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The Effect of Cognitive Conflict-Based Learning (CCBL) Model on Remediation of Misconceptions

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ABSTRACT
The phenomenon of misconception and poor conceptual understanding is a problem that often occurs in science learning, not least in physics learning. Learning models that specifically aim to improve conceptual understanding and remediate misconceptions are not widely available. This study aims to determine the effect of the CCBL model in improving conceptual understanding and remediating misconceptions of students. The method consisted of pretest-posttest control group quasi-experimental design. The sample consisted of 89 students from three groups in the physics department. The research instrument was a static fluid concept test, a type of two-level multiple-choice test, and an open reason answer. Percentage techniques and descriptive narrative were used to obtain the level of understanding of students' concepts. These results indicated that the CCBL model was effective in remediating student misconceptions. The implication of this research is that the CCBL model has the syntax that capable of remediating students' misconceptions, namely; (1) activation of preconceptions and misconceptions; (2) presentation of cognitive conflict; (3) discovery of concepts and equations; and (4) reflection. It is recommended to conduct further research to see the significance of the effectiveness of the CCBL model.

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Introduction

Several studies have revealed that misconceptions tend to occur in learning science. These misconceptions appear in almost all fields of sciences, such as physics (Al-Rsa'i et al., 2020; Alwan, 2011; Çepni & Keleş, 2006; Kaniawati et al., 2019), chemistry (Baddock & Bucat, 2008; Mubarokah et al., 2018; Niaz, 1995), and biology (Chrzanowski et al., 2018; Foster, 2012; Khotimah, 2015; Septiana et al., 2015), even in mathematics (Kabaca et al., 2011; Liang, 2016; Parwati & Suharta, 2020). The cause of the misconception is the interaction of students with their environment before they enroll to formal education institutions. In general, they have their own concepts rooted in their everyday experiences before they gain new knowledge or concepts in the classrooms. The misconceptions mostly arise not due to the misunderstandings about the concepts during the lesson, but rather, the preliminary concepts (preconceptions) the students acquire when interacting with the environment, and then, are brought into their formal classrooms (David & Clement, 1987). The students construct the concepts through their life experiences outside the formal classroom continuously. In other words, before entering the class, the students have formed their own concepts such as the concepts of force, weight, pressure and so forth which they have as their initial concepts and which often do not agree with the scientific concepts held by the experts. This shows that in science learning, misconceptions are prone to occur.

Constructivist philosophy states that knowledge is constructed by students through their interactions with the environment, challenges and learning material (Suparno, 2013). The learning process occurs when students connect previous knowledge with new knowledge. During construction of new knowledge, students often construct new knowledge incompletely because of their limited abilities or because their ideas have been mixed with other ideas that they experienced in daily life. This is the main factor that causes misconceptions in learning process. As Meyer (1993) states that when the connection between previous knowledge and new knowledge is not in line, then misunderstanding or misconceptions occur in science learning. Therefore, students must be given the opportunity to develop their curiosity, so that they experience the process of understanding something (by constructing knowledge) and making conceptual changes.

Several researchers are concerned about the problem of misconception. They investigate and develop the types of instruments for diagnosing the misconceptions (Anam et al., 2019; Dirman et al., 2022; Gurel et al., 2015; Habiddin & Page, 2019; Schleigh et al., 2015), identify the learning materials leading to misconceptions (Alwan, 2011; Kartal et al., 2011; Taşar, 2010) and find the proper learning strategies or methods for remediating the misconceptions (Baser, 2006; Foster, 2012; Halim et al., 2014; Samsudin et al., 2021; Saputri & Sarwanto, 2011; Taufiq, 2012; Taufiq & Hindarto, 2011).

Researchers and educators are always trying to find solutions to overcome students' misconceptions in science learning. Before starting learning in class, lecturers need to understand that students' cognitive structures have been formed as a preconception of the events they experience every day. However, these preconceptions are not necessarily true and in accordance with real experiences. Santa and Alvermann (1991, as cited in Rohandi, 2009) stated that in science learning, students need to admit that scientific concepts are contrary to the theory they get from their experience of interacting with the environment. In their cognitive structure, there is a conflict called cognitive conflict. They need confidence that their theories are incomplete, incompatible or inconsistent with experimental evidence (Rohandi, 2009). Furthermore, Santa and Alvermann (1991, as cited in Rohandi, 2009) explained that in science learning, students need repeated opportunities in terms of "wrestling" with inconsistencies between the ideas they have and the scientific explanations of experts. They need to organize their way of thinking and make appropriate connections between the ideas they have with various scientific concepts. Therefore, science learning must provide various experiences and facilitate students to carry out various scientific searches through observation and experiment activities. Students need to be aware of their misconceptions and find scientific concepts that are scientifically correct.

The misconceptions that the students own can persist if the science learning in the classroom does not involve them in constructing the concepts/knowledge, as the main characteristic of the learning of science needs the process of concept/knowledge construction through interaction with the environment. Physics is not just a series of facts, rather, it is a process to interact with the physical environment. The interaction can be a discovery process that develops the curiosity of learners. In comprehending the abstract concepts of physics, the students should be involved in the process of observing physics concepts as well as principles discovery in order for the learning to become meaningful and make sure that there will not be any mistakes or misconceptions during the learning. The mistakes in understanding the concepts are often referred as alternative concepts or naive concepts. If the misconceptions are not remedied in the early stages of education, they will linger until the next stage of education. Misconceptions will continue to persist if the lecturer does not provide opportunities for students to review the misconceptions they have obtained previously (Carin, 1997). The misconceptions might still exist even though the students have finished their studies, both in secondary and higher education. Several studies have revealed that misconceptions also occur in teacher candidates (Baser, 2006; Kabaca et al., 2011; Kartal et al., 2011; Şahin et al., 2010; Taufiq, 2012).

The misconceptions held by the teacher candidates need to be remedied in order to prevent them from sharing these misconceptions with their students in the future. Therefore, remediation of misconceptions is very important.

Remediation means a treatment or a healing process (Suharso & Retnoningsih, 2012). Misconception remedial may refer to the treatments or the process of correcting the misconceptions. The students with misconceptions need to be treated so that they realize their mistakes and reconstruct scientifically accepted new concepts. Studies in the literature show that teaching which takes student's misconceptions into consideration and is based on the concept of the conceptual change mostly has a positive influence on students' ideas (Küçüközer & Kocakülah, 2008). The best way to eliminate misconceptions is by exposing and confronting them directly (Carin, 1997). Confronting or dealing with misconceptions needs to be done more than just teaching the facts of science, but, it should be based on experiences and should motivate students to change.

Pintrich et al. (1993) state that the important conditions in changing or remediating misconceptions are (1) there must be a sense of dissatisfaction with the wrong beliefs of students, (2) new understandings must be intelligible by students and help them better understand ideas, (3) the new conception must be plausible, that is, it must relate meaningfully to the existing knowledge organization of students, (4) the new framework must be useful (fruitful) to facilitate further study or study. These conditions need to be created by the lecturer to change the misconceptions of students through various strategies or learning models as an effort to remediate the misconceptions. Learning models or strategies that are widely applied by researchers to overcome the problem of low concept understanding and remediating misconceptions are cognitive conflict models or strategies (Mufit et al., 2020). Cognitive conflict learning has various stages, but in general, there are three main stages; namely (1) the preliminary stage to find out the students' initial concepts; (2) the conflict phase to invite students to think deeply and realize the misunderstandings they have experienced; and (3) the completion stage, to guide students to have a correct understanding of the concept. Conflict cognitive learning through various stages suggested by experts has the highest influence in increasing concept understanding and reducing student misconceptions, especially in physics learning.

The model used in this study is a cognitive conflict-based learning model (CCBL Model). This CCBL model consists of four steps, which are designed to overcome or remediate student misconceptions. The development of the CCBL Model is carried out based on the consideration that students find it difficult to understand physics concepts and there are many misconceptions about understanding physics concepts. The phenomenon of misconception cannot be avoided by students because in general, misconceptions occur when students interact with the environment or natural phenomena and build their own physics concepts based on their intuition (Çepni, 2009; Mufit & Fauzan, 2019). A brief description of student activities and lecturer activities in each CCBL model step can be seen in Table 1.

Table 1

Brief Description of the CCBL Model Syntax and the Activities of Lecturer and Student.

Phase	Phase Description of the CCBL Model
Activation of Preconception and Misconception	Recalling initial knowledge in order to find out students' understanding of concepts and misconceptions, before gaining new knowledge. Lecturer activities: Provide a kind of concept test in order to activate and identify the initial concepts and misconceptions of students (written or oral). Student activities: Answer several questions about the concepts given by lecturer.

