Promoting the hydrostatic conceptual change test (HCCT) with four-tier diagnostic test item

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Abstract. Hydrostatic Conceptual Change Test (HCCT) is a diagnostic test instrument to identify students’ conception on Hydrostatic field. It is very important to support the learning process in the classroom. Based on that point of view, the researcher decided to develop HCCT instrument test into four-tier test diagnostic items. The resolve of this research is planned as the first step of four-tier test-formatted HCCT development as one of investigative test instrument on Hydrostatic. The research method used the 4D model which has four comprehensive steps: 1) defining, 2) designing, 3) developing and 4) disseminating. The instrument developed has been tried to 30 students in one of senior high schools. The data showed that four-tier- test-formatted HCCT is able to identify student’s conception level of Hydrostatic. In conclusion, the development of four-tier test-formatted HCCT is one of potential diagnostic test instrument that able to classify the category of students who misconception, no understanding, understanding, partial understanding and no codeable about concept of Hydrostatic.

1. Introduction
Various old-style and new-style measuring and assessing such as interviews, concept maps, open-ended tests, portfolios and diagnostic tests are used in defining the understanding levels of the students in related to concepts and their misconceptions [1-6]. As well as determining level conception in concept of physics, numerous instruments can be used to defining it, many researchers developed it [7-9]. One of that instrument is an instrument diagnostic test on four-tier diagnostic test item [10]. This test item is used to analyze the level of student conception is several field, including physics concept. This four-tier format consists of tier-1 in the form of question, tier-2 in the form of level confidence on answer (tier-1), tier-3 in the form of reason and tier-4 in the form of level confidence on reason (tier-3) [11]. However, this instrument is still rarely used.

Numerous diagnostic test instruments are used to reveal the level of student conception on physics concept, such as Electricity [12], optics [13], temperature and heat [14] and other subjects. One of the many physics concepts tested is the concept of Hydrostatic. Many researchers made the development of Hydrostatic test. Some of them developed the test instrument consisting 30 multiple choices. However, this instrument cannot be used to analyze the level of student conception because the format is a matter of multiple choice so that it only tests students’ conceptions on the concept of Hydrostatic.

The development of HCCT test instruments conducted by researchers is to present it into a four-tier test format. This is considering that the four-tier test is a form of diagnostic test instrument used to analyze the student’s conception level. The development of diagnostic test instruments is to be of limited development as it is limited to test whether HCCT four-tier test format has the potential to analyze
students’ conception level on concept of Hydrostatic. Thus, whether the HCCT four-tier test format also has the potential to uncover students’ misconceptions.

2. Methods
A learning material, Hydrostatic Conceptual Change Test, is developed using research and development method, 4D, which has four comprehensive steps; Defining, Designing, Developing and Disseminating. The defining and designing steps was organized from the definition of a two-tier and four-tier test. Developing steps is a development of diagnostic test through a four-tier test. Beside that in these steps also validated by the experts. For the disseminating step, elaborated the implementation of instrument to categorize the student into misconceptions, no understanding, understanding, partial understanding and un-codeable. The instrument was implemented to 30 students in Junior High School. The research subject is class VIII students who have studied the concept of hydrostatic.

3. Results and Discussion
HCCT instrument formatted four-tier test is developed to analyze the level students’ conception of the concept of hydrostatic. In detail, the development of this instrument follows 4D research model:

3.1. Defining
Defining is the first step to develop HCCT instrument. The level students’ conceptions on Hydrostatic can be determined by Hydrostatic Conceptual Change Test (HCCT). Therefore, diagnosing the level of students’ conception can be employed by the development of HCCT formatted four-tier test diagnostic items.

3.2. Designing
In this phase, we used four steps; 1) collect the concept of material, 2) reanalyse the design of four-tier test which developed by Samsudin [11] and make a blue-print, 3) conceptualizing learning material and 4) organize the concept using blue-print of four-tier test. The four-tier test design was developed from multiple choice questions as shown in Figure 1.a format designed to be a four-tier test that exhibited by Figure 1.b [11]. The construction of the four-tier test consists of four question which has detailed question. Started by tier-1 which is the main question, tier-2 is the level of confidence for the answer (tier-1), tier-3 is the reason still connected to the question (tier-1), and tier-4 is the level of confidence for the reason (tier-3). This instrument is planned by researcher to categorized student level conception on Hydrostatic.

