have misconceptions tend to be higher than the increase in the quantity of students who have misconceptions, seen from the results of the DQM test. So, it can be concluded that the CLIS model can reduce the quantity of students who have misconceptions.

The increase in students' misconceptions in concept number 2 is because previously students were more accustomed to learning that was lecture in nature and focused on memorizing formulas, so that when they were given lessons regarding concept mastery, students would experience difficulties in learning. Apart from that, students lack knowledge in Archimedes' law material, and because students are not used to receiving lessons that use video demonstrations and experiments, this is proven by the statements of some students on the student response sheet, namely that students have difficulty in predicting the answer to the problem that the teacher gives and students state that that CLIS learning is different from usual learning. One of the triggers for an increase in students' misconceptions is external factors and the students themselves (Suryawirawati et al., 2018).

Positive Student Response to the CLIS Learning Model

The results of the analysis of student responses to the CLIS learning model that has been implemented show that student responses are in the positive category. In the CLIS model, student learning is more interesting, students can watch video demonstrations and carry out experiments, and in the CLIS model there is a stage for students to improve their predictions. According to (Anwar et al., 2017), the application of the CLIS learning model to energy material received a very good response from students.

All activities in the CLIS Learning Model are implemented

All stages of the CLIS model learning are carried out in accordance with the RPP that has been created. When the learning model is implemented, all teacher activities are carried out according to the time allotted and student activities run smoothly because students always answer when the teacher asks, so that all stages of CLIS learning can be carried out in full.

CONCLUSION

Based on the results of research data analysis regarding the decrease in the quantity of students who had misconceptions after implementing the CLIS learning model, the quantity of students who had misconceptions experienced the highest decrease in the concept "Objects sink in water because objects are heavier than water" namely 64.2% in the medium category. The average student response to the CLIS learning model was 85% in the positive category, and the implementation of the CLIS learning model was 100% in the category of all activities carried out. So it can be concluded that the CLIS model can be used as an alternative learning model to reduce the number of students who have misconceptions about Archimedes' law material.

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