Presentation of Cognitive Conflict	Presenting phenomena that can trigger conflict in the mind (cognitive) of students. Lecturer activities: Presenting anomalous phenomena and proposing hypotheses to trigger cognitive conflicts. Student activities: answering hypotheses, deep thinking, exploring ideas about a given phenomenon.
Discovery of Concepts and Equations	Finding concepts and principles (equations) through experimental activities and group discussions. Lecturer activities: organizing groups and facilitating experimental and discussion activities, as well as providing scaffolding. Student activities: conducting experiments and discussions to construct new knowledge by collaborating to share ideas, looking for logical relationships, checking new information, and revising old information.
Reflection	Conduct class discussions and evaluations to get feedback on understanding concepts and misconceptions. Lecturer activities: Facilitating class discussions, confirming knowledge, and resolving misconceptions. Student activities: Group presentations, suggest ideas, share ideas, and restructure ideas.

Note. Source: Mufit & Fauzan (2019)

A lecturer needs to understand the nature and characteristics of student misconceptions in order to be capable of preparing appropriate learning strategies to change student misconceptions. It should be understood that it is easier for student to build knowledge from scratch when compared to changing knowledge, namely misconceptions (Suparno, 2013). A student will be able to change his alternative concept if she/he begins to doubt the concept itself in order that the correct concept proposed to become useful. This is what underlies the first phase of the CCBL model, which is for activating students' preconceptions & misconceptions. In the second phase, phenomena that cause conflict in students' cognition are presented. Students, who often experience misconceptions, face with opposing events that oppose their naive concepts (Zimrot & Ashkenazi, 2007). In the third phase, students are guided to find concepts and similarities through experimental activities and discussions. Students carry out observations and experiments, which are two activities carried out by scientists in discovering scientific concepts & principles. Conant (1958, as cited in Sumaji, 2009) states that science is a series of concepts and conceptual schemes that are interrelated with one another, and grow as a result of experiment and observation. Carin and Sund (1989, as cited in Budi, 2009) also argue that science is a system for understanding the universe by collecting data from controlled experiment and observation activities. The fourth phase is reflection, which aims to enable lecturers to assess the extent to which students have progressed in understanding the concepts after carrying out the previous phase. Reflection is carried out through the presentation of the findings of concepts and similarities by groups of students. Presentation activities are accompanied by class discussions through lecturer guidance. The class dialogue that occurs during the class discussion process will provide feedback for the lecturer to find out the extent to which students have understood the concepts and misconceptions that still occur. As Presseisen, et al (1994, as cited in Ormrod, 2006). stated that classroom dialogue is very beneficial for lecturers because by monitoring their comments or questions carefully, lecturers can identify and resolve misconceptions that can hinder their ability to acquire broader knowledge and skills. Through the syntax of the CCBL model that has been explained, students' misconceptions in physics learning can be remedied accordingly.

Previous research shows that the CCBL model which consists of 4 phases, namely; (1) activation of preconceptions and misconceptions; (2) presentation of cognitive conflict; (3) discovery of concepts and equations; and (4) reflection, has been tested for validity through expert reviews and limited trials with students. This CCBL model is declared valid and practical, and has an impact on increasing conceptual understanding and remediating misconceptions (Mufit et al., 2018). The CCBL model is consistent with the philosophy of constructivism theory, which allows students to construct new concepts or knowledge. Lecturers do not dominate the learning activities and are not in a hurry to teach content, as well as investigate their initial knowledge. Students are given the opportunity to be aware of conceptual errors (misconceptions) that may occur in building new concepts and lead to cognitive conflicts of learners in getting new concepts correctly. The CCBL model trains students to think deeply, find and realize mistakes, find and test ideas, and build new concepts or knowledge (Mufit et al., 2019). Other research also shows that the best solution to achieving a conceptual understanding of motion material is to actively involve students in the process of finding concepts and equations through real experimental video analysis. The application of real experimental video analysis to the third phase of CCBL syntax has the potential to improve conceptual understanding and restore physical misunderstandings in the concept of motion (Mufit et al., 2019). Through the application of the CCBL model in learning, students are guided systematically to find concepts and equations of motion by conducting experiments like scientists. Several studies on the development of cognitive conflict-based teaching materials have been carried out (Arifin et al., 2021; Delvia et al., 2021; Luthfi et al., 2021). Teaching materials are arranged according to the syntax of the CCBL model, by integrating a virtual laboratory in the third syntax. Teaching materials are developed through development/design research as a support system for the CCBL model in applying this model to physics learning. This article reports the results of testing the effect of the CCBL model through experimental research in the field test phase.

Methods

The design of this research was a pretest-posttest control group quasi-experimental design. The sample for this study consisted of three groups of first-year Physics Education Department students who took Basic Physics courses in Padang City, Indonesia. Sampling used a disproportionate stratified random sampling technique because there are two tertiary institutions that have a disproportionate number of students. The first tertiary institution had one class, so all students were taken as samples (one experimental group). The second tertiary institution had four classes, so two classes were selected as samples, namely one experimental group and one control group, which were randomly selected.. The research design can be seen in Table 1. The CCBL model as given treatment was applied to the experimental groups while the control group was implemented the traditional learning methods. The experimental groups were given treatment by applying the CCBL model assisted by student worksheets. Student worksheets were structured according to the four CCBL model syntax. In the control group, traditional learning was applied, namely explanations by the lecturer, group discussions assisted by worksheets, and student group presentations. Worksheets in the control group contained questions about learning material, as topics for discussion. The three sample groups are taught by the same lecturer, namely the researcher (lecturer-researcher). The research was conducted for four weeks, the first week was given a pretest and the sixth week was given a posttest for the three sample groups. Static fluid material that became the topic of research included hydrostatic pressure, Pascal's principle, Archimedes principle, surface tension, meniscus and capillary. In the experimental groups, the material is arranged according to the CCBL model syntax. In the third phase, students conduct experiments and group discussions to find concepts and similarities about the topic. The design of worksheets or teaching materials arranged according to the CCBL model syntax can be seen in Delvia et al. (2021) and Luthfi et al. (2021).

Table 2

Experiment Research Design

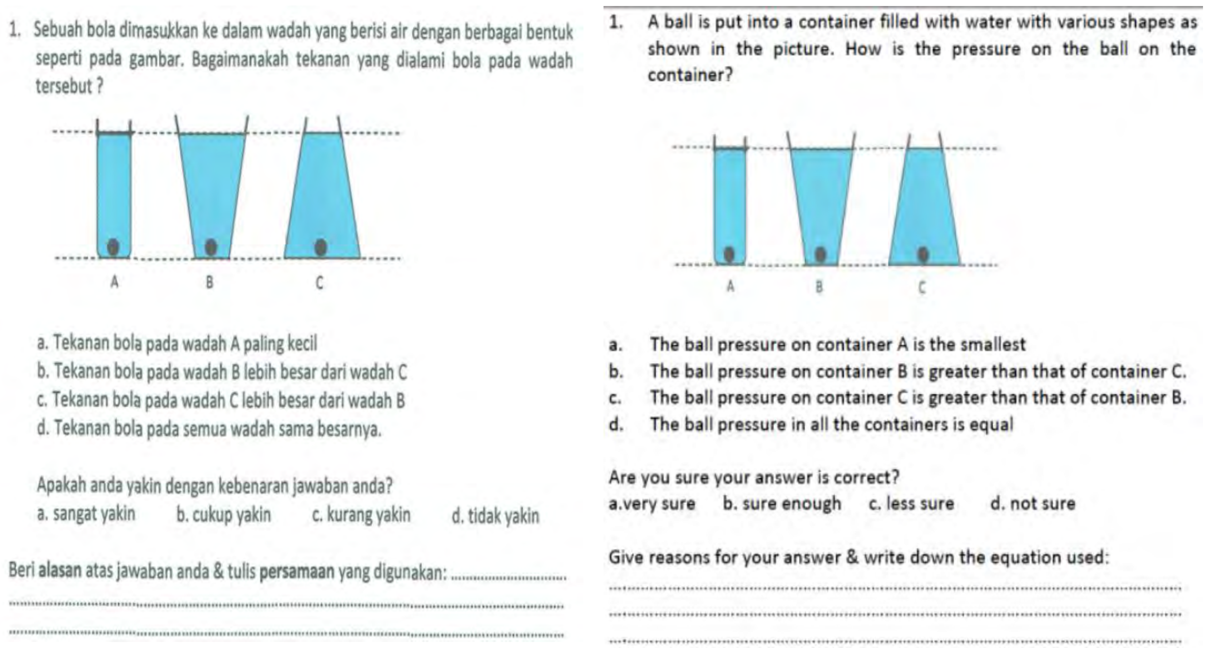
Samples	The Number of Students	Pre-test	Treatment	Post-test
Experiment Group 1	25	Concept test	X	Concept test
Experiment Group 2	32	Concept test	X	Concept test
Control Group	32	Concept test	-	Concept test

Note. X = Treatment: CCBL Model

The instrument in this study was a static fluid concept test consisting of 16 items. This test is a two-tier multiple-choice test consisting of multiple-choice items with beliefs regarding the answers and the reasons for the answers in an open-ended test (Figure 1).

