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Conceptual Change Level of K-11 Students on the Hydrostatic Pressure Concept Using Virtual Conceptual Change Laboratory

Yunina Surtiana*[1)], Andi Suhandi [2)], Achmad Samsudin[2)], Parsaoran Siaahan[2)], Wawan Setiawan[3)]

[1)] Doctoral Program in Natural Sciences, Universitas Pendidikan Indonesia, Bandung, 40154, Indonesia
[2)] Department of Physics Education, Universitas Pendidikan Indonesia, Bandung, 40154, Indonesia
[3)] Computer Science Education Program, Universitas Pendidikan Indonesia, Bandung, 40154, Indonesia

**Corresponding author:yuninasurtiana@upi.edu*

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Abstract – *Identification has been carried out to get an overview of the student's Level conceptual change of K-11 student on the hydrostatic pressure concept using Virtual Conceptual Change Laboratory (VCCLab). The VCCLab was created to accomplish the conceptual change level of students' construction and reconstruction. This investigation aimed to decide the degree of students' applied change identified in the concept of hydrostatic pressure by involving in VCCLab activities. The strategy utilized was a quantitative enlightening technique which was conducted on a day and a half at class XI-one of the senior high school in West Java Province. The level of students' conceptual change was identified by using a diagnostic test in the Four - tier test (FTT) format and the results of the students' worksheets were analyzed based on the guidelines for determining the level of conceptual change. Conceptual change level consists of 1) Scientific conception from the beginning (SCFB); 2) Static (S); 3) Reconstruction (R); 4) Construction (C); and 5) Disorientation (D). The results of the research with VCCLab showed that level 1) scientific conception from the beginning (SCFB) is around 11.1%; 2) Static (S) is around 5.55%; 3) Reconstruction (R) is around 66,7%; 4) Construction (K) is around 16,7% and Disorientation (D) is 0%. In line with the results obtained, it is known that VCCLab can remediate missconception and reach the degree of calculated change in students' construction and reconstruction.*

Keywords: *Level of Conceptual Change, Physics Experiment, Remediation Misconception, VCCLab Model*

I. INTRODUCTION

Useful exercises can possibly be utilized in exercises that can work with the interaction of reasonable change among students. The conceptual change approach developed in the 1980s contributes substantially to improving science learning and teaching (Duit & Treagust, 2003). The conceptual change approach introduced by (Posner et al., 1982) involves teachers making alternative frameworks of students explicitly before designing a teaching approach consisting of ideas that are not in accordance with the conceptions of students so that students can feel dissatisfied with the concepts they have.

(Posner et al., 1982) published a paper regarding the needs that must be fulfilled to enable students' conceptual change. Fisrtly, the existing concepts must be dissatisfaction; students must have experiences which load them to lose faith in the ability of their current concepts to solve problems. Secondly, the new concept must be intelligible; the student must be able to understand sufficiently how experience can be structured by the new concept. Thirdly, the new concept must appear plausible; any new concept adapted must be least appear to have the ability to solve the problems generated by its predecessor. Finally, the new concept must be fruitful; it should have the capability to open up new areas of inquiry. There are five features of conceptual ecology related to the four conditions of a conceptual change above, i.e. (1) anomalies, (2) analogies and metaphors, (3) epistemological commitments, (4) metaphysical beliefs and concepts, and (5) other knowledge (Syuhendri, 2016).

Practical activities are used for activities that can facilitate the process of remediating misconceptions or changing wrong conceptions (conceptual changes) among students, because laboratory activities can also apply conditions of empathy for changes in these conceptions. The practicum mode that specifically aims at changing conceptions is known as *CCLab* (Conceptual Change Laboratory). The advantage of the laboratory activity mode compared to the face-to-face mode and text mode is that students can be facilitated to construct and change the conceptions they have in deep empirical exploration activities by students so that the constructivism view can actually be applied (Suhandi et al., 2020).

The *CCLab* (Conceptual Change Laboratory) model can be done with real or virtual practicum activities, labeled *VCCLab* (Surtiana et al., 2020). The use of virtual laboratories is very helpful for students in accommodating the conceptions of students, to replace old wrong conceptions into new scientific conceptions. (İnce et al., 2015). Virtual laboratories contribute to making learning more meaningful (Juškaite, 2019). Furthermore, according to (Akpan et al., 2016) virtual laboratories provide the opportunity to carry out investigations and experiments without harming anything, including living things that might be sampled. The results of research conducted on fifteen students who tried virtual laboratories also showed positive traits and encouraged and motivated them to better understand concepts. In addition, (Ilyas et al., 2020) stated that virtual labs can improve student learning outcomes and scientific attitudes. Many studies have found that virtual media can help remediate misconceptions. One form of virtual media that can be used to remediate student misconceptions is Physics Education of Technology (PhET) (Ajredini et al., 2014). PhET is a learning medium in the form of virtual experiments developed by the University of Colorado (Perkins, 2006).

