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# The Implementation of Refutation Text in Predict-Observe-Explain (POE) Learning Model to Decrease Students' Misconception

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A R T I C L E I N F O

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A B S T R A C T

The aim of this paper was to know the decreasing numbers of student's misconceptions after given a Refutation Text in Predict-Observe-Explain (POE) learning model by the researcher. The hydrostatic pressure misconceptions consist of five sub-misconceptions, Pascal and also the Archimedes Laws' misconceptions. This research was a quantitative research with a weak experimental design. Sampling technique applied purposive sampling and has involved 32 students in the 9th grade of junior high school in Pandeglang, Banten, Indonesia. The diagnostic test was a multiple-choice form with a three-tier-test (TTT) formats. The result of this research showed that there are quantity reductions in the students' misconception about the hydrostatic pressure. The biggest decreasing percentage of the numbers of the students' misconception was about the misconceptions 1, that is 79.31%. Misconceptions-1 *was the magnitude of Hydrostatic Pressure that was inversely proportional to its area surface*. For the lowest percentage was 41.18% in the Mis-5. The form of Mis-5 was that *the pipe that has a small cross-sectional area will have greater* pressure. For the future research, it is suggested for combining strategies or methods for optimal reduction in the numbers of the students' misconceptions.



## 1. Introduction

Students gained their conceptual understanding through the learning process and also experience within their environment (Saleh, 2011:p.249). Sometimes, while students in the classroom, they had pre-conception. Students may have different conceptions from the scientific conception because they have wrong experiences. These mistakes could create misconception (Akpinar & Tan, 2011:p.139). Moreover, physics learning process only emphasizes on the mastery of mathematical calculation. The teacher still uses oral explanation in front of the class so that the consequence is a one-way communication; the students even rarely do an experiment in the laboratory, and not all schools have good facilities in their laboratory (Pratiwi & Wasis, 2013:p.118).

One effort to reduce misconceptions is by giving treatments of constructivist learning approach and raising a cognitive conflict in the learning process. The Predict-Observe-Explain (POE) is a learning model that gives learning experience to the students. POE claimed that the students are able to find the concepts and construct knowledge by themselves (Acar Sesen, 2013:p.240), (Chen, *et.al*, 2013:p.212). In other words, the meaningful learning process should be able to make students understand easily and explain it scientifically, so it is not only applicable in the class but also in their daily life (Kurt & Ayas, 2012:p.980).

In the implementation of POE learning, students' understanding can be investigated in three ways. First, students are required to predict some events and justify their predictions. Second, students should

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describe what they see. Third, they should link the prediction with the observation result. In the POE learning model, students will experience conceptual changes at the observation stage because students experience cognitive conflicts. Cognitive conflicts occur because their prediction results are different from their observations; so in the explanation stage, students will replace their pre-conception with a scientific conception (Coştu, *et.al,* 2012:p.5).

Like the other learning model, POE has the weakness, too. Its weakness is students tend to notice the phenomenon that they predicted. It implied they (perhaps) missed some crucial events in the observation process. It could affect the "explaining" stage of the POE model (Treagust, Mthembu, & Candrasegaran, 2014:p.266). The other one is students have less confidence to write their answers in the "explaining" syntax (Acar Sesen, 2013:p.244). Based on that, this study tried to cover it by using a Refutation Text (RT).

RT is a text that contains explanations about misconception by refuting them explicitly, and then it gives a sort of common-sense explanation scientifically (Broughton, Sinatra, & Reynolds, 2010:p.4). RT can help students explain more confidently so students could understand the concept better than before. Students, who have confidence in their ability to learn, indirectly increase the likelihood of conceptual change as related to the main purpose of teaching (Clark, 2012:p.6). RT could make students become more confident to write their answers, to write their reasoning in the "explaining" stage. Students' confidence implicitly could promote the conceptual change process.