Figure 1

Problem 1 on Hydrostatic Pressure



The concept test data analysis used five categories of conceptual understanding levels with the criteria as described in Table 2, further, simplified into three categories, namely SU, SM, and NU (Mufit et al., 2020; Puspitasari et al., 2021).

Table 3

Categories of Concept Understanding Levels

Concept Understanding Levels	Code	Criterion of Answer		
		Objective test	Confidence	Reason
Sound Understanding	SU	True	Very Sure/ Sure Enough	Responses that included all components of the validated response

Partial Understanding	PU	True	Very Sure/ Sure Enough	Responses that included at least one of the components of validated response, but not all the components.
Partial Understanding with Specific Misconception	PUSM	True	Very Sure/ Sure Enough	Responses that showed understanding of the concept, but also made a statement, which demonstrated a misunderstanding.
Specific Misconception	SM	True or False	Very Sure/ Sure Enough	Responses that included illogical or incorrect information.
No Understanding	NU	True or False	Not Sure/ Less Sure	Repeated the question; contained irrelevant information or an unclear response; left the response blank

Note. Source: Mufit et al. (2020); Puspitasari et al. (2021)

Concept tests have been tested on a group of 30 students to see empirical validity, namely construct validity and test reliability. The data obtained from the test results are qualitative data on the level of understanding of the concept with the categories SU, PU, PUSM, SM, and NU (Table 2). Before the data were analyzed, the data had been scored by converting the qualitative data into the appropriate quantitative (numbers), that is, respectively converted into numbers 5, 4, 3, 2 and 1. Furthermore, the construct validity data were analyzed by product-moment correlation statistics using SPSS 20. Based on the product-moment correlation table, it is found that all concept test questions were valid, because t_{count} was greater than t_{table} = 0.374 at a significant level of 0.05. The reliability of the test was tested internally (internal consistency) by analyzing the consistency of the items on the instrument, using the Alpha Cronbach method. The results of the reliability analysis using SPSS 20 indicated that the concept test instrument has high reliability, with a coefficient value of r_{11} = 0.771.

Based on the analysis of the difficulty index for each item, the value was in the range of 0.39-0.56, which indicated that all (16 items) of the static fluid concept test were within the moderate criteria. Meanwhile, the results of the analysis of the difference in the questions found that the values were in the range of 3% - 38%, and there were no negative items, with the maximum score set for each question was 4, meaning "partial understanding" (PU). Suwarto (2013) states that the differentiation power of a diagnostic test is carried out to ensure that there are no test items with negative discriminating power. Low item discrepancy can still be used because diagnostic tests (misconceptions) do not aim to measure the ability of students (achievement tests), but to determine students' understanding of the concept of learning material. Overall, based on the analysis described, the static fluid concept test can be used as an instrument in measuring the level of understanding of students' concepts.

The pretest and posttest data in this study were analyzed using percentage techniques. In addition, the data were also analyzed qualitatively based on the students' reasoning answers. The level of students' conceptual understanding (SU, SM, NU) from the pretest and posttest results of the experimental group and control group was used to determine the effectiveness of the CCBL model in improving conceptual understanding and remediating misconceptions.

Findings

The percentage of students' concept comprehension levels based on pretest and posttest results in the three sample groups can be seen in Figure 2 and Figure 3. Figure 2 shows that there is an increase in the number of students who belong to the category of Sound Understanding (SU) of the three sample groups in both experimental and control groups. However, the percentage of the gain in the control group (22.4%) is smaller than in the experimental groups (27.7% and 28.5%).

Figure 2

Increase of Sound Understanding (SU) Category

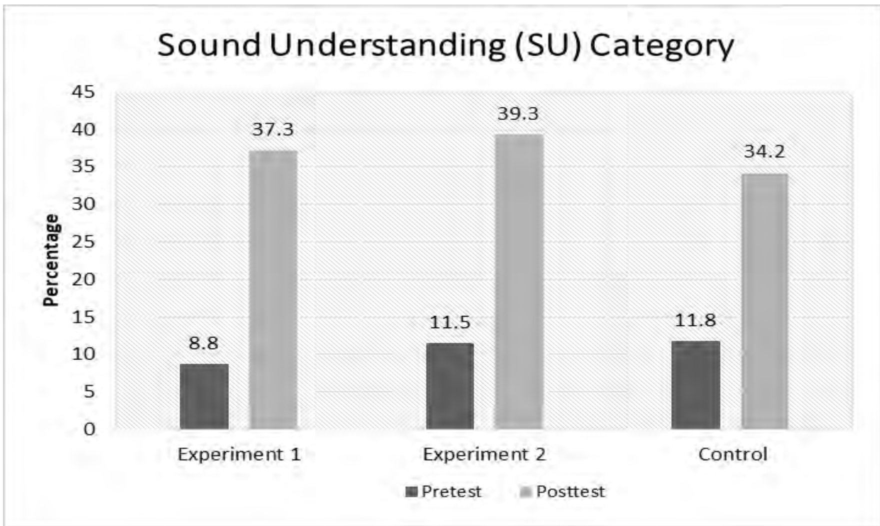
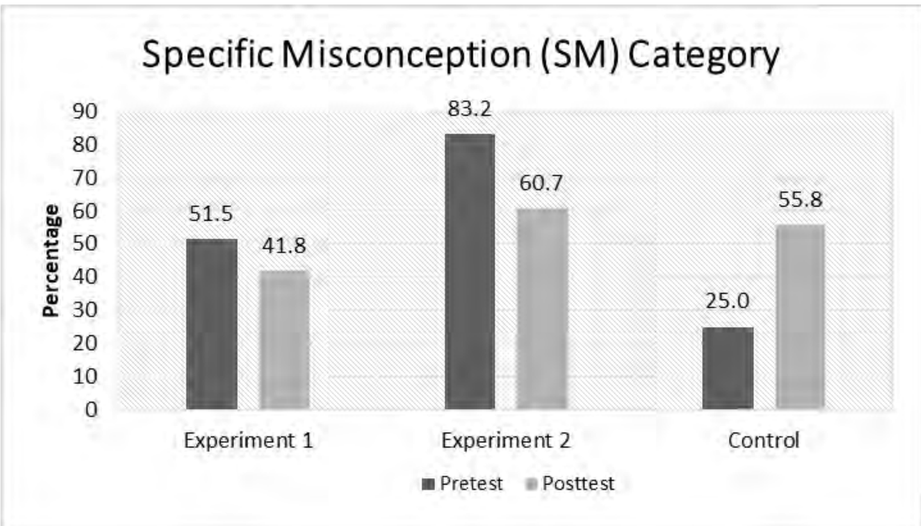


Figure 3 indicates that the students in all sample groups had misconceptions when doing the pretest. The misconceptions were mostly found, respectively, in the experimental group 2, the experimental group 1 and the control group. However, after the learning process, based on the posttest results, both experimental groups got a reduction in the number of students in the 'misconception' category by 9.8% and 22.5%, while in the control group the number increased by 30.8%.

Figure 3

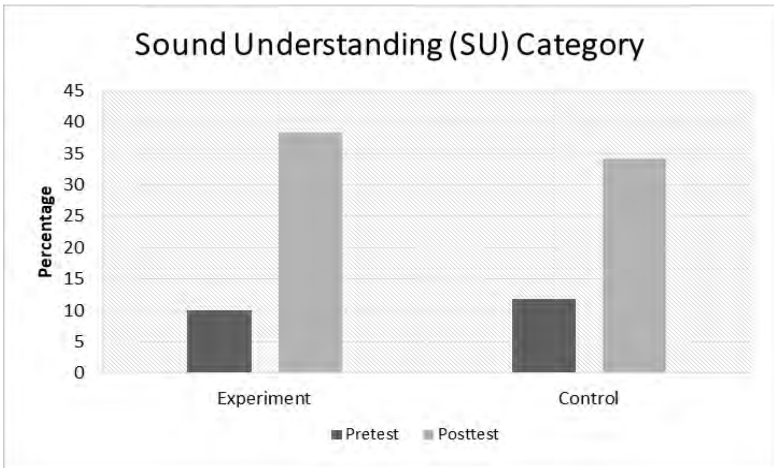
The Change of Specific Misconception (SM) Category