The use of virtual PhET experiments can assist teachers in remediating students' misconceptions, because it can make it easier for students to carry out abstract physics experiments. Students can do virtual experiments regarding the phenomenon of parallel electrical circuits, hydrostatic pressure and spring coefficients that occur in everyday life that are difficult to do in real time (Putri, 2020). Indirectly, students who experience misconceptions will change their initial conceptions of physics material by doing a virtual PhET practicum. This is the advantage of Virtual *CCLab*, in addition to being able to conduct abstract physics experiments. Virtual *CCLab* also makes it easier for students to do practicum, especially for distance learning because it can be accessed anywhere and anytime by using internet access. Virtual *CCLab* can also be done in school computer laboratories and can minimize practicum time so that it becomes more effective and efficient (Surtiana et al., 2020).

Assuming the student are given a persuaded learning treatment, a few alternatives will happen in the difference in origination. Conceivably the origination stays (unaltered), might alter in a superior course, and may turn close to the more terrible. Since the underlying condition of understudy origination additionally shifts, some are thoroughly vacant with no underlying information, some of which as of now have the right starting information, and some who have mistaken information will likewise fluctuate the types of origination change occurring. Regarding this to name the changing types of origination that happened, presented the term level conceptual change (Hermita et al., 2018).

The applied change level is the level that depicts the state of origination change from the underlying state before the learning is executed to the last state subsequent to learning. The theoretical degree of progress is isolated into a few classifications, as follows: 1) having a scientific conception, 2) static, 3) Reconctruction, 4) Conctruction, and 5) Disorientation. All along, scientific conception is a degree of applied change where students show responsibility for originations both in the initial response and in the final response. Static is the degree of theoretical change that shows consistent responsibility for, to be specific missconception or lack knowledge both in the initial responses and in the final response. Disorientation is the level of conceptual change where the students change towards a more regrettable one, for instance, from a scientific conception in the initial response to a missconception or lack of knowledge in the final response. Reconctruction is a level of conceptual change where students conception change for better, to be specific from a condition of missconception in initial response to scientific conception in the final response (Hermita et al., 2017). In the interim, construction is the level of conceptual change in which the students' origination likewise alters to a superior course, specifically from absence of information in the initial response to logical ideas in the final response. In this way, to know the level of conceptual change accomplished by the students, we need to know the difference between the initial state in the beginning and the end of the showing movement, which is normally done by giving the origination test at the time when the learning takes place (Hermita et al., 2018).

The results of the misconception identified in the concept of hydrostatic pressure show that most students assumed that the amount of hydrostatic pressure at a point in a liquid was influenced by the depth of the point from the surface of the liquid. In such cases, many teachers report that many students state the greater the density of the liquid, the greater the hydrostatic pressure that will be given to the object being immersed in it.

This article investigates the interaction and results acquired from the examination exercises that have been completed. This examination was led to get an outline of the degree of reasonable change that happens in K-11 students during *VCCLab* activity on the idea of hydrostatic pressure concept.

II. METHODS

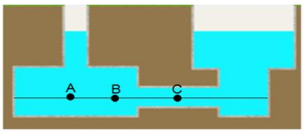
The research method used is quantitative descriptive method. This method is used to retrieve data then process and analyze them to be able to draw conclusions. The four-tier test (FTT) instrument is given to prospective K-11 students of senior high school as many as 36 students randomly selected after students learn the concept of hydrostatic pressure.

The state of the students' conception is known dependent on the aftereffects of the origination test in the four-tier test design identified with the idea of hydrostatic pressure factor during the students doing activity in the Pretest (Identification of the initial conception and the level of conception confidence of learners), practicum part I (Practical activities are oriented towards the confrontation of conception beliefs), and practicum part II (The conception accommodation practicum activity is oriented to the discovery of new scientific conceptions), Posttest (Identification of the final conception and the level of confidence of the conception). The state of the conception of students is categorized according to (Gurel et al., 2015). A sample of conception test used in this research is shown in Figure 1.

