The preliminary study of the application of the conceptual change laboratory (CC-Lab) for overcoming high school students misconception related to the concept of floating, drifting and sinking

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Abstract. This preliminary study was conducted to get an overview of the effects of applying the CC-Lab model to conceptual changes of high school students related to the concept of floating, drifting and sinking. The CC-Lab consists of four main activity stages of Lab, namely: 1) the stage of identifying student preconceptions, 2) the stage of conception confronting Lab, 3) the stage of conceptual Lab, and 4) the Stage of identifying the final conception of the student. A pre-experiment method with one group pretest-posttest design was used in this research. There are 37 students consisting of 22 female students and 15 male students, in one of the high schools in the West Bandung district of West Java province. Lab activities are carried out cooperatively in small groups. The instrument used to collect data is a conception test in the four tier test format related to the concept of floating, drifting and sinking. The results showed that before the application of the CC-Lab, the number of students in each conception category were: scientific conception (10%), misconception (62%), and no conception (28%), while after the activity of CC-Lab, the number of students in each category of conception became: scientific conception (82%), misconception (12%), and no conception (6%). These results indicate that the implementation of the CC-Lab model has a high effectiveness in remediating the misconceptions that occur among high school students regarding the concept of floating, drifting and sinking.

1. Introduction

Until now, research on misconceptions is still being carried out intensively by researchers in the field of education, including the field of Physics education at various levels. Research on misconception is focused on two areas, namely, the area of identifying misconceptions and the area of misconception remediation. Research in the area of identification of misconceptions has produced a variety of instruments to identify misconceptions, such as conception tests in two-tier test formats [1], in three-tier test formats[2], and in four-tier tests [3]. Whereas research in the area of misconception remediation has resulted in various strategies for learning that are oriented towards conceptual change, such as cognitive conflict strategies [4], discrevent event strategies [5], and bridging analogy strategies[6].
The implementation of teaching oriented to conceptual change is usually done through the mode of face-to-face learning in the classroom and text mode. For teaching with face-to-face mode in the classroom, it is often used conceptual change oriented instruction model (CCOI model), while remedial teaching with text mode is often used conceptual change text (CCText). The CCOI and CCText models are developed based on four conditions needed for conception change, namely dissatisfaction, intelligibility, plausibility, and fruitfulness [7]. One of the CCOI models that is often used for remedial teaching with the mode of face-to-face learning in the classroom is the six-stage conceptual change model (CCM) formulated by Stepans, which consists of the following six stages of the learning process: 1) The phase of disclosure of students’ conceptions, 2) Phase of disclosure of students’ conception of beliefs, 3) Phase of confrontation of conception beliefs, 4) Phase of accommodation of new conceptions, 5) Strengthening of conception reinforcement, and 6) Phase of expansion of conception [8]. Whereas the parts of CCText that are often used include: 1) part 1. Text of disclosure of students’ initial conception, 2) part 2. Text of conception confrontation, 3) part3. Text of scientific explanations, 4) part 4. Text of statement of conception changes and 5) part 5. text of disclosure of students’ final conception.

In physics teaching there is one more mode of activity that can be used, namely the mode of laboratory activity. In physics learning, laboratory activities have a fairly central role in instilling a comprehensive understanding of physical content and providing various skills, both science process skills and high-order thinking skills (HOTS).

Laboratory activities also have the good potential to be used for activities that can facilitate the process of conceptual change, because through laboratory activities four conditions for conceptual change can also be implemented. The advantage of the mode of laboratory activities is that students can be facilitated to construct and change their conceptions through in-depth exploration activities by themselves. So the view of constructivism can be truly applied. As a CCOI and CCText, the laboratory-oriented conceptual change is given the term CCLab, which stands for conceptual change laboratory, which means laboratoryt activities oriented to changing student conceptions. In our research group the CCLab syntax and its supporting material such as worksheet have been developed.

Preliminary study on the implementation of the CC-Lab model in teaching the concept of floating, drifting and shinking was carried out to explore its potential in facilitating the achievement of scientific conceptions and their effectiveness in remediating the misconceptions of high school students. This article describes the process and results obtained from the preliminary study on the CC-Lab implementation that has been carried out.