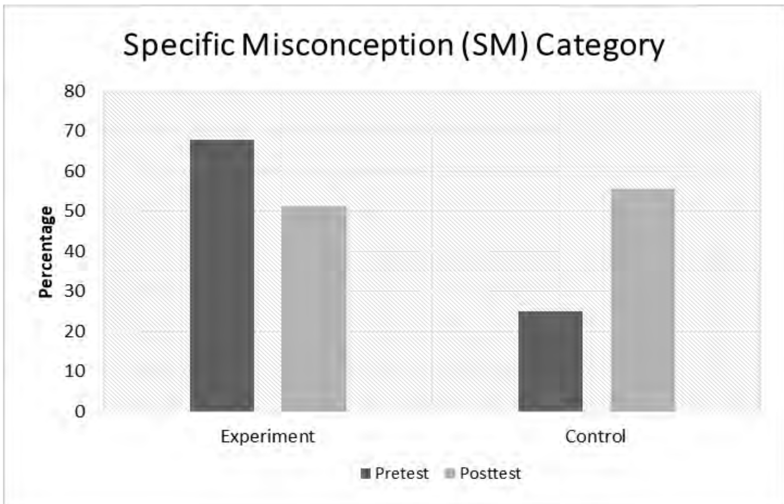
The effort to compare the students' level of conceptual understanding in the experimental and control group was made by combining the two experimental groups. The three sample groups were classified into two groups: the experimental group (combined experimental groups 1 and 2) and the control group. Figure 4 shows the result of the pretest and posttest comparisons in the experimental and control group. In the experimental group, the category of "sound understanding" increases by 28.2%, and in the control group, it increases by 22.4%. Meanwhile, the category of "specific misconception" in the experimental group reduces by 16.5%, and on the contrary, it increases by 30.8% in the control group. These results suggest that the CCBL model is effective in enhancing conceptual understanding and in reducing or remediating students' misconceptions.

Figure 4

The Change of Concept Understanding Level



(a) SU Category



(b) SM Category

Based on the analysis of the 16 answers from the 'multiple choice test' section of the static fluid concept test (by ignoring the students' reasons), it is also found that the average score of the experimental group is better than the average score of the control group. Table 4 presents the results of pretest and posttest correct answers from the multiple-choice test. Overall, the percentage of the initial knowledge average score of the control group is better than the one of the experimental group, however, the gain of the correct answers in the experimental group is better than the one in the control group.

Table 4

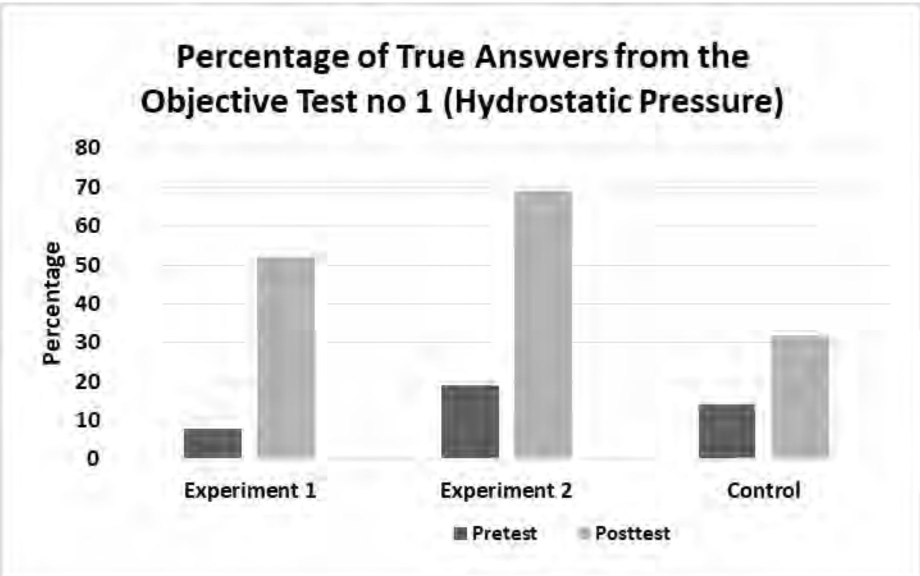
Percentage Increase in Correct Answers from the 16 Multiple Choice Test

Sample Group	Pre-test (%)	Post-test (%)	Gain (%)
Experiment	26	49	23
Control	29	45	16

The results of the descriptive analysis of students' reasoning answers also indicated that the change in students' conceptual understandings in the experimental group was better than the one in the control group. One of the concepts seen was hydrostatic pressure on problem 1 (Figure 1). The percentage gain of the correct answers from the multiple-choice (objective test) on problem 1 (by ignoring the students' reasoning answers) indicated that the percentage of the correct answers in the experimental groups (44% and 45%) was better than in the control group (18%). The results of the pretest and posttest's correct answers from the objective test on problem 1 are presented in Figure 5.

Figure 5

Ratio of True Answer on Number 1 Objective Test



The results of this objective test's analysis were also relevant to the students' reasoning answers; the experimental group's reasoning answer has improved better than the control group. Table 5 shows the recapitulation result of the reasoning answers.

Table 5

Percentage of Change in the Reason's Answer on Objective Test Number 1

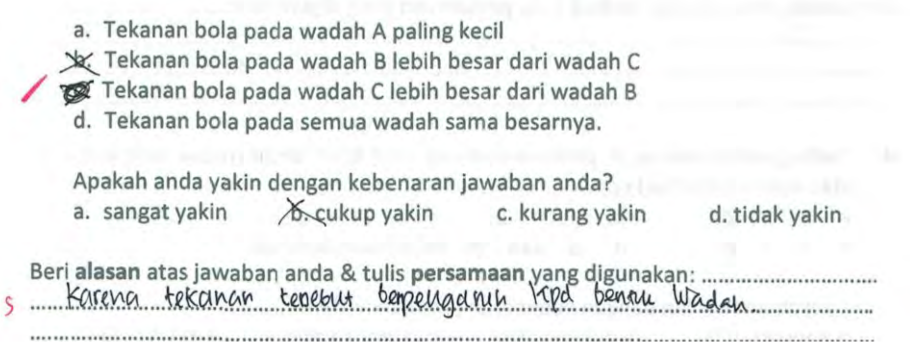
Change of Conceptual: Pre-test to Post-test	Exp 1. (%)	Exp 2. (%)	Control (%)
False (NU, SM) → True (PU, SU)	40	66	16
False (NU, SM) → True+Misconception (PUSM)	0	12	0
False (NU, SM) → False (NU, SM)	56	19	75
True (PU, SU) → True (PU, SU)	4	3	9

Based on Table 5, we can see that before the learning took place, only a small number of students understood the concept (3-9%), while most of the students did not understand the concept and experienced misconceptions. After the learning finished, the number of students who had misconceptions increased by 75% and only a few students experienced the conceptual changes (16%) in the control group, compared to the experimental groups.

Figure 6 shows the change in the concept of students in the experimental group from the specifics misconception (SM) category at the pretest to the sound understanding (SU) category at the posttest.

Figure 6

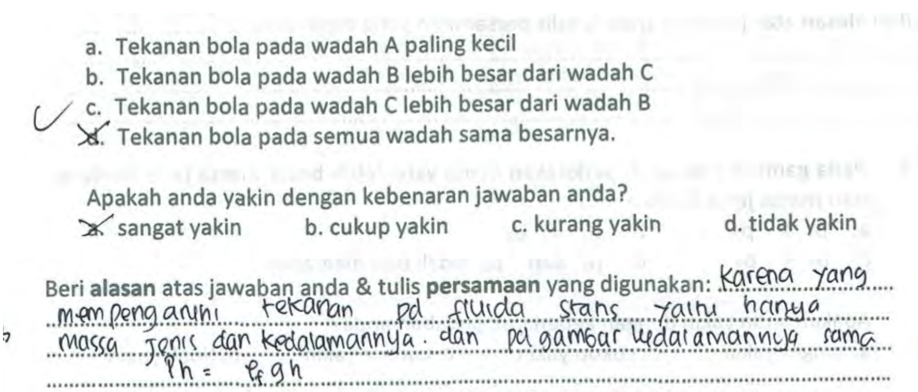
Changes in Student Answers in the Experiment Group from the Misconception Category (SM) to Understanding the Concept (SU).


a. Tekanan bola pada wadah A paling kecil
~~b.~~ Tekanan bola pada wadah B lebih besar dari wadah C
~~c.~~ Tekanan bola pada wadah C lebih besar dari wadah B
d. Tekanan bola pada semua wadah sama besarnya.

Apakah anda yakin dengan kebenaran jawaban anda?
a. sangat yakin ~~b.~~ cukup yakin c. kurang yakin d. tidak yakin

Beri **alasan** atas jawaban anda & tulis **persamaan** yang digunakan:
5 Karena tekanan tersebut berpengaruh kpd bentuk wadah

The answer to the reason (Pretest): *Because the pressure affects the shape of the container*.


a. Tekanan bola pada wadah A paling kecil
b. Tekanan bola pada wadah B lebih besar dari wadah C
c. Tekanan bola pada wadah C lebih besar dari wadah B
~~d.~~ Tekanan bola pada semua wadah sama besarnya.