HYDROSTATIC PRESSURE CONCEPTION TEST

Tier 1

The image below shows the vessel connected to the connector in the form of a small passage filled with water.



What do you think about the ratio of hydrostatic pressure at points A, B and C is…..

A. The hydrostatic pressure at A is greater than the hydrostatic pressure at B and the hydrostatic pressure at B is greater than the hydrostatic pressure at C.
B. The hydrostatic pressure at point A is smaller than the hydrostatic pressure at point B and the hydrostatic pressure at B is smaller than the hydrostatic pressure at C.
C. The hydrostatic pressure at point A is the same as the hydrostatic pressure at point B and the hydrostatic pressure at point C.

Tier 2

Are you sure about the answer you gave in Tier 1?

A. Sure
B. Not sure

Tier 3

The right explanation according to your choice in ***Tier 1*** is:

A. The hydrostatic pressure at a point in the liquid is generated by the liquid above that point, so that the amount of hydrostatic pressure is proportional to the height of the liquid above the point under review. Because the level of the liquid above point A is higher than above point B and above point C, the hydrostatic pressure at point A is greater than at point B and at point C.
B. B. The hydrostatic pressure at a point in the liquid is influenced by the width or narrowing of the vessel containing the liquid, the narrower the vessel where the liquid is, the greater the hydrostatic pressure. Since point C is in the narrowest vessel compared to point A and point B, the hydrostatic pressure at point C is greater than at point B and at point A.
C. The hydrostatic pressure at a point in the liquid is generated by the liquid above that point, so that the amount of hydrostatic pressure is proportional to the depth of the point in terms of the water surface. Since the three points (namely A, B and C) are at the same depth from the water level, the hydrostatic pressure at point A is the same as at point B and the same as at point C.
D. ……………………………………………………………….

Tier 4

Are you sure about the answer you gave the ***Tier 3*** ?

A. Sure
B. Not sure

Figure 1. Sample of HPFT test items used in this study.

There are various possible circumstances applied like the conception of K-11 students revealed in parts I and II of the *VCCLab*, namely having a scientific conception (SC), not having a conception (LK), and misconception (M). This states of conception can change to others conception state types after participating in the activity *VCCLab*. The type of state change of the conception in the initial state (part I) of the *VCCLab* to the final state (delayed test) known as the conceptual change level. There are various levels of conceptual change that can occur in students that is to have a scientific conception from beginning (SCFB), construction (C), reconstruction (R), static (S) and disorientation (D), can be seen in Table 1.

Table 1. Determination Guidelines Level Conceptual Change

No	Level of Conceptual Change	Determination Guidelines Level Conceptual Change		
		Pre-Conceptions	Change to	Post-Conceptions
1	Scientific conception from beginning (SCFB)	SC		SC
2.	Static (S)	MC		MC
3.	Reconsturction (R)	MC		SC
		MC		LK
4.	Contruction (C)	LK		SC
5.	Disorientation (D)	SC		MC
		SC		LK
		LK		MC

Notes: LK, MC, SC stand for Lack of Knowledge, Misconceptions and Scientific Conceptions.

The effectiveness of *VCCLab* in supporting K-11 students to reach the level of construction and reconstruction conception is determined by counting the number of students who reached the level construction and reconstruction as an effect *VCCLab* activity. Table 2 shows the effectiveness classification of *VCCLab* in supporting K-11 students to reach the level of construction and reconstruction conception.

Table 2. Classification of Effectiveness *VCCLab* in Supporting Students to Reach Construction and Reconstruction Level of Conception

Student quantity (S) that reached the level contruction and reconstruction conception as effect *VCCLab* activity (%)	Classification of Effectiveness
75 < S ≤ 100	High
50 < S ≤ 75	Middle
S ≤ 75	Low

III. RESULTS AND DISCUSSION

The results of identification of the level of conceptual change of K-11 students on the concept hydrostatic pressure can be seen in Table 3.