## 2. Method

This study was using weak-experimental design. This design was employed because there are no control variables (Fraenkel & Wallen, 2008:p.265). This study was held at one of state (middle) schools in Pandeglang Regency, Banten, Indonesia. The sampling technique used was purposive sampling. The consideration of using this sampling was to differentiate the student who had a misconception with the other student who did not have any knowledge of the concept. Therefore, the samples who were selected in this study were students who learned the Hydrostatic Pressure and Archimedes Laws. The total numbers of samples involved are 32 students (the 9th-grade students).

The instruments in this study were test and non-test. The non-test instrument was an observation sheet. This sheet is to check the steps of POE stages. The benefit of using this sheet is to support the diagnostic test results. The instrument that was used to reveal the misconception is the diagnostic approach. The diagnostic test that was used in this study was a three-tier-test. This test differed from any common tests in the class examination. The structures of this test are: the 1st-tier constitutes questions in the form of multiple choices to examine student's conceptual understanding or students' mastery concept; the 2nd -tier was to examine students' reasoning after answering the 1st -tier. The 3rd -tier was to ask students' certainty in the answering process. This test was chosen because it was effective to know students who either have misconceptions or conceptual understanding (Muliyani & Kaniawati, 2015:p.572).

The total numbers of the tests are six questions. Since this was a three-tier-test, the total number of items filled by students are 18 items. This test was given twice in the pre- and post-test sessions. The answer sheets have to be analyzed in order to differentiate which one contains misconception and which one does not. The decision of the answer of the three-tier-test adopted by Muliyani & Kaniawati (2015:p.573) is shown in Table 1 below.

Table 1. The Decision Of Three Tier-Test

| ***Tier-1*** | ***Tier-2*** | ***Tier-3*** | ***Decision*** |
|---|---|---|---|
| Right | Right | Sure | Right concept |
| Right | Right | Not sure | *Lucky guess* |
| Right | Wrong | Sure | Misconception |
| Right | Wrong | Not sure | Guess |
| Wrong | Wrong | Sure | Misconception |
| Wrong | Wrong | Not sure | Lack of knowledge |
| Wrong | Right | Sure | Misconception |
| Wrong | Right | Not sure | Guess |

Based on Table 1, students showed misconception if their answers are wrong and unsure about it. For example, if the 1st tier is correct, the 2nd tier is wrong, and they are not certain, it was categorized into misconception. The important point which contributes to this study's decision making on the misconception or lack of knowledge was the unavailability of error decision. This decision includes several different misconception options with some literature that decided errors in wrong answers. The researcher believed that the students have lack of proficiency about scientific conceptions, neither do they capable of explaining the true answers in terms of the concept nor explain the others. Thus, the researcher assumes that the students have poor scientific conception. Students with good conceptual understanding were those who had ample of scientific knowledge. In other words, they can answer correctly although the instruction or structure of the sentences was changed.

Based on this, the students who answered some concepts correctly or are able to explain a part of the concepts (which means they also believed some others are the wrong concept) are classified into misconception. Operationally, the decision of misconception or not follows the regulations: if the students are right in the tier-1 and wrong in the tier-2, they are categorized into misconception; if the students' answers are wrong in the tier-1 and correct in the tier-2, the students are also classified into misconception.

To decrease the quantity of students' misconception is by decreasing the number of students' wrong concept. Therefore, the researcher used DQM formula (Kurniawan, Suhandi, & Hasanah, 2016:p.3) to calculate the decreasing quantity of students' misconception, as follows:

$$DQM = \frac{\%pretest - \%posttest}{\%pretest - \%ideal}$$

DQM = decreasing quantity of misconception
%pre-test = the percentage of student that misconception before treatment.
%posttest = the percentage of student that misconception after treatment.
%Ideal = expected percentage (0 %)

Table 2. the decreasing misconceptions

| ***Score (%)*** | ***Criteria*** |
|---|---|
| $70 < DQM \leq 100$ | High |
| $30 < DQM \leq 70$ | Medium |
| $0 < DQM \leq 30$ | Low |

To measure the RT, the author calculated its readability by adapting the Close technique. The Close technique is in the of incomplete tests in order to know difficulties that are encountered by the students. Therefore, the selection of Close technique in RT is very compatible with purposive sampling technique because students will not be able to fill in the blank points if they have never had previous learning experiences. in every text, there are five until ten words erased and replaced with underline (blank point), see Figure 3. To calculate the readability of RT, the author used the formula as in the following.

$$text\_readability(tr) = \frac{\sum right\_word}{\sum lost\_word} \times 100$$

After the calculation showed results, then it must be compared to the Table 3 for obtaining the criteria.

