Science Education and Application Journal (SEAJ)
Program Studi Pendidikan IPA
Universitas Islam Lamongan
http://jurnalpendidikan.unisla.ac.id/index.php/SEAJ

September, 2023. Vol. 5, No, 2
p-ISSN: 2656-6672
e-ISSN: 2656-8365
pp. 124 - 137

Conceptual Understanding in Static Fluid through the Recitation Program for Students at SMA Ar-Rohmah International Islamic Boarding School

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Article Info

Article History
Received: 16 March 2023
Revised: 27 August 2023
Published: 25 September 2023

Keywords
Understanding concept, recitation program, fluid static

Abstract

Conceptual understanding of physics is one of the important factors to improve the quality of learning physics. However, several studies have shown that student's conceptual understanding is low, especially in static fluid material. Several studies have attempted to use recitation programs and have succeeded in increasing understanding of the concept. Student's conceptual understanding can be improved through independent learning. Independent learning can use recitation programs, but not many available static fluid recitation programs are equipped with concept explanations and do not yet cover students who study in a formal and boarding school system, such as boarding school students. Existing recitation programs are widely used by students to support independent learning. Recitation of students is still rare because of the lack of independent learning. Therefore, this study aims to improve boarding school student's conceptual understanding in static fluid material through recitation program. This research is quantitative research with a quasi-experimental and one group pretest-posttest design. The recitation program is given in the form of an interesting computer-assisted animation outside of learning. The subjects of this study were 40 students of class XI Natural Science 1 at the SMA International Islamic Boarding School Ar-Rohmah Dau, Malang. The research instruments included valid recitation programs and pretest-posttest questions. Data obtained from the results of the conceptual understanding test supported by interviews. The results showed that there was an increase in students' understanding of the concept which was calculated through an N-gain of 0.45 in the medium category and an effect-size of 1.68 in the strong category. The findings of this study imply that the recitation program can improve student's understanding of concepts like previous research, and practically that teachers can utilize the recitation program as student learning material.

Citations: *Maghfiroh, Alifiyah Nindi, et al. 2023. Conceptual Understanding in Static Fluid through the Recitation Program for Students at SMA Ar-Rohmah International Islamic Boarding School. Science Education and Application Journal (SEAJ).*

INTRODUCTION

Understanding of concepts is a factor that needs attention in improving the quality of learning physics (Docktor et al., 2015; Harahap & Nasution, 2021; Tatsar et al., 2020). Understanding of concepts also plays a role in increasing proficiency in the process of solving problems and producing meaningful learning as a representation of learning outcomes, including the assessment and development of learning such as strategies, approaches, models and learning methods. Conceptual understanding for students is needed to achieve indicators of the cognitive level of creating and being able to solve problems. However, students' understanding of concepts is still relatively low in static fluid material due to a lack of basic knowledge and understanding of concepts to understand other concepts related to these basic concepts (Siahaan et al., 2021). One understanding of physics concepts that needs to be improved is static fluid material (Amalina et al., 2021; Anderson & Krathwohl, 2001; Prahastiwi et al., 2022; Rizal Wicaksono et al., 2019; Sofiuddin et al., 2018). Static fluid itself is the initial material on the topic of fluid in high school, where if there is a misconception about static fluid material, it might happen to dynamic fluid material (Saputra et al., 2019).

Static fluid is an important material that requires special understanding in a context that includes theory or core competencies III and IV in the Indonesian curriculum guide. The basic concepts that need to be mastered on the topic of static fluids include Pascal's law, hydrostatic pressure and Archimedes' law (Diyana et al., 2020; Pebriana et al., 2018; Tatsar et al., 2020; Young & Meredith, 2017). Several previous studies have found that students' understanding of concepts is relatively low (Prahastiwi et al., 2022; Puspita et al., 2019). In the hydrostatic pressure sub-material, many students have difficulty identifying the amount of pressure in a horizontal line and explaining the hydrostatic pressure system of objects at different depth positions (Puspita et al., 2019; Sofiuddin et al., 2018). Students also experience difficulties in explaining the concept of Archimedes' law, especially when objects are floating (Amalina et al., 2021; Rizal Wicaksono et al., 2019; Tatsar et al., 2020). Misconceptions were also experienced by 48.08% of students on Pascal's law material in determining the pressure of liquids in closed spaces with larger cross-sectional areas (Adi et al., 2018; Nisa' et al., 2022).