3.3. Developing
The third phase is Developing. There are several steps taken at this phase, including: 1) judgment and 2) revision. Researchers conducted judgment to two experts in Physics Education Department at Indonesia University of Education. At this stage, researchers got input in terms of sentence structure, the structure of the four-tier test, and concept of material. The example the instrument test describe in Figure 1.
The result of judgment and developing phase shows in table 1.

| No | Fairness | Qualification | Validity E1 | Validity E2 | Validity E3 | Qualification | Reliability | Qualification |
|----|----------|---------------|-------------|-------------|-------------|---------------|--------------|---------------|
| 1  | 0.31     | Enough        |             |             |             |               |              |               |
| 2  | 0.25     | Enough        |             |             |             |               |              |               |
| 3  | 0.42     | Good          |             |             |             |               |              |               |
| 4  | 0.25     | Enough        |             |             |             |               |              |               |
| 5  | 0.37     | Enough        |             |             |             |               |              |               |
| 6  | 0.44     | Good          |             |             |             |               |              |               |
| 7  | 0.25     | Enough        | 0.84        | 0.94        | 1.00        | Very High     | 0.72         | High          |
| 8  | 0.44     | Good          |             |             |             |               |              |               |
| 9  | 0.37     | Enough        |             |             |             |               |              |               |
| 10 | 0.31     | Enough        |             |             |             |               |              |               |
| 11 | 0.42     | Good          |             |             |             |               |              |               |
| 12 | 0.25     | Enough        |             |             |             |               |              |               |

Notes: E1: Expert 1  
E2: Expert 2  
E3: Expert 3

The second step is revision. After revision, HCCT questions used in the study amounted to 12 questions. The form of question 1 in a four-tier test format is as follows:

1.1. The picture below shows a Hartl plane that is useful for identifying hydrostatic pressures. It consists of a U-Tube with an open end filled with water. The other end is dipped in a vessel filled by water (Figure 2).
If the tip of the pipe dipped deeper, then the amount of hydrostatic pressure on the liquid… .
   a. no change
   b. getting smaller
   c. getting bigger
   d. there is no difference in altitude
1.2 are you satisfied with your answers?
   a. Sure
   b. Not sure
1.3 Reason:
   a. The greatest hydrostatic pressure is on the surface.
   b. The hydrostatic pressure is uniform, independent of depth.
   c. Hydrostatic pressure is proportional to the depth of the liquid.
   d. The hydrostatic pressure is inversely proportional to the depth of the liquid.
   e. … .
1.4 Are you satisfied with your answer?
   a. Sure
   b. Not sure

3.4. Disseminating
In this phase, the instrument is disseminated in the evaluation of learning process on Hydrostatic. The students at 26 Junior High School, Bandung, was chosen as the subject of dissemination. The students included are 30 students in one class. The dissemination phase took one session consist of 60 minutes. Here is a documentation of disseminating phase:
The results of the study data categorized into five categories, namely the conception level to understand the concepts (U), no understanding (NU), misconceptions (M), partial understanding (PU) and un codeable (UC) [11]. Here is the resulting data:

![Category of Students’ Level Conceptions](image)

**Figure 4. The Category of Students’ Level Conceptions**

It can be inferred from the above figure that the level of students’ conception on the concept of Hydrostatic is quite good. It shows the percentage of misconception is the second lowest of all level student’s conception which is 1.92%. On the other hand, partial understanding and understanding are in the highest rank with value more than 40%. These data are taken from a class that has followed hydrostatic class. So, PU and U have big value than M, NU and UC.

4. Conclusion

The four-tier diagnostic HCCT test is an instrument developed by researcher to be used to diagnose students’ conception levels on concept of Hydrostatic. This is considering that the concept of Hydrostatic is an essential concept that must be owned by student in supporting on studying other subjects. Based on the findings, the students’ answer on these instruments can be encoded into five levels of conception which are Misconception (M), No Understanding (NU), Understanding (U), Partial Understanding (PU), and Un-Codeable (UC). Therefore, the HCCT diagnostic test instrument of this four-tier test format can be used to analyze the level of students’ conceptions. This shows that the use of HCCT diagnostic test instruments in the four-tier test format also has the potential to analyze students’ misconceptions on the Hydrostatic concept.

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