Table 3. Conceptual Change Level Profile of College students

Level of conceptual Change	Student	Amount	Presentace (%)
Scientific conception from the beginning (SCFB)	3,7,18,32	4	11,1
Static (S)	20,26	2	5,55
Reconstruction (R)	1,2,4,6,8,9,11,12,13,14,15, 17,19,21,22,23,24,28,29,30,31,34,35,36	24	66,7
Construction (C)	5,10,16,25,27,33	6	16,7
Disorientation (D)	0	0	0

The table 3 above showed the level of the forthcoming K-11 students number at each level of conceptual change that happened. Of the subjects of the field preliminaries of VCCLab use in healing instructing, 11,1% was at the degree of Scientific conception from the beginning (SCFB), 5.55% was at static level (S), 66,7% was in Reconstuction (R), 16,7% is at Construction (C) level and 0% is at the Disorientation level (D). This shows that the utilization of *VCCLab* has high adequacy in accomplishing the degree of construction and reconstruction (66,7% + 16,7% = 83,4%). It very well may be guaranteed that the utilization of *VCCLab* has high viability in the remediation of missconception that happen in K-11 students in hydrostatic pressure concepts.

The changing example of K-11 understudies' originations on the idea of hydrostatic pressure concepts started introductory reaction to definite reaction (Figure 2) shows that of the 36 students who are the examination subjects have blended reactions. From that reaction there are 4 students who offer responses as scientific conception, 26 students addressed missconseption, and 6 students have no concept.

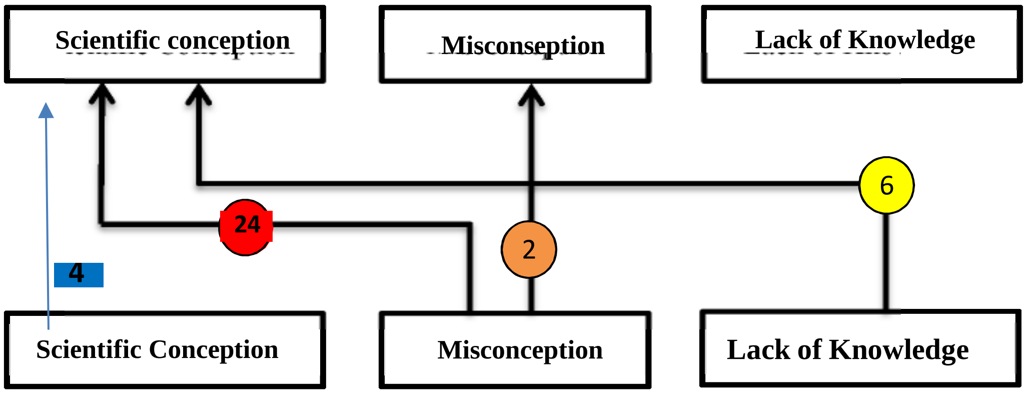


Figure 2. Analysis K-11 student conceptual change .

The progress of students' origination changes is dependent on the qualities of the underlying idea that obviously after *VCCLab* is used, the circumstance turns into the opposite of the first idea in which the misconception is like the scientific conception. At first, only 4 out of 36 students had the right response to the scientific conception. However, after in the last reaction after *VCCLab* activity, students who answered using scientific conceptions increased to 24 students. All things considered, there are still misconception occurred in 2 students.

The fact that the recurrence circulation of conceptual changes to the origination has resulted in the conceptual change level of the students about the hydrostatic pressure concept during *VCCLab* activity. The whole levels of conceptual change can be found in Figure 3 below.

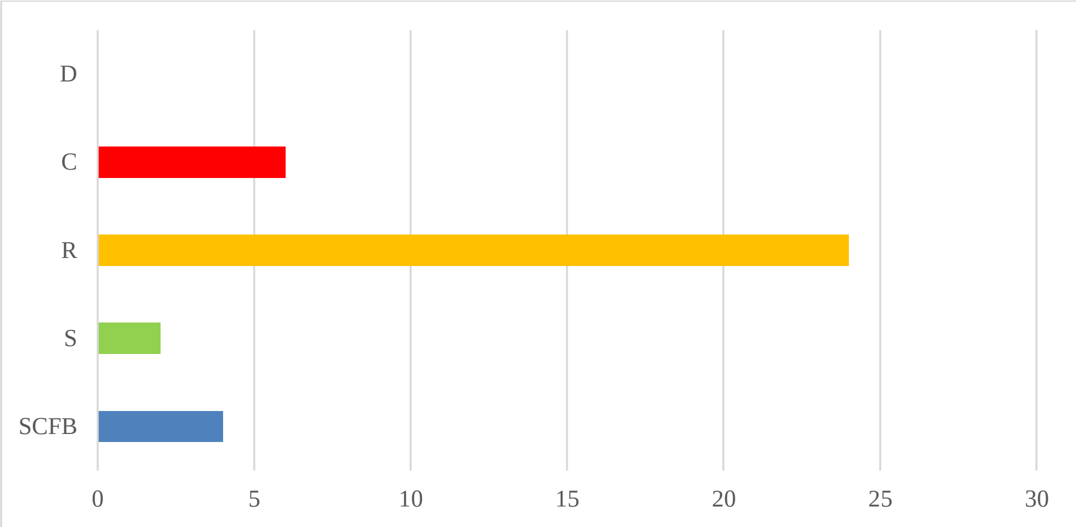


Figure 3. Bar Charts Percentage of total students at Each Level of Conceptual Change.