The low understanding of students' concepts occurs because initial knowledge is not in accordance with scientific knowledge, this can interfere with forming new knowledge (Docktor & Mestre, 2014; Sutopo et al., 2017). Students are said to understand concepts when they are able to connect new knowledge and old knowledge and are able to construct meaning from learning both in written and graphic form (Anderson & Krathwohl, 2001; Suryani & Muliyani, 2019). Sometimes students are able to answer a question but are unable to answer the same concept with different question editors, because many students are fixated on similarities as the center for obtaining quantitative answers by ignoring conceptual information (Docktor et al., 2015; Suryani & Muliyani, 2019).

Scientifically correct concepts can be useful for students to solve problems based on correct concepts (Febryanti & Taqwa, 2021). One way to increase students' understanding of physics concepts and principles is to provide conceptual exercises with feedback (Hermawati et al., 2021; Koenig et al., 2007; Sutopo et al., 2017). Feedback must be given immediately to find out the location of the error and can be corrected immediately so that misunderstandings do not occur (Amalina et al., 2021; Kehrer et al., 2013; Taqwa et al., 2017). Providing feedback on conceptual questions is more effectively packaged through a recitation program.

Recitation is an alternative for deepening concepts outside of class hours in the form of certain assignments (Hermawati et al., 2021; Pebriana et al., 2018; Taqwa et al., 2017). Recitation is proven to increase understanding of concepts (Taqwa et al., 2017). Concept deepening is given to help students solve problems that are in accordance with the content that has been taught in class but are still having difficulties (Amalina et al., 2021). Recitation can be given in the form of conceptual exercises with feedback , this can help students to verify the concepts that have been obtained (Oliveira & Oliveira, 2013; Pebriana et al., 2018). Recitation accompanied by feedback is a form of presenting teaching materials for understanding concepts that students can do independently outside of study hours (Adha & Parno, 2022; Hermawati et al., 2021; Taqwa et al., 2017).

Previous research on computer-assisted recitation programs to improve students' understanding of concepts includes Pebriana, Sutopo, and Diantoro (2018) on the topic of fluid dynamics, Taqwa, Hidayat, and Sutopo (2017) on the topic of particle dynamics, Adha and

Parno (2022) on the topic vector, and Febryanti and Taqwa (2021) on the topic of kinematics. The results found that student's understanding of concepts increased significantly and experienced conceptual changes for the better. However, from the research that has been done, no one has conducted this research on high school students, especially in boarding school-based schools.

Boarding school-based school is a place of learning that has a formal school system and a boarding school as a place to study the Al-Quran in the same environment. In the school area between students interact with each other and also with the teachers. Thus the cognitive, affective and psychomotor learning of students is more optimally trained (Haryono & Sa'diyah, 2021; Yusuf Maimun et al., 2021). In line with the findings of Umiarso and Mawardianti (2018) which states that the integration of the school and Islamic curricula can create students who have balanced cognitive and affective abilities, can even develop social sensitivity, independent learning and respect for their environment.

The recitation program can act as an effort for student learning independence. Learning independence is an individual's positive mental attitude for the convenience of carrying out planning activities to achieve goals so that they can self-evaluate (Kurnia Bungsu et al., 2019). Learning independence is very important to increase students' understanding of concepts and there is a need for learning motivation to increase their understanding (Adha & Parno, 2022; Hermawati et al., 2021). This independent learning supports the concept of a boarding school-based school, which has the goal of creating students who are balanced between cognitive and personality (Umiarso & Mawardianti, 2018). To support the cognitive abilities of boarding school students in the form of understanding the concept of physics with the concept of independent learning, researchers are trying to use a static fluid recitation program in the form of computer-assisted animation that students can easily access. This solution is used because the recitation program is intended to develop conceptual understanding which is designed as individual assistance and feedback that students can use without assistants or teachers (Diyana et al., 2020; Docktor & Mestre, 2014) while static fluid is physics material whose phenomena occur in everyday life and to solve problems students need understanding regarding the relationship between static fluid concepts in theory and daily practice (Diyana et al., 2020). Therefore this study aims to improve boarding school student's conceptual understanding in static fluid material through the recitation program.

METHODS

The type of research conducted was quantitative research using a quasi-experimental or quasi-experimental approach with a one-group pretest-posttest research design. This method was carried out using existing groups with the aim of increasing student's conceptual understanding of static fluid material after being given treatment through a recitation program (Hastjarjo, 2019; Sugiyono, 2016).