Apakah anda yakin dengan kebenaran jawaban anda?
~~a.~~ sangat yakin b. cukup yakin c. kurang yakin d. tidak yakin

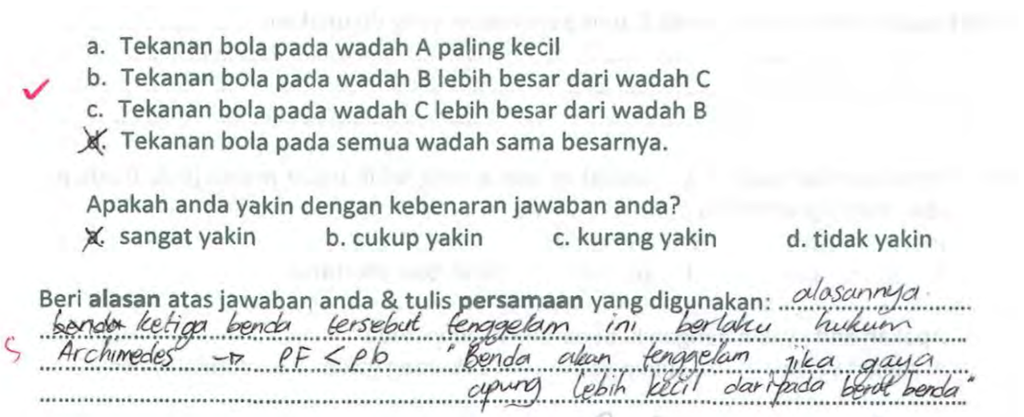
Beri **alasan** atas jawaban anda & tulis **persamaan** yang digunakan: Karena yang mempengaruhi tekanan pd fluida statis yaitu hanya massa jenis dan kedalamannya. dan pd gambar kedalamannya sama
Ph = ρf g h

The answer to the reason (posttest): *Because what affects the pressure in static fluid is only its density and depth, and in the image the depth is the same.* $P_h = \rho_f . g . h$

The analysis results of the concept test indicated that the ordinary multiple-choice test was not able to measure the students' conceptual understanding properly. After combining the results of the multiple-choice test with the reasoning answers and the beliefs of the students, it was found that, basically, the students did not understand the concepts or experienced misconceptions even though their answers for the objective test were correct. Figure 7 shows students who answered correctly objectively even though they experienced misconceptions. Figure 8 shows students who answered the objective questions correctly but did not actually understand the concept.

Figure 7

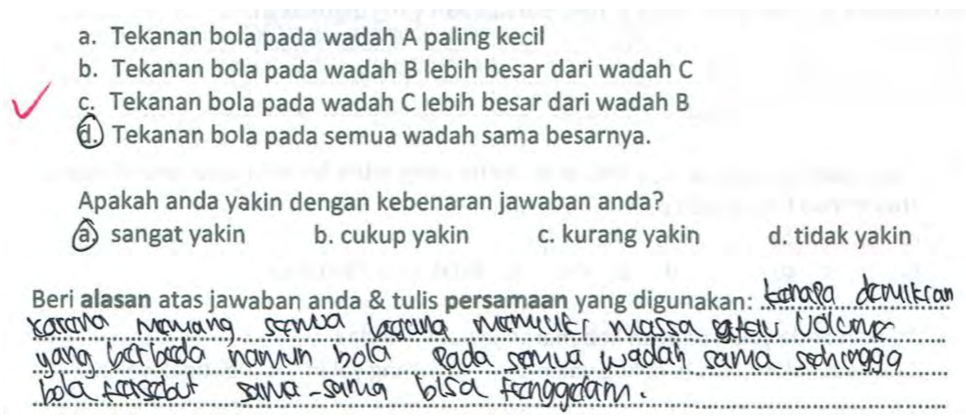
Students Who Answer the Objective Correctly, but Actually Experience Misconceptions


a. Tekanan bola pada wadah A paling kecil
b. Tekanan bola pada wadah B lebih besar dari wadah C
c. Tekanan bola pada wadah C lebih besar dari wadah B
d. Tekanan bola pada semua wadah sama besarnya.

Apakah anda yakin dengan kebenaran jawaban anda?
a. sangat yakin b. cukup yakin c. kurang yakin d. tidak yakin

Beri **alasan** atas jawaban anda & tulis **persamaan** yang digunakan: alasannya benda ketiga benda tersebut tenggelam ini berlaku hukum Archimedes → ρf < ρb "Benda akan tenggelam jika gaya apung lebih kecil daripada ~~berat~~ benda"

The answer to the reason: *All three objects sink because Archimedes' law applies:* → $\rho f < \rho b$. *The object will sink if the buoyancy force is less than the object's weight.*


a. Tekanan bola pada wadah A paling kecil
b. Tekanan bola pada wadah B lebih besar dari wadah C
c. Tekanan bola pada wadah C lebih besar dari wadah B
d. Tekanan bola pada semua wadah sama besarnya.

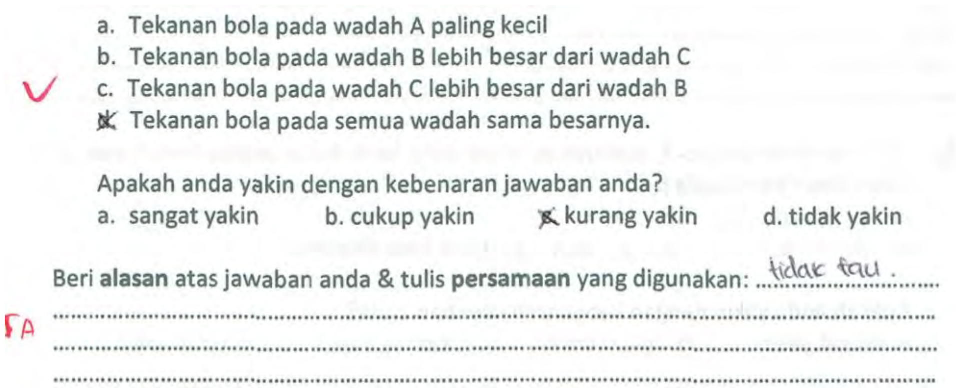
Apakah anda yakin dengan kebenaran jawaban anda?
a. sangat yakin b. cukup yakin c. kurang yakin d. tidak yakin

Beri **alasan** atas jawaban anda & tulis **persamaan** yang digunakan: kenapa demikian karena memang semua wadah memiliki massa atau volume yang berbeda namun bola pada semua wadah sama sehingga bola tersebut sama-sama bisa tenggelam.

The answer to the reason: *All the containers have different mass or volume, but the balls in all the containers are the same, so the balls can equally sink*

Figure 8

Students Who Answer Objective Questions Correctly, but Actually Don't Understand the Concept


a. Tekanan bola pada wadah A paling kecil
b. Tekanan bola pada wadah B lebih besar dari wadah C
c. Tekanan bola pada wadah C lebih besar dari wadah B
d. Tekanan bola pada semua wadah sama besarnya.

Apakah anda yakin dengan kebenaran jawaban anda?
a. sangat yakin b. cukup yakin c. kurang yakin d. tidak yakin

Beri **alasan** atas jawaban anda & tulis **persamaan** yang digunakan: tidak tau .

FA

Answer reason: *Don't know*

Discussion

The cognitive conflict-based learning model (CCBL model) can improve conceptual understanding and remediate student misconceptions. In this study, the experimental group and the control group both experienced an increase in concept understanding. This increase occurred because the two sample groups equally involved students in active group discussions and presentations. However, learning in the control group cannot remediate misconceptions, on the contrary, increased them. This happened because at the beginning of learning, students in the control group were not activated with their preconceptions and misconceptions, so they did not realize that they had misconceptions. In addition, in the control group, students only actively discussed the questions without carrying out the concept discovery process either through experiments or discussions. Meanwhile, the experimental group that applied the CCBL model experienced a significant reduction in misconceptions because of the role of the four CCBL model syntax which was able to identify and correct student misconceptions, and facilitate conceptual changes to the correct concept. The phases in the syntax consists of; (1) activation of preconception and misconception; (2) presentation of cognitive conflict; (3) concept and equation discovery; and (4) reflection. The syntax of the cognitive conflict-based learning model has the benefit/impact in improving students' conceptual understandings and remediating their misconceptions. The role of the model supporting system, especially the cognitive conflict-based students' worksheet is also very helpful in implementing this learning model so that the implementation is more effective.

In the first phase, activation of preconceptions and misconceptions plays important role in making students aware of their misconceptions. At this stage, by using students' worksheets, the students take a simple objective test about the concepts to learn. The process of students' recalling their prior knowledge will take place, which has an advantage as self-evaluation in order to know their initial concepts, whether the misconceptions are found or not. The prior knowledge activation is a process of recalling what the students have already known about the new topic, as an attempt to achieve a meaningful learning (Ormrod, 2006). The activation of students' initial knowledge is increasingly recognized to have a crucial role in learning. Learning that ignores the initial knowledge will fail to provide meaningful learning (Brown & Clement, 1989). The first phase is useful for lecturers to know the initial concepts and to identify the misconceptions of the students before the learning continues to the next stage. Kartal et al. (2011) suggest that when starting a new topic, a lecturer should conduct some tests to find out students' misconceptions in order for the lecturer to know the appropriate strategies and methods to implement meaningful learning. According to Putri et al. (2022), one of the factors that influences conceptual change is students' prior knowledge.