2. Methods
A pre-experiment method with one group pretest-posttest design was used in this research. There are 37 students consisting of 22 female students and 15 male students, in one of the high schools in the West Bandung district of West Java province. Lab activities are carried out cooperatively in small groups. The CC-Lab consists of five main activity stages of Lab, namely: 1) the stage of identifying student preconceptions, 2) the stage of conception confronting Lab, 3) the stage of conceptual Lab, 4) the stage of enrichment and strengthening conception and 5) the Stage of identifying the final conception of the student. In detail, the stages, activities and supporting material for CC-Lab activities are presented in Table 1.

| Stage of CC-Lab                          | Students Activity                        | Supporting Material                                             |
|-----------------------------------------|------------------------------------------|----------------------------------------------------------------|
| Identification of students' initial    | Students answer conception test in       | Conception test in four tier test format related to the         |
| conception and level of                | the four tier test format                | concept of floating, drifting and shinking                      |
| conception beliefs                     |                                          |                                                                  |
Lab activities that are oriented to the confrontation of student conception beliefs (cognitive conflict strategy) | Students carry out laboratory activities to confront the beliefs of their conceptions | Worksheet CCB-Lab (verification lab) | Tools and Material: Riil or Virtual apparatus
| Exploration through laboratory activities oriented to the discovery of new scientific conceptions to replace the old conception that was missed (conception accommodation process) | Students carry out explorations in the form of laboratory activities to find scientific conceptions to replace the old conception that is missed with a new scientific conception (conception accommodation process) | Worksheet Conceptual Laboratory | Tools and Material: Riil or Virtual apparatus
| Enrichment and strengthening conception through review of other relevant contexts | Students listen and respond to the expansion and strengthening of the new conception presented by the teacher | Multimedia visual (Video fenomena, virtual simulation, and dynamic analogy)
| Identification of students' final conception and level of conception beliefs | Students answer conception test in the four tier test format | Conception test in four tier test format related to the concept of floating, drifting and shrinking

The instrument used to collect data in this study consisted of conception tests in the Four Tier Test format about floating, drifting and shrinking concept or abbreviated as FDSFTTest. Figure 1 shows the FDSFTTest items used in this study.

**FDSFTTest item**

**Tier 1**
An object made of glass when dipped in water will position it
A. Always sinking
B. Always floating
C. Can sink but can also float

**Tier 2**
Are you sure of the answers you gave to Tier 1?
A. Sure
B. Not sure

**Tier 3**
The right explanation for your choice of Tier 1 answers is ...
A. Objects will float or sink in water depending on the ratio of density of object to the density of water. Because the density of objects made of glass material is greater than the density of water, then the object made of glass material will always sink when dipped in water.
B. Objects will float or sink in water depending on the ratio of the weight of the object and the buoyant force acting on the object by water. If the weight of a glass object is greater than the buoyant force acting on it, the object will sink, and vice versa.
C. Glass is a waterproof material so that it will get a large buoyant force from water and the effect of objects made of glass will always float when dipped in water
D. ..............................................................

**Tier 4**
Are you sure of the answers you gave to Tier 3?
A. Sure
B. Not sure

**Figure 1.** FDSFT Test items used in this study
The categorization of conception states of high school students based on conception test results data with the four-tier test format was carried out using guidelines formulated by Gurel et al. [3]. The data analysis techniques used in this study include the calculation of the decrease in the quantity of students whose misconceptions after participating in the CC-Lab activity. Decreasing the quantity of students whose misconceptions between before and after CC-Lab activity are calculated using equation (1).

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\Delta M (%) = \frac{M_{fCT} - M_{iCT}}{M_{iCT} - M_{ideal}} \times 100\%
\]

Here \(\Delta M\) is a decrease in quantity of students whose misconception, \(M_{iCT}\) is the number of students who misconception at initial conceptual test, \(M_{fCT}\) is the number of students who misconception at final conceptual test, and \(M_{ideal}\) is the ideal minimum of number of student whose misconception, that is zero (0). The criteria for determining the level of decrease in the quantity of students who have misconceptions between conceptual test-1 and conceptual test-2 are: High if \(70% \leq \Delta M\), Moderate if \(30% \leq \Delta M < 70\%\) and Low if \(\Delta M < 30\%\) [9].

3. Result and Discussion

Figure 2 shows a bar diagram of the number of students in each state of conception before and after CC-Lab activities. Before the application of the CC-Lab, the number of students in each conception category were: scientific conception (10%), misconception (62%), and no conception (28%), while after the activity of CC-Lab, the number of students in each category of conception became: scientific conception (82%), misconception (12%), and no conception (6%). It can be seen that there is a significant change in conception from the state of misconception and no conception to be a scientific conception as the effect of implementation the CC-Lab.