Table 1. Design pretest-posttest

Pretest	Treatment	Postest
O_1	X	O_2

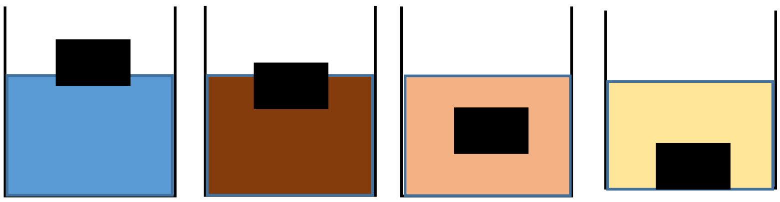
This research conducted at SMA Ar-Rohmah Putri International Islamic Boarding School with a total of 40 respondents in class XI Natural Science 1. The research was conducted in a computer laboratory outside of class hours. Student understanding was obtained through a pretest-posttest using a question instrument packaged in a Google form. One example of a test item can be seen in Figure 5. The pretest is given after students get the static fluid material in class. Two weeks after the pretest, students were given the opportunity to use the static fluid material recitation program for one week and then do the posttest.

The recitation program is given in the form of an interesting animation in the Microsoft Power Point Show which consists of 17 multiple choice conceptual practice questions with feedback as shown in Figure 1. The recitation program instrument and the conceptual problem instrument have been declared valid by two validators who come from a physics teacher at SMA Ar-Rohmah Putri International Islamic Boarding School and a lecturer at Malang State University so that it can be used as a research instrument. This is in accordance with Arikunto (2013) In addition to expert validation, the results of the test instrument trials have also been declared valid and reliable.

QUESTION

The picture below shows 4 vessels filled with different liquids. If 4 identical beams are placed in each vessel and produce the conditions as shown in the figure, then the lifting force experienced by the beams in each vessel is……

$(m_1 = m_2 = m_3 = m_4)$



1 2 3 4

$F_{A1} = F_{A2} > F_{A3} > F_{A4}$

$F_{A1} < F_{A2} = F_{A3} = F_{A4}$

$\boldsymbol{F_{A1} = F_{A2} = F_{A3} > F_{A4}}$

$F_{A1} > F_{A2} > F_{A3} > F_{A4}$

$F_{A1} = F_{A2} = F_{A3} = F_{A4}$

FEEDBACK

(A)

YAHH WRONG

You seem to think that objects 1 and 2 both float and the lifting force is greater than objects 3 and 4. You need to remember again that the magnitude of the lifting force for floating and floating objects is $F_A = W$ and for sinking objects it is $F_A < W$.

(B)

YAHH WRONG

You seem to think that objects 2, 3, 4 have the same lifting force and are greater than the lifting force of object 1. You need to remember again that the magnitude of the lifting force for floating and floating objects is $F_A = W$ and for sinking objects it is $F_A < W$.

(C)

YAYY TRUE

You already understand the principle of the Archimedes force. The weight of the object immersed in system 1, 2, 3, 4 is the same. The lift force for floating and floating objects is the same $F_A = W$ and for sinking objects is $F_A < W$. Based on this description, objects 1, 2 and 3 have the same state and object 4 has a W which is heavier than its buoyant force.

(D)
YAHH WRONG
You seem to think that the position of object 1 is on the surface then objects 2 3 and 4 are getting closer and closer to the bottom. Therefore, the buoyant force for objects 1 > 2 > 3 > 4 you need to remember again that the magnitude of the lifting force for floating and floating objects is $F_A = W$ and for sinking objects is $F_A < W$..

(E)
YAHH WRONG
You seem to think that all objects have the same mass, so the lift force on them is the same. You need to remember again that the magnitude of the lifting force for floating and floating objects is $F_A = W$ and for sinking objects it is $F_A < W$.

Figure 1. Example of questions and feedback on the recitation program

The focus of the research is to find out the increase in students' understanding of concepts obtained from the pretest-posttest results. The data was then analyzed using a paired t-test and a normalized N-gain test was carried out to see an increase in students' understanding of concepts (Sundari et al., 2021). Interviews were conducted with several students to obtain supporting data after knowing the student's N-gain category. The N-gain value can be determined using the following categories (Hake, 1998).