The second phase, cognitive conflict presentation, is given by presenting physics phenomena that can encounter misconceptions. At the end of the phenomena, the students answer some questions provided in the students' worksheet as hypotheses. This stage plays a role in stimulating conceptual conflicts in students before they discover new concepts which are scientifically correct. At this stage, the students are given the opportunity to predict an event by providing temporary answers (hypotheses) for each question about the concepts to learn. The activity of asking learners to make predictions will activate the existing beliefs and disbeliefs (Ormrod, 2006). Predictions prior to the discovery stage are important to encourage the students' confidence in finding the concepts and conceptual interrelationships through equations. Trumper (1997) argues that the first step required for conceptual change is to allow learners to realize the need for initial conceptual change and to feel dissatisfied with their prior knowledge. Conceptual conflict is one of the effective ideas to help students recognize such dissatisfaction (Meyer, 1993). Akmam et al. (2022a) also stated that cognitive conflict strategies have advantages, namely helping students to connect between concepts and instill new concepts correctly, so that they can last a long time. Rahim et al. (2015) propose five elements of cognitive conflict strategy in developing multimedia learning materials in which two of the elements, namely meaningful information and challenging students' existing concepts are relevant to this second phase.

The third phase, concepts and equations discovery, plays important role in achieving a long-lasting conceptual understanding of students' memories. This stage is conducted through experiment and discussion activities in groups. The students are given an opportunity to work collaboratively in exploring, constructing and sharing ideas, searching logical relations, checking new information, and revising old information to construct new knowledge. Ormrod (2006) states that the knowledge constructed socially by two or more people in collaboration will be better than the knowledge constructed individually. Constructing the knowledge socially involves the students' active collaboration to gain a better understanding of various information and events. The experiment activity in the implementation of the conflict based learning model yields a better understanding of the concepts compared to the demonstration activity in cognitive conflict strategy implementation investigated by Baddock & Bucat (2008). The experiment activity involves students more, while the demonstration activity involves more lecturers' roles.

This discovery activity is in accordance with the theory of constructivism which states that learners should find the information by themselves and transform the complex information, review the new information with old rules and revise it when it is no longer appropriate (Al Tabany, 2014). In this process of discovery, students construct the new knowledge and relate it to their prior knowledge, which is either preconception or misconception. This activity will trigger the conceptual change in students and create meaningful learning. Kaçar & Balim (2021) state that inquiry has a positive effect on students' understanding of concepts and is a good method of reducing misconceptions. Conceptual change through experimental and inquiry activities is an effective strategy in remediating misconceptions (Resbiantoro et al., 2022).

This stage of concepts and equations discovery is also helpful in correcting the students' views which consider that physics equations and the concepts in them are separable. The students no longer perceive that the physics equations (formulas) are only mathematical operations, which are memorized without knowing the meaning of physics in those equations. The process of concepts discovery and its organization in the form of equations is the attempt to gain a conceptual understanding. Ormrod (2006) states that when learners form many logical connections between various concepts and specific principles, they will achieve a conceptual understanding. The stage of this concepts and equations discovery also contributes to the improvement of students' attitudes towards physics lessons in which they used to think that physics is difficult, containing formulas without meaning of physics.

The fourth phase, reflection, plays an important role in evaluating the progress of students' conceptual understanding levels after finishing the previous stages. Firstly, it is carried out with a class discussion activity about the discovery activity which has been conducted in the third stage. One group presents their work and the other group responds regarding the problems or the similar and the different results they get during the discovery activity. The class dialogues are very useful for lecturers since by monitoring the comments or questions of the students carefully, the lecturers can identify and solve the misconceptions which can hinder their ability to gain broad knowledge and skills (Ormrod, 2006). The dialogues which take place during the class discussion will be the feedback for lecturers to figure out the students' conceptual understanding progress as well as the misconceptions they still hold. Feedback activities after carrying out practical simulations function directly in reflecting student understanding (Sasmito & Sekarsari, 2022). When students have moved from an idea of personal knowledge to a scientific understanding, it is said that students have experienced a conceptual transformation (Ezema et al., 2022).

Besides the feedback for the lecturers, the class discussion also strengthens the students' conceptual understandings because the process of comprehension construction takes place during the class dialogues as a whole. The groups' experiences during the discovery activity will be exposed during class discussion, and each group will share their experiences which further enrich their knowledge. Hacker et al. (1998) suggest that learners are able to remember various new ideas and experiences more effectively and accurately when they discuss the problems together through class discussions. Therefore, contemporary experts recommend that the class discussion activities should be conducted routinely during learning activities. During this class discussion, the lecturers are able to provide direct feedback if the misconceptions occur or the concepts are not well understood by the students.

The reflection on students' conceptual understandings can also be done through test items that the students do individually. The evaluation questions require conceptual understanding as well as an understanding of the relation between concepts through their mathematical equations. The work of learners in solving the evaluation items can be the feedback for lecturers to know the comprehension levels and misconceptions that remain after the learning process is completed. In a computational physics course, it was also stated that the reflection stage is useful for providing feedback on the construction process and the results obtained, as well as providing corrections and strengthening students' understanding of concepts (Akmam et al., 2022b).

The results of this study are relevant to Baser (2006) who states that the cognitive conflict-based learning of physics can enhance the students' conceptual understanding of temperature and heat, compared to other conventional learning models. Even though both types of learning resulted in the gain of conceptual understanding, yet, the experimental groups have more gains. The advantage of this model of cognitive conflict-based learning in comparison to Baser's is the syntax of concepts and equations discovery. The cognitive-conflict strategy can also overcome misconceptions by using multimedia learning materials (Arifin et al., 2021; Kabaca et al., 2011; Rahim et al., 2015), including using the Adobe Animate CC application (Aini & Mufit, 2022; Anggraini et al., 2022; Dhanil & Mufit, 2021).

The results of this study also revealed that the students almost at all times encountered the misconceptions, including the teacher candidates. Although the students were able to answer the objective test correctly but from their reasoning answers, they definitely did not understand the concepts or held misconceptions. The misconceptions occurred in a student of primary school teacher candidate who academically had high scores (Taşar, 2010). The student comprehended the basic concept (of acceleration), however, when the basic concept was applied in particular situations (which are also applicable), she encountered misconceptions.

Şahin et al. (2010) also found out students' misconceptions on fluid concept (hydrostatic pressure). The remedial attempt for the misconceptions was done by using Conceptual Change Text (CCT) technique, that is, a technique which utilized the computer's animations. Şahin et al. (2010) stated that the weakness of this technique was that the students did not conduct the experiments directly. The weaknesses in Şahin's study can be overcomed by using this CCBL model, which can remediate the misconceptions about hydrostatic pressure by direct experiment activities.

Foster (2012) argued that the appropriate socio-cognitive conflict can overcome students' misconceptions in evolution lessons. The cognitive conflict was stimulated through discussion activities. The students were encouraged to express their opinions and ideas freely. Then, their way of thinking was confronted with different experience (anomaly data) that was inconsistent with their current understanding. This kind of activity was relevant to the third syntax (concepts and equations discovery) of this CCBL model. In addition to the experiment activities, the students also had discussions to express their ideas and think thoroughly for finding the correct concepts and equations.

Samsudin et al. (2021) implemented the PDEODE*E (Predict, Discuss, Explain, Observe, Discuss, Explore, and Explain) learning strategy combined with the Think-Pair-Share (T-P-S) type of cooperative learning to improve conceptual understanding and reduce misconceptions. The strategy stages are almost the same as the syntax of the CCBL model, but the CCBL model is simpler. The PDEODE*E task strategy with the Think-Pair-Share model is effective for reconstructing students' conceptions from misconceptions to conditions of scientific concepts on work and energy.

Other studies have also shown that the application of the e-Service Learning-assisted Cognitive Conflict Strategy can reduce student misconceptions by 85% and is effective in improving students' mathematical problem-solving abilities (Parwati & Suharta, 2020). This strategy has five phases, namely introduction, exploration, accommodation, resolution and generalization, which are also almost the same as the syntax of the CCBL model.

The effect of the cognitive conflict strategy on students' conceptual changes was also carried out by Madu & Orji (2015). They used three stages of strategy, namely; (a) identifying the student's current state of knowledge; (b) confronting students with contradictory information; and (c) evaluating the degree of conceptual change. The first stage of the strategy corresponds to the first phase of the CCBL syntax, which is to identify students' initial conceptual understanding. The third stage of the strategy is in accordance with the fourth phase of CCBL syntax, namely evaluating or reflecting to find out the concept changes that occur. The results of this study indicated that students have misconceptions in conceptualizing temperature and heat, and cognitive conflict strategies were effective in making conceptual changes to these students.