Table 3. the readability Criteria

| ***Score (%)*** | ***Criteria*** |
|---|---|
| $61 \leq tr \leq 100$ | High |
| $41 \leq tr \leq 60$ | Medium |
| $0 \leq tr \leq 40$ | Low |

In this research, the treatment used was POE learning model assisted with refutation text. There are three stages of this model, namely: predicting, observing, and explaining.

The first syntax is ***Predict*ing**. Students have to be able to predict the related phenomena of hydrostatic pressure. In the process, the misconception could be revealed because students wrote the answers to the questions with their certainty on the predicting sheets. The 2nd syntax is ***Observ*ing**. At this stage, students did some experiments to prove their prediction in the prior step. In the process (observation stage), students also wrote their prediction by adding their certainty on the prediction sheet. If their conception (in the predicting stage) is different from the experimental result, they can be classified into students with poor misconception.

The last one is ***Explain*ing**. This final stage is comprehensive understanding. Students must explain the result of experiments, and the differences about experiments if their answers were different from experiment results. At this stage, the students could show their comprehension by writing correct answers on the report sheet.

After the POE steps entirely completed, it is time for the Refutation Text (RT). This text was given by the researcher and its function is to strengthen students' confidence. The content of RT is specifically to investigate hydrostatic pressure, Pascal's concept and Archimedes' concept. Generally, the RT was divided into three parts. The first part reveals the common misconceptions of the concept of hydrostatic pressure, Pascal's concept and the concept of Archimedes. The second part of RT was to deny misconceptions in the first part and convey a scientific conception.

## 3. Discussion

The analysis discusses the distribution of misconceptions. These misconceptions are collected to make diagnostic items of the three tier-tests. Table 4 below presents misconceptions.

Table 4. Misconceptions on FLUID STATIC

| No. Mis | Misconceptions |
|---|---|
| 1 | The magnitude of hydrostatic pressure is inverse with its area |
| 2 | The largest hydrostatic pressure in the connected vessel is the smallest (surface) area of the vessel. |
| 3 | The hydrostatic pressure in the different cube in a connected vessel is not same because of its different depth. |
| 4 | The largest hydrostatic pressure in the connected vessel is the highest column in the vessel. |
| 5 | The pipe that has a small cross-sectional area will have a greater pressure. |
| 6 | The objects float when the container contains more water capacity. |
| 7 | The objects will be drown |
| | Ted if they have heavier weights. |
| | 8 |
| | The objects will float if they are smaller. |
| 9 | The more viscous liquid, the more likely objects will float. |
| 10 | The thin flat objects will float. |

Table 4, Mis-2, has been tested twice; for the test's items number 2 & 6 the questions were administered with different emphasis vessel: larger and smaller vessels. Similarly, the Mis-2 2 and the Mis-3 were also asked in different questions (in forms of different statements from test no 3 & 4). Based on the analyedsis of the answers of the three tier-tests, it was proven that Mis-1 shows the highest reduction in the numbers of students with high misconceptions.