Table 2. N-gain category

No	N-gain value	Category
1.	(<g>) > 0.7	High
2.	0.7 > (<g>) < 0.3	Medium
3.	(<g>) < 0.3	Low

RESULTS AND DISCUSSION

Improving Students ' Understanding of Concepts

The descriptive statistics obtained from the research results aim to describe data on students' conceptual understanding before and after being given a static fluid recitation program. Data on the results of students' understanding of the concept are shown in Table 3.

Table 3. Results of Descriptive Statistics to Improve Understanding of Concepts

Statistics	Pretest	Posttest
N	40	40
Min Value	16.67	33.33
Maximum Value	66.67	91.67
Standard Deviation	13.91717	16.17738
Means	41.0417	66.4583

Based on the table above, it is known that there was an increase in the average value of the pretest by 41.04% after being given treatment using the recitation program, the average value of the posttest increased to 66.45%, the increase was 25.41%. The minimum score obtained at the pretest was 16.67 while at the posttest it was 91.67. Furthermore, normality tests and homogeneity tests were carried out as prerequisites for parametric statistical analysis to see the significance of distributed and homogeneous data (Santoso, 2016). The homogeneity test result data is 0.312 and the normality test results are presented in Table 4.

Table 4. Concept Understanding Normality Test Results

Data	Shapiro-Wilk			Explanation
	Statistics	df	Sig.	
Pretest	.951	40	082	Normal
Posttest	.951	40	083	Normal

Based on these results, the data is declared normally distributed and homogeneous. Then a paired sample t-test was carried out to see the differences in pretest-posttest data before and after being given a static fluid material recitation program. The results of the paired sample t-test are presented as follows.

Table 2. Paired Sample t-Test results

	TestValue = 100			
	t	df	Sig.(2-tailed)	Mean Differences
Pretest-Posttest	-18,610	39	.000	-25.41667

The results of the paired sample t-test showed that there were significant differences in students' understanding of concepts before and after using the static fluid recitation program. Meanwhile, for increasing students' conceptual understanding, it is classified as moderate, which can be seen in Table 6.

Table 6. N-gain Test Results

Pretest Average	Posttest average	N-gain	Category
41.0417	66.4583	0.457907	Medium

The results of the effect size test analysis were carried out to find out how much influence the recitation program that had been given had on students' conceptual understanding. Based on Table 7, the effect size value is 1.68 in the strong category (Leech et al., 2005). That is, the recitation program given to students is said to be effective in increasing students' conceptual understanding of static fluid material.

Table 7. Effect size test results

Mean (posttest - pretest)	Std. Deviation	Effect-Size
25.4167	15.0473	1.68912

The increase in student's understanding of concepts can be seen from the increase in the score of each item. We can see an increase in understanding of the concept in Figure 2. Based on the graph, there is a significant increase in value. The highest increase was seen in question number 12, which was 45% and the lowest increase was in question number 9, which was 2.5%. Based on the results of student interviews after using the static fluid recitation program, there were many positive responses given. Many students said they could understand static fluid material more after getting the recitation program. The animations that are made are very interesting to make students motivated and more enthusiastic to use them.