The picture above shows that the *VCCLab* has high adequacy in reaching at the degree of applied change construction and reconstruction of K-11 studensts. There is an adjustment in the origination of the underlying state to the last, a superior state shows that there is a great progress in learning that happens to student during their participating in *VCCLab* activity. The progress is considered positive as not any solitary student had his origination changed to the worse or experience disorientation.

For all students who initially had scientific conception, nothing has changed to be a confusion or not to have an origination, however remain immovably on a condition of scientific conception. This shows that logical clarification and support of the ideas introduced at *VCCLab* can assist them with settling the logical originations they as of now have.

In this research, the development and testing of *VCCLab* have been carried out. *VCCLab* was developed through specific approaches and strategies to remediate misconceptions that occur in students. The approach that is often used is the Conceptual Change Approach (CCA), while one of the strategies that is quite widely used is the cognitive conflict strategy. Conflict strategies in learning physics is effective enough to reduce the students' misconceptions in promoting a higher balance of knowledge. Students use the cognitive conflict strategy to solve the problem by expressing ideas so they are challenged to prove an idea (Basori et al., 2020; Haryono et al., 2020). Researchers who have used CCA with cognitive conflict strategies in teaching remedial physics include: (Başer, 2006; Kang et al., 2010) and (Madu & Orji, 2015). Teaching was carried out with the aim of fixing the misconceptions that occur in students is known as remedial teaching.

The *VCCLab* model in practicum exercises that are completed can work with the difference in originations from wrong originations to logical originations in the personalities of a student; those who feel that the investigation exercises in the third phase of the *VCCLab* are introduced, truly organized, legitimate, judicious; it can also help students to comprehend the ideas of physical science in the material and are in accordance with what they do in the second stage. Therefore, they can acknowledge it as new originations that will be kept to supplant the originations they have been seeing so far have ended up matching the new training material introduced, and it will acquire support of origination through the cycle of absorption. Concerning students who have the underlying information that isn't adjusted (not appropriate) with new instructing materials introduced, there will be a psychological struggle measure that makes a lopsidedness (disequilibrium) at the top of the priority list (Pratiwi et al., 2019). From these conditions there will be two prospects, first, there will be a gridlock (no origination) and the subsequent will happen the interaction of convenience that can empower the cycle of change and variation so that was not reasonable to be fit and can acknowledge another scientific conception.

The results of this study are in line with previous studies on changing conceptions related to physics concepts such as those conducted by (Corkett & Benevides, 2015; Ozkan & Selcuk, 2015) which show that the conceptual change approach has potential. It is very common to use in remedial learning to support conceptual understanding, while the virtual conceptual change laboratory (*VCCLab*) model is a new learning model developed and the limited field test results shows that the use of the *VCCLab* model in remedial teaching activities with lab activity mode has high effectiveness in restoring student misconceptions regarding the concept of physics (Suhandi et al., 2020).

IV. CONCLUSION AND SUGGESTION

Based on the research data, there are 5 (five) levels of Conceptual Changes occurs in K-11 students, namely 1) scientific conception from the beginning (SCFB) around 11,1%; 2) Static (S) approximately 5,55%; 3) Reconstruction (R) around 66,67%; 4) Construction (C) around 16,7%; and Disorientation (D) 0%. It leads to the conclusion that the *VCCLab* movement has high viability dealing with the accomplishment of theoretical change level of development and recreation of origination. All of the students who had recently had a scientific conception didn't transform into misguided judgments or have no origination except for being persistent in the condition of logical originations. This indicates that logical clarifications and the support of originations introduced on *VCClab* can help them in setting up the logical ideas they previously had.

In this way, *VCCLab* can be viably used in applying changes exercises identified with the idea of hydrostatic pressing factor. Notwithstanding, it was important to make enhancements in certain pieces of *VCCLab*, with the goal that it can possibly work with understudy's degree of calculated change. Moreover, *VCCLab* can be created in different physical science ideas.

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