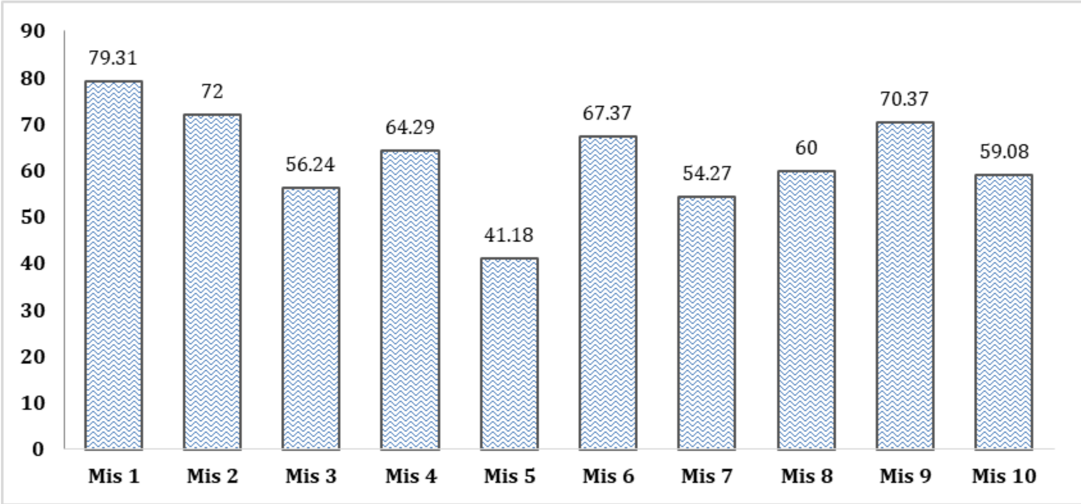



**Figure 1. The DQM of Misconception**

Figure 1 shows the decreasing numbers of student who showed poor concepts in the high category (in the average of DQM). Unfortunately, Mis-3 decrease fewer than 60% only (medium category). These data were obtained by using formula (1). During the data processing as presented in Fig 1, the shocking result is that there is none of the the student have scientific conception in Mis-2, 3, and 4 in the pre-test. The highest DQM score was in the Mis-1, *"the magnitude of hydrostatic pressure is inverse with its area"*. This misconception seems to be based on the pressure of the solid object. In the solid object, a larger force happened in the fixed area, which must be resulted from a larger pressure. They had answered that the areas were proportional with hydrostatic pressure. In contrast to the prior result of Figure 1, the smallest DQM of the study occurred in the Mis-5, "*the pipe that has a small cross-sectional area made the pressure greater".* After obtaining the percentage, that result must match the criteria in Table 2. To summarize, Table 5 showed the final decision on students' answers.

Table 5. THE DECISION OF DQM

| *Code of Misconceptions* | *Decision of DQM* |
|---|---|
| Mis-1 | High |
| Mis-2 | High |
| Mis-3 | Medium |
| Mis-4 | Medium |
| Mis-5 | Medium |
| Mis-6 | Medium |
| Mis-7 | Medium |
| Mis-8 | Medium |
| Mis-9 | High |
| Mis-10 | Medium |

Look at Table 5, there were three misconceptions that decrease significantly on the high criteria and the other (seven misconceptions) in the medium criteria. This result was caused by the cognitive conflicts in students' mind that were totally different from each other while learning in this study. In the cognitive conflict process, students faced three options, 1) they had to retain their concepts; 2) they had to partially revise their concepts through assimilation process; 3) they had to change their alternative concepts and replace them with the new scientific knowledge.

The stages of POE that were designed to stimulate the conceptual change process were the result of observations which latter were compared to the predicting sheet. The conceptual change process occurred in the observing stage because there was a big probability to cognitive conflict happened in the students' mind. Therefore, the students changed their prior concepts with the new scientific concepts at the Explaining stage (Coştu, *et al*., 2012:p.244).

Students' requirement is to make preparations before entering the class. They had been given some questions to reveal their initial concepts in their mind about the research subject (the concept of Hydrostatic pressure and the Archimedes Laws). At the *Observing proce*ss, students who showed misconception could be experiencing the anomaly situation that is contradictory to their concepts. The anomaly situation could be referred to students' dissatisfaction with their recent concepts because there were differences between the predictions with the result. Students who experienced this situation (anomaly situation) tend to change their past concepts to avoid conflict in their mind even though not all of the students might experience this anomaly. Based on the data of the research and direct observation, it can be concluded that students tend to reject the result of the experiment that was different from theirs. It implies that the report of an experiment cannot always be accepted by students, especially if it is totally different (Suparno, 2005:p.114-115).