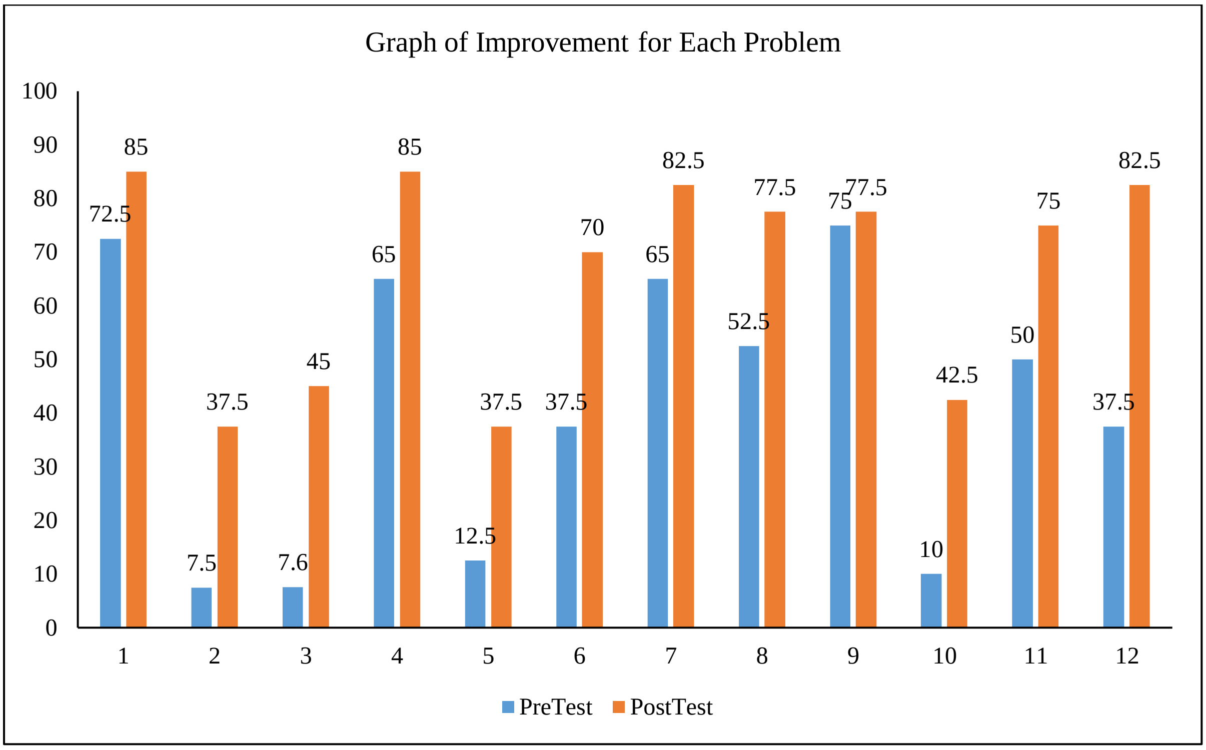


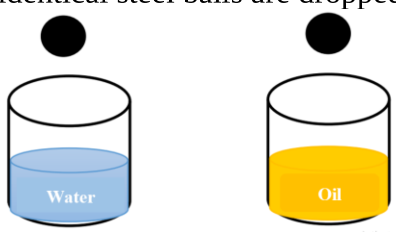
Figure 1. Graph of increasing students' understanding of each question

Distribution of Students ' Understanding of Concepts

We can understand the increase in conceptual understanding by presenting the distribution of students' understanding of one of the questions in each sub-material.

Hydrostatic Pressure

In a simple experiment, there are two vessels with different types of fluids. Then two identical steel balls are dropped into the vessel from the same height.



The ratio of the depth (h) of the surface of the water and oil after the two steel balls are inserted into the two vessels is... $\rho_{steel} > \rho_{water} > \rho_{oil}$

a. $h_{water} > h_{oil}$, because the density of water is greater than that of oil.
b. $h_{oil} > h_{water}$, because the density of oil is less than the density of water so objects in oil float more easily.
c. $h_{water} = h_{oil}$, because the volume of fluid displaced by the ball is the same in both vessels.
d. The surface heights of oil and water cannot be compared because the density values of oil, water and iron are not known.
e. The density of water is less than the density of oil, so the surface area of water is higher than oil

Figure 2. Hydrostatic pressure test questions

Table 3. Distribution of General Understanding of Students during Pretest Posttest

Answer Choices	Pretest (%)	Posttest (%)
$h_{water} > h_{oil}$ because the density of water is greater than that of oil.	47.5	32.5
$h_{oil} > h_{water}$ because the density of oil is less than the density of water so objects in oil float more easily.	20	12.5
$h_{water} = h_{oil}$ because the volume of fluid displaced by the ball is the same in both vessels.	12.5	37.5
The surface heights of oil and water cannot be compared because the density values of oil, water and iron are not known.	12.5	15
The density of water is less than the density of oil, so the surface area of water is higher than oil	7,5	2,5

Based on the distribution table of students' understanding, it showed that 47.5% of students answered A. Students gave the reason that $\rho \sim h$ the greater the density value, the greater the depth. As many as 20% of students who chose answer B revealed that when the same object is put into a different fluid, the value of h will be greater for the object that has the ρsmaller one. This means that the density is inversely proportional to the depth. Some students who answered D and E revealed that they randomly chose that answer. These findings support previous research (Prastiwi et al., 2018; Puspita et al., 2019) that students still experience many misconceptions

In the posttest, it was found that 37.5% of students chose the correct answer. Students revealed that they identified the intent of the question first to make it easier to answer the question. They explained that the increase in the height of the water level in the two fluids will be the same because the objects that are inserted are identical and the initial heights of the two fluids are also the same. They also added information if it is known that the density of steel is more than the density of water and oil, which means that steel will sink if it is put in water and oil, and the physics concept regarding static fluids is in accordance with the explanation from Serway and Jewett (2018).