In general, CCBL model or strategies are widely used by researchers or educators to improve conceptual understanding and remediate student misconceptions, as well as to improve other competencies such as mathematical problem-solving skills and critical thinking (Mufit et al., 2020). Real experimental video analysis can be applied to the third phase of the CCBL syntax, namely concept and equation discovery. Some phenomena of motion are difficult to observe directly such as free fall, parabolic motion, inclined plane motion and motion in collision events, but through video recording and tracker programs, students can still conduct real experiments on the third phase of the CCBL syntax. The CCBL model provides more meaningful and enjoyable learning, mainly because of the experiment and discussion activities which give chances to the students to explore the new concepts. The concepts and equations discovery stage plays a role in changing the students' perceptions of physics which view physics as tricky and merely about formulas and equations.

Conclusion and Implications

The cognitive conflict-based learning model (CCBL) has an effect on increasing conceptual understanding and remediating misconceptions. The CCBL model has a smart syntax, which is especially useful for remediating students' misconceptions, namely; (1) preconception and misconception activation; (2) cognitive conflict presentation; (3) concepts and equations discovery; and (4) reflection. Learning that ignores prior knowledge (including misconception) and does not engage the students in the discovery process will potentially increase misconceptions since, in general, the new students have misconceptions that they got from their previous education. The ordinary multiple-choice test is not quite effective in revealing students' misconceptions because it cannot figure out whether the students do guessing (not understanding the concepts) or understand the concepts but with misconceptions. It is necessary to provide two-tier multiple-choice test or an objective test with open-ended answers to uncover the students' misconceptions.

This research can be used by educators as an alternative effective learning model to remediate misconceptions. Moreover, it is applied in science learning which is prone to student misconceptions. The government in charge of curriculum preparation may consider using the CCBL model as one of the recommended models in the new curriculum. The CCBL model is specifically designed to improve conceptual understanding and correct students' misconceptions. This will enrich the types of models, in addition to problem-based learning (PBL), inquiry or discovery learning, and project-based learning (PjBL) models that have been previously recommended by the government. For further studies, it is suggested to explore the effectiveness of this CCBL model in depth, both in the field of physics and other fields such as biology, chemistry and mathematics. The next researchers can also conduct development research to produce teaching materials or learning media products that are designed according to the CCBL model syntax, as a support system for the implementation of the CCBL model in learning.

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Appendix

Examples of Some Student Work on Worksheets Based on Cognitive Conflict in the Experimental Class

LKM Fluida Statis — Berbasis Konflik Kognitif

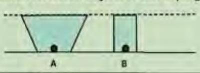
D. Latihan (20 menit) : AKTIVASI PRAKONSEPSI & MISKONSEPSI

Petunjuk !

1. Bacalah dengan cermat setiap fenomena fluida statis berikut ini. Setiap fenomena terdiri dari beberapa pernyataan.
2. Pada setiap pernyataan, berilah tanda checklist (√) pada salah satu kolom: B, S atau T, dengan keterangan :
   - B : jika anda yakin pernyataan BENAR
   - S : jika anda yakin pernyataan SALAH
   - T : jika anda TIDAK TAHU

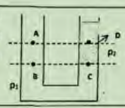
No 1 — Fenomena Fluida Statis

Sebuah kelereng dimasukkan ke dalam bejana A dan B yang berisi air, seperti pada gambar.



No	Pernyataan	B	S	T
a	Kelereng A mendapat tekanan lebih besar daripada kelereng B		√	
b	Tekanan yang dialami kelereng A dan B sama besar		√	
c	Tekanan oleh air ditentukan oleh bentuk bejana.			√
d	Tekanan oleh air ditentukan oleh kedalaman	√		
e	Tekanan oleh air ditentukan oleh massa air			√

2. Sebuah pipa U diisi dengan dua jenis fluida yang berbeda, dengan massa jenis masing-masing ρ_1 dan ρ_2 seperti pada gambar.



No	Pernyataan	B	S	T
a	Tekanan fluida di titik A sama dengan tekanan di titik B			√
b	Tekanan fluida di titik A sama dengan tekanan di titik D		√	
c	Tekanan fluida di titik B sama dengan tekanan di titik C	√		
d	Massa jenis ρ_1 lebih besar dari massa jenis ρ_2	√		
e	Tekanan fluida dipengaruhi oleh massa jenis fluida	√		

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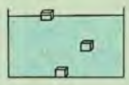
3. Melalui sebuah dongkrak hidrolik yang kecil, manusia dapat mengangkat mobil yang besar. Sistem ini mirip dengan pipa U berisi fluida yang berpenampang besar (A2) dan kecil (A1), seperti pada gambar.

No	Pernyataan	B	S	T
a	Gaya oleh tangan manusia pada penampang A1 diteruskan sama besar kepada fluida pada penampang A2.	√		
b	Tekanan akibat tangan manusia pada penampang A1 diteruskan sama besar kepada fluida pada penampang A2.		√	
c	Untuk mengangkat mobil, penampang pipa A2 tidak harus lebih besar dari penampang A1.	√		

4 Tiga jenis balok berukuran sama dimasukkan ke dalam bejana berisi air. Ada yang mengapung, melayang dan tenggelam, seperti pada gambar.



No	Pernyataan	B	S	T
a	Balok tenggelam karena balok tersebut lebih berat dari air.		√	
b	Balok yang melayang dan mengapung mendapat gaya ke atas, sedangkan balok yang tenggelam tidak.		√	
c	Balok yang mengapung, mendapat gaya ke atas yang lebih besar dibanding balok yang melayang.	√		
d	Massa jenis balok yang melayang sama besar dengan massa jenis air.	√		

5 Serangga air dapat berjalan di atas permukaan air, seperti terlihat pada gambar. Penyebab hal itu adalah:

LKM Fluida Statis — Berbasis Konflik Kognitif

No	Pernyataan	B	S	T
a	Serangga air mempunyai massa jenis yang lebih kecil dibanding massa jenis air.		√	
b	Gaya ke atas (gaya apung) serangga lebih besar dibanding gaya berat serangga.	√		
c	Pada permukaan air seolah-olah ada selaput karena adanya gaya kohesi antar molekul air.		√	
d	Adanya gaya adhesi antara kaki serangga dengan molekul air.	√		

6 Saat ujung kain dimasukkan ke dalam air, air akan merembes naik ke bagian atas kain. Apa penyebab fenomena ini ?

No	Pernyataan	B	S	T
a	Sifat air yang mempunyai gaya ke atas.		√	
b	Adhesi antara partikel air dan partikel kain lebih besar dibanding kohesi antar partikel air.	√		
c	Kain mempunyai pori-pori yang kosong (ibarat tabung tipis), sehingga mudah diisi oleh partikel air.	√		
d	Ada pengaruh tegangan permukaan air.			√

E. Lembar Kerja (150 menit):

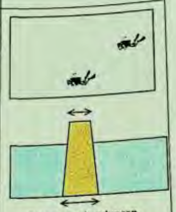
PENYAJIAN KONFLIK KOGNITIF

Ayo renungkan dan pikirkan fenomena fluida statis berikut ini ! (15 menit)

No 1. Tekanan Hidrostatis — Fenomena Fluida Statis

a. Andi menyelam di danau dekat rumahnya. Semakin dalam Andi menyelam, telinganya terasa semakin sakit. Kenapa ya ??

b. Struktur bendungan selalu dibuat lebih lebar pada bagian bawahnya. Kenapa dibuat seperti itu ??



Tulis jawaban sementara (hipotesismu) !

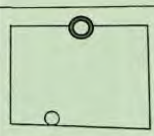
a. Pengaruh tekanan, semakin dalam kita menyelam maka tekanan semakin besar.

b. Untuk mengurangi tekanan dan besarnya gesekan antara air dan bendungan

2. Hukum Archimedes

a. Dua bola logam, masing-masing bola berongga dan bola pejal. Keduanya mempunyai massa yang sama. Saat keduanya dimasukkan ke dalam air, ternyata bola berongga mengapung dan bola pejal tenggelam. Kenapa bisa begitu ya.. ??

b. Andi merasa lebih mudah mengapung saat mandi di air laut dibanding air sungai. Kenapa ya.. ??



Dipindai dengan CamScanner

LKM Fluida Statis

Berbasis Konflik Kognitif

Tulis jawaban sementara (hipotesismu) !

a. Dipengaruhi oleh massa jenis

b. Massa jenis air laut lebih besar dibandingkan massa jenis air sungai

3. Hukum Pascal

Pada tempat pencucian mobil, dengan menggunakan dongkrak hidrolik, gaya oleh tangan manusia bisa mengangkat mobil yang jauh lebih besar. Kok bisa yaa ??