Generally, students' beliefs would be disturbed when they encountered the fact where experimental result of measurement of hydrostatic pressure is equal to the equal depth. It was valid in every area and the shapes of the container. This condition stimulated students' dissatisfaction with their concepts so that it stimulated strong conceptual change process (scientific view), which could happen immediately.

Not all students could accept the result of the experiment and change their concepts. There were some students who still retained their wrong concepts. They take a hard line because they thought some of the procedures of the experiment were wrong or the experiment was precisely wrong. If they failed in revising their conception or only absorb half of the concepts, the student could not experience the accommodative process. This process was only applicable to students that have not changed their conception to the scientific concepts during the learning process. The students that did not change their conceptions, retain their prior concepts, and only take a partial scientific concept and retain the other parts could pass the accommodation process. If the accommodation process failed, the conceptual change process would fail, too. For instance: at the beginning of learning the hydrostatic pressure, almost all of the students misunderstood that hydrostatic pressure was inverse with its area. This assumption indicated that a lot of students had the misconception.

The process of repairing students' conceptual understanding (in this study is called as misconception) occurred in the *Explaining* stage. At the Explaining process, students were allowed to discuss the results of the observation and compared them with their predictions worksheet that they worked previously. The discussion process could give contributions to the conceptual change in students' mind. The re-structure of the conceptual understanding could be done by implementing several steps beside discovering what the misconception was. Gooding & Metz (2011: p.36) state that discussion process, while they are re-structuring their conceptions, helps them find their misconceptions as soon as possible by themselves.

Based on the fact in the class, almost all groups still encountered difficulty to analyze the observation results. This problem is supported by the evidence of attitude scale (97.57% from 100%); students experienced a difficulty in analyzing the process of data from the experiments. After a comprehensive observation, it was found that all of the students had less practice in the laboratory. So, the *Observ*ation stage was the first experience for all students. It implied that the difficulties of observing process existed because they were not ready to face the distinction between the prediction and the result of the experiment. Most of the difficulties of POE learning model was to give logical reasoning scientifically; to handle the differences between prediction and observation.

Besides that, the side effect of less experiment skill by students caused lack of confidence in explaining the concept scientifically if their prediction was not same as the experiment result. It was supported by Suparno (2005: p.88) who stated that students are able to change their concepts if they are absolutely sure with the new knowledge. It means that if they are certain about the new right concepts, they will change their prior conceptions.

There are several reasons why the decreasing percentage did not reach 0% (didn't reach the ideal target). The first, students still hold on their pre-conception although they had seen the result of the experiment was in contrast with their mind. Due to that, they did not want to repair their conception with the new one (Acar Sesen, 2013:p.240). The second, the innovative teaching model is not familiar with the students' habits and their teacher either. The different of learning process could affect the student to be uncertain about their answers (Pourhosein Gilakjani, 2012:p.110). The last one, teachers' skill to implement the new model or to make inquiry questions or teachers' knowledge could affect the result of the study. For complement data on Fig 1, students' answers on the RT was analyzed by using (2) and the result then was converted to Table 6.

Table 6. Readability of Refutation text

| Refutation text (RT) | | |
|---|---|---|
| *The concept of the text* | *Score* | *Readability* |
| Hydrostatic pressure | 60.06 | Medium |
| Pascal's Law | 54,09 | Medium |
| Archimedes Law | 51,73 | Medium |

There is a similarity between data in Fig 1 and data in Table 4. Most of the result of the analysis is stagnant in the medium category (except Mis-3). The example of the test and the RT could be seen below. Misconception (Hydrostatic pressure): The magnitude of hydrostatic pressure is inverse with its area.

Indicator: Students have the ability to determine the magnitude of hydrostatic pressure in the different area of glasses.

**1st -tier**:

Look at the picture!

There are two glasses with same properties but they have different areas. Glass 1 has area *A* and Glass 2 has area *2A*. Both of them poured with the same volume of water (see Fig.2).

How is the magnitude of **both hydrostatic pressure**s (on the base)?