There was an increase of 25% of students from the pretest and posttest choosing the correct answer option C. This increase occurred because of the recitation program and some students realized their mistakes because they were not careful in understanding the meaning of the questions. These findings support research by Febryanti and Taqwa (2021) which says that there is an increased understanding of concepts with a recitation program.

Archimedes' law

Lana throws a rock into the lake. The stone sank into the lake. The Archimedes force acting on the rock when the rock begins to sink is…..

a. Increasingly when reaching the bottom
b. It decreases when it reaches the bottom
c. Equal to zero when it is at the bottom
d. Constant until a moment reaches the bottom
e. Cannot be determined until it reaches the bottom

Figure 4. Archimedes' law test questions

Table 9. Distribution of General Understanding of Students during Pretest Posttest

Answer Choices	Pretest (%)	Posttest (%)
Increasingly when reaching the bottom	52.5	25
It decreases when it reaches the bottom	10	17.5
Equal to zero when it is at the bottom	25	12.5
Constant until a moment reaches the bottom	7,5	45
Cannot be determined until it reaches the bottom	5	0

More than one class chose answer option A during the pretest. Most of the students who were interviewed explained their understanding that the deeper an object is located, the greater the Archimedes force, they assume the magnitude of $W = F_A$. As many as 35% of students who chose answers B and C explained that the options had the same understanding. They assume that if an object sinks, the buoyant force decreases and when it reaches the bottom the buoyant force does not exist or is zero and 5% of students who answered E could not explain the reasons. Based on the results of an interview with one of the students who chose the correct answer, the students assumed that when an object sinks there will be an upward force. The concept is not quite right to be used as an excuse. When students are asked to identify questions, it is known that students fail to understand the meaning of the questions. This shows that students use their intuition in solving problems. This finding is supported by research (Puspita et al., 2019; Rizal Wicaksono et al., 2019) that students still have difficulty identifying the buoyancy of objects.

In the posttest, there was an increase in the number of students who answered correctly (D) by 45%. They can understand that the magnitude of the Archimedes force is not affected by the depth of the object. So, after the object enters the water the magnitude is the same (constant) just before it reaches the bottom (Serway & Jewett, 2018). Some students also explained that there is no change in density and no acceleration that works when an object begins to sink. After further identification, half of the students who chose the correct answer explained that they chose using intuition and some could conclude answers but could not explain in detail using Archimedes' style concepts.

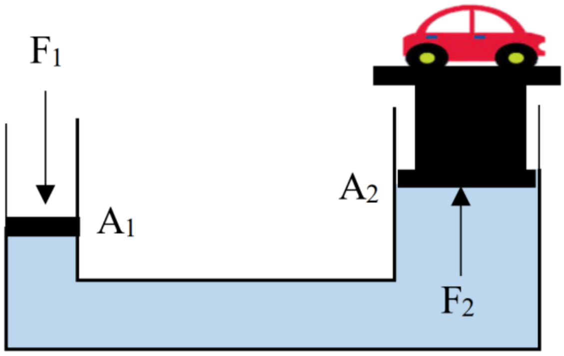
Based on the results of the pretest and posttest, the students' answers varied greatly towards the Archimedes style sub-material. The data above shows that students' understanding of concepts after using the recitation program has increased quite a bit. In line with the findings Pebriana, Sutopo, and Diantoro (2018) which stated that there was an increase in conceptual understanding after using the recitation program.

Pascal's law

Pascal's law is one of the sub-matters in static fluids that is relatively easy. There are only a few studies that reveal students' lack of understanding of the material (Adi et al., 2018; Purnamasari et al., 2017). However, when the pretest was found, the distribution of students' understanding was very diverse. Based on the interview results, students who chose answer A said that when the cross-sectional area is larger, the volume of water entering is more. Students who choose answer B think that the cross-sectional area affects the volume.