![Figure 2. Bar diagram of the number of students in each state of conception before and after CC-Lab activities](image)

The pattern of change in conception of high school students between before and after participating CC-Lab activities is shown in Figure 3.
In the picture above it appears that a total of 71% of high school students experienced a change in conception towards scientific conception after participating in CC-Lab activities, 49% came from misconceptions and 22% came from no conception. These results indicate that the implementation of CC-Lab on the concept of floating, drifting and shrinking has good potential in facilitating the achievement of scientific concepts.

Table 2 shows the quantity of students whose misconceptions was remediated during implementation of CC-Lab related to the concept of floating, drifting and sinking.

**Table 2.** Quantity of students who are misconceptions on the concept of Floating, drifting and shrinking was remediated

| Category | Students’ misconception at the iCT | Students’ misconception at the fCT | Decreased quantity of students (%) | High |
|----------|----------------------------------|-----------------------------------|-----------------------------------|------|
|          | 23                               | 5                                 | 78                                |      |

In Table 2, it appears that before CC-Lab activity, students who have misconceptions on the concept of floating, drifting and shrinking are quite large in number, namely 23 students. In Table 2, it is also shown that the quantity of students whose misconceptions has decreased dramatically after attending CC-Lab activity. There is only five students who are still misconceptions. Based on data of the quantity of students whose misconceptions at iCT and fCT, it can be calculated a decrease in the quantity of students whose misconceptions related to the concept of floating, drifting and shrinking ($\Delta M$) using equation (1) which results in a decrease in quantity of students whose misconceptions was 78%. These results indicate that the implementation of the CC-Lab model has a high effectiveness in remediating the misconceptions that occur among high school students regarding the concept of floating, drifting and sinking.
4. Conclusions
Based on the results of the preliminary study of the implementation of the CC-Lab model in teaching the concepts of floating, drifting and sharking, it can be concluded that the CC-Lab model has good potential in facilitating the achievement of scientific conceptions of high school students. CC-Lab implementation has a high effectiveness in remediating the misconceptions of high school students related to the concept of floating, drifting and sharking. It is recommended to implement CC-Lab models in teaching other physics content.

5. References
[1] Sahin C, Cepni S 2011 Development of a Two Tiered Test for determining Differentiation in Conceptual Structure related to “Floating-Sinking, Buoyancy and Pressure” Concepts Journal of Turkish Science Education 8 1 p 111-118
[2] Kirbulut Z D and Geban O 2014 Using Three-Tier Diagnostic Test to Assess Students’ Misconceptions of States of Matter Eurasia Journal of Mathematics, Science & Technology Education 2014 10 5 509-521
[3] Gurel D K, Eryilmaz A, McDermott L C 2015 A Review and Comparison of Diagnostic Instruments to Identify Students’ Misconceptions in Science Eurasia Journal of Mathematics, Science & Technology Education 11 5 989-1008
[4] Madu B C., and Orji E 2015 Effects of Cognitive Conflict Instructional Strategy on Students’ Conceptual Change in Temperature and Heat SAGE Open July-September 2015 1–9 5 3 2158244015594662
[5] Ho K and Chin C 2009 Using discrepant events with questioning and argumentation to target students’ science misconceptions International Science Education Conference, Singapore, 24-26 November 2009
[6] Abak A, Eryilmaz A, Yilmaz S, Yilmaz M 2001 Effect of Bridging Analogies on Students’ misconceptions about gravity and inertia Hacettepe Üniversitesi Eğitim Fakültesi Dergisi 20 1-8
[7] Hewson P W and Lemberger J 2000 Status as the hallmark of conceptual learning In: R Millar, J Leach and J Osborne (Eds.) Improving science education: The contribution of research pp.110-125 (Buckingham: Open University Press)
[8] Stepins J, Saigo B, and Ebert C 1999 Changing the classroom from within: Partnership, collegiality, and constructivism (2nd Ed) (Montgomery AL: Saiwood)
[9] Suhandi A, Hermita N, Samsudin A, Maftuh B, Costu B 2017 Effectiveness of Visual Multimedia Supported Conceptual Change Texts on Overcoming Students’ Misconception About Boiling Concept The Turkish Online Journal of Educational Technology Special Issue for INTE 2017

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