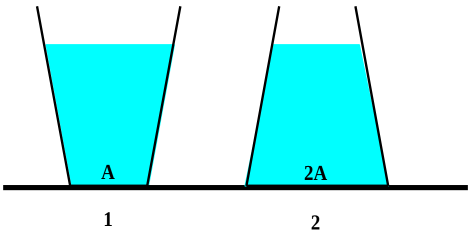



Figure 2. Glass with different area

a. The magnitude of hydrostatic pressure in the Glass 2 is larger than Glass 1
b. The magnitude of hydrostatic pressure in the Glass 1 is equal to Glass 2.
c. The magnitude of hydrostatic pressure in the Glass 1 is larger than Glass 2.

**2nd -tier:**

**The reasoning** of the answer is:

a. Since the area of Glass 1 is smaller than the area of Glass 2, so the Glass 1 had a larger hydrostatic pressure than Glass 2.
b. Because the depth of the two glasses is equal, so the base of the two glasses had the equal magnitude of hydrostatic pressure, too.
c. Since the base area of Glass 2 is larger than Glass 1, the base of Glass 2 had a larger hydrostatic pressure.
d. ....

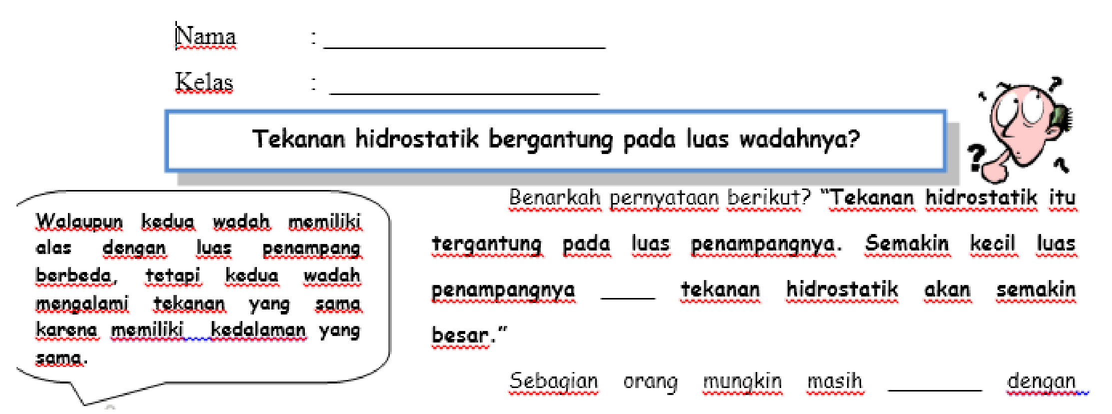
**3rd -tier:**

**The confidence**:

a. sure b. Not sure

Based on the example of the diagnostic test (three-tier-test), all of the answer options were designed to minimize the "guess" decision on students' answer. The structure of the test like this item was beneficial to recognize whether students' answer is better than before. Based on Table 1, the decision of students' answer as "guess" and "lucky guess" is minimal. The determination of distractors made to help researcher obtain data of which students had scientific conceptions, and which showed misconception as well as indicated the "lucky guess" students.

The analysis of the tiers pair is as follows: 1) The answer A on the 1st tier has paired with C on the reasoning statement. Logically, this student tended to show misconception because A seems to be more reasonable for C, 2) The answer B in the 1st tier has paired with B on the reasoning statement as well. In fact, this student tended to have a scientific conception. The statement of A had supported scientific reasoning on B, 3) The answer C on the 1st tier has paired with A on the reasoning statement, too. Logically, this student tended to show misconception because C seems to become the rationale for A.


Nama : ____________

Kelas : ____________

Tekanan hidrostatik bergantung pada luas wadahnya?

Walaupun kedua wadah memiliki alas dengan luas penampang berbeda, tetapi kedua wadah mengalami tekanan yang sama karena memiliki kedalaman yang sama.

Benarkah pernyataan berikut? "Tekanan hidrostatik itu tergantung pada luas penampangnya. Semakin kecil luas penampangnya ____ tekanan hidrostatik akan semakin besar."