During the posttest, the distribution of answers is very striking. As many as 82.5% of students chose the correct answer option. There was an increase of 42.5%. This increase occurred because students had understood the concept of Pascal's law after receiving the recitation program. Students have understood that the concept of Pascal's law works in a closed fluid system, so the volume of liquid has no effect on the cross-sectional area of the piston.

Look at the following picture!



Based on the figure, the hydraulic engine consists of two pistons that have different sizes, namely A_1 and A_2. If piston A_1 is given a force of F_1 then piston A_2 will get a thrust of F_2. Based on the concept of Pascal's Law, the volume of liquid that is transferred from piston A_1 to A_2 is…..

a. Larger because it has a different cross-sectional area.
b. Smaller because the piston A_1 has a smaller size.
c. Not the same because it has a different cross-sectional area
d. The same even though they have different cross-sectional areas.
e. Bigger because the A_2 piston has a larger size.

Figure 3. Pascal's law test questions

Table 4. Distribution of General Understanding of Students during Pretest Posttest

Answer Choices	Pretest (%)	Posttest (%)
Larger because it has a different cross-sectional area.	22.5	2,5
Smaller because the piston A_1 has a smaller size.	25	5
Not the same because it has a different cross-sectional area	12.5	10
The same even though they have different cross-sectional areas.	37.5	82.5
Bigger because the A_2 piston has a larger size.	2,5	0

Based on the results of the study, it was found that there were several reasons why students were less thorough in analyzing concepts to be represented in the questions. If students are led to identify questions, their understanding of Pascal's law is good enough, but when asked to conclude the correct answer there are still many difficulties that occur. This finding is supported by the research of Nisa', Munawaroh, and Yasir (2022) who found that students perceive pistons that have a larger cross section as well as greater pressure.

The static fluid recitation program was chosen as an innovation in modern learning media for students outside of study hours so that it is not boring and allows them to understand concepts more freely, one of which is by adding animated video media as in research by Dewi and Dewi (2023). This recitation program consists of static fluid material and several practice questions for each sub-chapter. Static fluid material is given so that students can recall the concepts they have acquired in class, then exercise questions are used to evaluate the learning they have learned. The success of the recitation program in increasing students' conceptual understanding cannot be separated from the 17 questions that has been given.

All practice questions are made using the same indicators as the test questions, but the shape is different. The differences in these questions are expected to increase student's understanding. The practice questions are in the form of multiple choice which are equipped with direct feedback, meaning that when students choose the wrong answer there is feedback containing student misconceptions. New questions can be continued when the student chooses the correct answer, when the student continues to choose the wrong answer he will get feedback from each answer he chooses. When the answer chosen is correct, there is also feedback which contains validation of the correct static fluid concept. This method makes students learn a lot and understand the misconceptions that are experienced then students will understand the concept of static fluid properly and correctly. When the answer chosen is correct, there is also feedback which contains validation of the correct static fluid concept. After all the recitation programs have been well realized, an evaluation is carried out to find out the results of students' understanding of the concept of static fluid by conducting a posttest. The test is carried out using the same 15 questions as the pretest. The recitation program equipped with animation is made attractive is made as attractive as possible to increase the attractiveness of students to learn and it is evident from the response questionnaire given that the feedback given by students is very good. The use of programs in schools based on boarding schools can run if schools have adequate facilities. Interestingly, this research succeeded in strengthening previous research which stated that the recitation program could increase students' understanding of concepts (Amalina et al., 2021; Febryanti & Taqwa, 2021; Sutopo et al., 2017; Taqwa et al., 2017), especially in static fluid material and for boarding school students. However, this research certainly has a limitation, namely that the researcher did not explore how often students open the recitation program that has been given, so that future research is expected to be able to create a recitation program with media that is able to detect the amount of time students study or repeat material outside of learning hours using this program.

CONCLUSION

The research was conducted to determine the increase in student's conceptual understanding through a recitation program on static fluid material. The results of the media validation in the form of a recitation program were 88.89% in the very good category. The increase is calculated using an N-gain of 0.45 in the medium category and the effect of using the recitation program is calculated using an effect size with a result of 1.68 in the strong category. It can be concluded that students' understanding of concepts increases with the static fluid recitation program.

SUGGESTIONS

Based on data analysis and discussion of research results, suggestions that can be used for further research are to use a recitation program to explore other physical phenomena and create a recitation program with media that is able to detect the amount of time students study. The recitation program is very helpful for increasing boarding school students' understanding of abstract concepts, especially the concept of static fluid.

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