Tulis jawaban sementara (hipotesismu) !

Karena, secara logika

$\frac{A_1}{F_1} = \frac{A_2}{F_2}$

Jadi luas penampang A_1 dan F_2 sama dengan A_2 dan F_1

4. Tegangan Permukaan

Sebuah klip kertas yang terbuat dari logam diletakkan secara perlahan di atas permukaan air. Ternyata klip kertas dapat mengambang di atas permukaan air. Saat klip didorong sedikit, klip langsung tenggelam.

Kenapa bisa demikian ?

Klip kertas dapat mengambang di atas permukaan air

LKM Fluida Statis

Berbasis Konflik Kognitif

Tulis jawaban sementara (hipotesismu) !

Karena tegangan permukaan klip kertas jika di geser maka genangannya akan berubah.

5. Kapilaritas

Pada saat ujung kain atau sumbu kompor dimasukkan ke dalam gelas berisi air, terlihat air 'naik' ke bagian atas kain atau sumbu kompor. Kenapa bisa begitu ??

Tulis jawaban sementara (hipotesismu) !

Suatu zat cair akan mengalir dari penampang besar ke kecil dan tekanan kecil ke besar besar kecil

LKM Fluida Statis

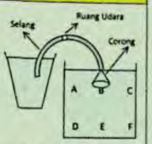
Berbasis Konflik Kognitif

Ayo lakukan eksperimen sederhana untuk menjawab rasa keingintahuanmu

PENEMUAN KONSEP DAN PERSAMAAN

No	Eksperimen Sederhana Fluida Statis
1	**Tekanan Hidrostatis (30 menit)**

Siapkan dua bejana berisi air dan selang yang dilengkapi corong seperti pada gambar. Buktikan bahwa fluida punya tekanan yang disebut tekanan hidrostatis. Temukan juga faktor yang mempengaruhi tekanan hidrostatis.



Langkah Kerja:

1. Isi selang dengan air, namun tinggalkan sedikit ruang untuk udara
2. Letakkan corong pada titik A, amati gerak udara dalam selang.
3. Beri tanda posisi udara dalam selang dengan spidol (misal O_1, O_2,...)
4. Ulangi langkah 1 dan 2 untuk titik B, C, D, E, dan F

Data :

Posisi Corong dalam bejana	Posisi udara dalam selang
Titik A	O_1
Titik B	O_1
Titik C	O_1
Titik D	O_2
Titik E	O_2
Titik F	O_2

Analisis :

1. Sewaktu corong dimasukkan ke dalam bejana semakin 'dalam', apakah udara dalam selang juga bergerak menjauhi corong? Ya
2. Pada saat udara dalam selang bergerak semakin jauh dari corong, apakah berarti tekanan air dalam bejana semakin besar ? Ya
3. Titik mana dalam fluida yang mempunyai tekanan paling tinggi ? D, E, F
4. Titik mana dalam fluida yang mempunyai tekanan paling rendah ? A, B, C

12

Berbasis Konflik Kognitif

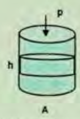
Kesimpulan: (buat kesimpulan dari pertanyaan berikut ini !)

Apakah fluida yang diam (statis) mempunyai tekanan ? Ya

Faktor utama apa yang mempengaruhi tekanan hidrostatis ? Kedalaman (h)

Mari Turunkan Persamaannya !!

Turunkan persamaan tekanan hidrostatis (p_h) dari konsep tekanan p = F/A pada elemen fluida setinggi h dan luas penampang A.



$P = \frac{W}{A} = \frac{m.g}{A}$

$= \frac{\rho V.g}{A} = \frac{\rho A h.g}{A}$

$\boxed{P = \rho g h}$

Tuliskan persamaan yang kamu dapatkan ! : $\boxed{P = \rho g h}$

Dari persamaan yang diperoleh, apa saja yang mempengaruhi tekanan hidrostatis ?

1. h = kedalaman
2.
3.

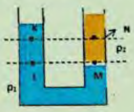
Bagaimanakah jika permukaan fluida bersentuhan dengan udara terbuka ? Apakah ada pengaruh tekanan udara (atmosfir) ?

Tuliskan Persamaan tekanan hidrostatis yang dipengaruhi oleh tekanan udara (atmosfir) : $\boxed{P_h = P_0 + \rho g h}$

Mari kita selidiki fenomena dua fluida yang berbeda jenis dalam pipa U berikut ini ! (prinsip kerja hidrometer)

Misalkan pipa U yang diisi dengan dua jenis fluida yang berbeda, sehingga membentuk susunan fluida seperti pada gambar berikut ini.

Diantara titik K, L, M dan N pada fluida, apakah ada titik yang mempunyai tekanan yang sama ? Kalau ada, titik manakah itu ?



Jawab : L dan M

Apa alasanmu: karna kedalamanya sama dan massa jenisnya sama

Tuliskan persamaan tekanan di pada titik-titik tersebut, dan temukan persamaan yang menyatakan hubungan antara massa jenis fluida (ρ) dengan kedalaman (h) !

$P_{hL} = P_{hM}$

$P_0 + \rho_1 g h_1 = P_0 + \rho_2 g h_2$

$\rho_1 h_1 = \rho_2 h_2$

Tulis persamaan akhir yang kamu dapatkan di sini !

$\boxed{\rho_1 h_1 = \rho_2 h_2}$

Apa makna dari persamaan tersebut :

$\rho_1 = \frac{\rho_2 h_2}{h_1}$, massa jenis berbanding terbalik dengan kedalaman

Berikan contoh penerapan hukum hidrostatis !

1. ...
2. ...
3. ...

LKM Fluida Statis

Berbasis Konflik Kognitif

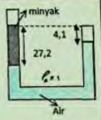
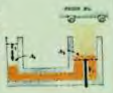
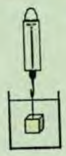
F. Evaluasi

Agar lebih paham, selesaikan persoalan fluida statis berikut ini secara individu ! (Waktu 30 menit)

Petunjuk !

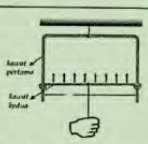
Sebelum menyelesaikan soal secara hitungan (menggunakan persamaan), tuliskan dulu konsep atau prinsip fisika yang mendasarinya.

EVALUASI DAN REFLEKSI

No	Soal
1	Air dituangkan ke dalam tabung berbentuk U yang terbuka pada kedua ujungnya. Lalu dituangkan minyak sehingga keduanya setimbang dan tidak bercampur. Tinggi minyak dalam tabung adalah 27,2 cm seperti pada gambar. Berapakah massa jenis minyak ? 
2	Tekanan ukur maksimum pada lift hidrolik adalah 18 atm. Berapa massa mobil terbesar yang dapat diangkatnya jika diameter jalur output adalah 22 cm. 
3	Sebuah balok alumunium tidak berongga bermassa 2 kg digantung pada kait sebuah neraca pegas. Massa jenis alumunium adalah 2700 kg/m³. Berapakah hasil bacaan neraca pegas ketika balok alumunium : a. Berada di udara b. Tercelup seluruhnya di dalam air c. Tercelup setengah bagian di dalam air. 

LKM Fluida Statis

Berbasis Konflik Kognitif

4	Sebuah balok kayu yang panjang, lebar dan tingginya berturut-turut: 50 cm, 50 cm dan 30 cm sedang terapung di permukaan danau. Tiba-tiba hinggap seekor bangau di atas kayu tersebut. Saat tenang, tinggi bagian kayu yang menonjol di atas air adalah 10 cm (massa jenis kayu 0,6 gr/cm³). Hitunglah : a. Massa balok kayu b. Massa bangau 
5	Sebuah peralatan kawat berbentuk U (kawat pertama) dilengkapi dengan kawat lurus (kawat kedua) yang ringan dan dapat digerakkan, panjangnya 5 cm, seperti pada gambar. Pada saat dicelupkan ke dalam larutan air sabun, kawat lurus tertarik ke atas.  (Sumber: http://fisikazone.com) a. Apa yang menyebabkan kawat lurus tertarik ke atas ? b. Berapakah besar gaya yang diperlukan untuk menarik kawat lurus tanpa merobek selaput larutan sabun ? (Tegangan permukaan larutan sabun 0,025 N/m) c. Kenapa untuk mencuci pakaian kotor digunakan air sabun, dan lebih baik menggunakan air hangat ?
6	Pembuluh xylem (pipa sempit yang mengangkut sari makanan dari tanah ke bagian atas pohon) memiliki diameter 0,002 cm. Berapa kira-kira tinggi air yang dapat naik dari permukaan tanah, jika tegangan permukaan air 0,0735 N/m ? (Anggap sudut kontaknya 0°).  (sumber: https://pixabay.com)