Sebagian orang mungkin masih ________ dengan

**Figure 3 Refutation text for Hydrostatic Pressure (Indonesian version)**

Figure 1 is made in Bahasa Indonesia. So, there is easiness in the reading process of Refutation text. Students could understand the structure of the sentences, and it should make them understand the concept in the Refutation Text easily. The RT originally made by the researcher. It has been judged by the expert on physics and the expert from the language center.

In this study, the researcher tried to translate the RT (Indonesia version) to the English version. Figure 3 is the crop of the RT (as seen in Figure 2). The basics composition of the RT is to contradict the student's belief of physics concepts (in this case: Hydrostatic Pressure and Archimedes Laws), and hope their conception would be correct as well as fixed with scientific conception.

Name: ______________________

Grade: ______________________

Does hydrostatic pressure depend on its area?

Although both of the containers had different areas, the hydrostatic pressures are equal because they have the equal depth .

Is that a correct statement? The magnitude of hydrostatics pressure depends on its area. If its area less, ____ so the amount of hydrostatic pressure is larger.

Some peoples perhaps still____ with____

**Figure 3. Refutation text for Hydrostatic Pressure (English Version)**

After analyzing the data, it could be concluded that POE assisted with RT was able to reduce the number of students who have high misconceptions. The biggest reduction in the quantity of students' misconception is Mis-1, and the smallest one is Mis-3. So, the students must have self-awareness of misconceptions. For further research, it is suggested that it is highly significant for combining other methods to reduce the quantity of the students who possess low conceptions. To summarize, this session could be seen in the RT, which was the researcher original work. Figure 3 has the misconception students' worksheet and Figure 4 was the scientific students' worksheet.

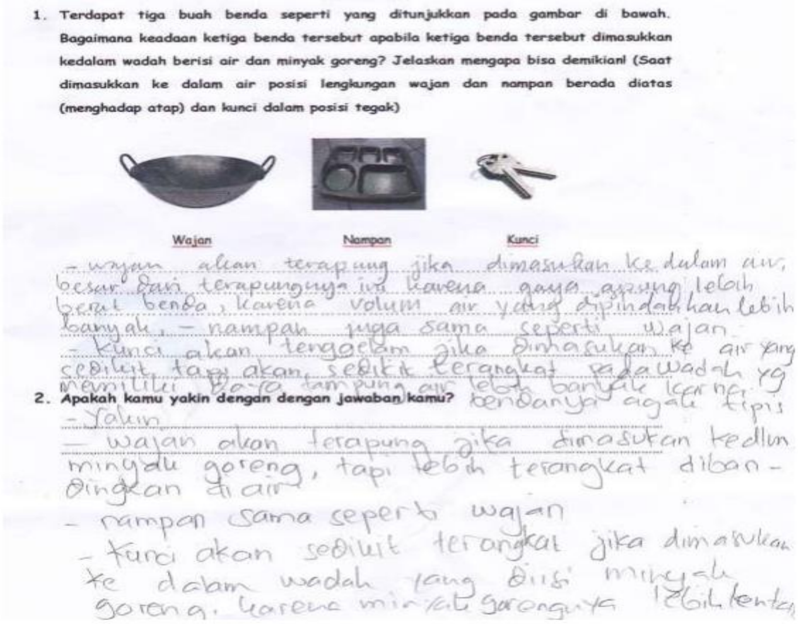



**Figure 4. Misconception students' worksheet (Indonesian version)**

## 4. Conclusions

The result of this research showed that there are quantity reductions in the students' misconception about the hydrostatic pressure. The biggest decreasing percentage of the numbers of the students' misconception was about the misconceptions 1, that is 79.31%. Misconceptions-1 was the magnitude of Hydrostatic Pressure that was inversely proportional to its area surface. For the lowest percentage was 41.18% in the Mis-5. The form of Mis-5 was that the pipe that has a small cross-sectional area will have greater pressure. For the future research, it is suggested for combining strategies or methods for optimal reduction in the numbers of the students' misconceptions.

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