The development of 5E-POW (predict-observe-write) learning model assisted by virtual simulation to reduce the quantity of high school students' misconceptions on fluid topics

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Abstract. This study was aimed by the number of students who were experiencing misconception on the Fluid Topic. Therefore, it requires a learning method that is able to facilitate students to learn which is marked by a student misconception into a scientific misconception. The purpose of this study is to develop an existing learning models to reduce the quantity of students' misconception. This research includes mixed methods research with embedded experimental model approach that combine qualitative and quantitative research procedures in one study to solve the problem. The priority of the model is quantitative, with qualitative data attached to methodology. A number of research subjects in the readability test of student worksheets (LKPD) were 5 (five) students in one high school in West Bandung Regency. The research subjects for the trial treatments and devices were 25 students in one high school in Central Sulawesi. The implementation of research subjects consisted of 25 students in one of high schools in Central Sulawesi province. The instruments used for this study were Four-Tier Diagnostic Test and Questionnaire to determine students' response about the program being developed. The developed learning model has syntactic: engage, explore (predict-observe-write), explain, elaborate and evaluate (5E-POW). It can be declared that based on the data analysis of the average value N-gain on conception acquired by 77.05% and the decrease on the average quantity by -47.45%. The conclusion derived from the data obtained is that research has also successfully developed a 5e-pow model with virtual simulations to decrease the quantity of high school student misconception on the Fluid Topic.

1. Introduction

Physics is one of the lessons that has a concept study in everyday life [1]. One of the subject matters that is often found by students in daily life is static fluid. Many students had misconceptions on static fluid material [2][3][4][5][6]. This is supported by several researchers [7][8][9][10] who say that many students experience misconceptions on static fluid material, including the Archimedes law, the determination of stress experienced by an object contained in a liquid.

Misconception is an interpretation of concepts in a statement that is not true. Another understanding [11] of misconceptions is one's ability to define a wrong concept, the application of a concept that is not correct, how to classify the wrong ones even how to connect between the wrong concepts. From the
above understanding, misconception can be interpreted as a conception that is not in accordance with scientific understanding or understanding accepted by scientists. Some researchers have tried to remediate misconceptions in students. The step to overcome misconceptions that occur in the classroom is to change the teacher-centered learning model to a student-centered learning model [12], and also with the use of media in learning. Therefore, we need a model that can facilitate students in learning and the use of media in learning, because good learning will make students’ understanding of concepts increase [13].

Most research that has been done in remediating misconceptions uses only one approach. There are still few studies that use more than one approach in remediating misconceptions that occur in students. The approach that has been carried out by previous research in remediating misconceptions is to use conceptual change tasks, computer assistance and also constructivist learning models [14][15]. One learning model that is based on constructivism is the 5E learning cycle learning model. The 5E learning cycle learning model is a learning model that has 5 stages in the learning process. The stages of the 5E learning cycle are engage, explore, explain, elaborate and evaluate. Several studies have applied the 5E learning cycle in remediating misconceptions. Research conducted [16] compares the 5E learning cycle and the 5E learning cycle by inserting several types of approaches in remediating misconceptions in 8th grade junior high school students with static fluid material. Based on these results it is found that the 5E learning cycle by inserting several types of approaches is better in remediating students' misconceptions. The research is also supported by research conducted [17], which concludes that combining the 5E learning cycle with several types of approaches is able to make students more familiar with buoyancy style material.

The explore phase in the syntax of learning cycle 5E, students conduct exploratory activities with group friends who have been formed to test the hypothesis to solve the given problems. In conducting exploration it is expected that students will build communication with classmates to summarize the existing problems. At this stage, the teacher is only a facilitator. At the explore stage, of course students’ analytical skills are very much needed, where the analysis carried out by students is determined by making a hypothesis of an outcome to be carried out. Because at this stage requires the ability of students to predict, observe and explain, activities that can facilitate these activities are needed. POE is an activity that can facilitate students' ability to analyze where POE provides opportunities for students to predict, observe and present them.

One learning model that is similar to POE is the think-talk-write (TTW) learning model. As the name implies, the TTW learning model has three stages in implementation in the classroom. The first phase is the think phase, in this phase students are given problems and think of the most appropriate prediction answers. The second phase is the talk phase, in this phase students communicate in the form of discussion to communicate the things they predict in the think phase. The last is the write phase, in this last phase students are asked to write down the conclusions they get during the learning process. Seeing the importance of the write phase is the TTW model so that there is a phase that is lacking in POE learning, namely the write phase and is developed into learning with four phases, namely the predict phase, observe phase, explain phase and write phase (POEW).

Based on the above problems, we need a learning media that can overcome these problems. The way that can be used to overcome the problem of tool limitations in practicum is to use virtual equipment (virtual apparatus) in the form of interactive computer simulations (virtual lab).

It is difficult to eliminate students' ideas using only traditional learning methods or using only one type of approach. Based on the description of the paragraph above it can be seen that the learning cycle 5E has flaws in remediating this misconception because there are weaknesses in the explore phase and the POW model is able to cover the shortcomings in that phase. This is because the POW model trains students' abilities to predict, observe, explain and write down students' ideas. The use of technology such as virtual simulations is also able to reduce the quantity of students' misconceptions and can even be used in a learning model.

The virtual simulation 5E-POW learning model that will be developed is a new breakthrough in learning innovation in an effort to remediate student misconceptions. That is because the 5E learning
cycle is one of the innovative learning that teachers often do when teaching. On the other hand the use of virtual simulations in learning is also beneficial for the teacher but also for students. The use of virtual simulations can be done by students anywhere and can also be used by teachers when the tools in the laboratory are inadequate in practicing.

Based on the description above, researchers are interested in conducting research under the title "Development of a 5E-POW (Predict-Observe-Write) learning model assisted with virtual simulations to reduce the quantity of high school students' misconceptions on fluid topics".

2. Methods
This research is a Mixed Methods research with Embedded Experimental Model approach. The population in this study were all students of class XI in one of the high schools located in Central Sulawesi. The sampling technique in this study was by purposive sampling which is "determining the sample with certain considerations" that is based on teacher recommendations. Based on observations, MIA classes in schools that are used as a place of research are not divided based on students' cognitive abilities (superior classes). If the class division is not based on the cognitive abilities of students it is expected that students in the class have normal distribution.

The conception test instrument used in this study was an instrument in the form of a four-tier diagnostic test totalling 29 items. The distribution of questions for each concept can be seen in Table 1.

Table 1. Distribution of questions for each concept

| Subject matter                  | Question number |
|---------------------------------|-----------------|
| The main law of hydrostaticism  | 1, 2, 3, 4, 5, 6, 7 |
| Pascal's law                    | 8, 9, 10, 11, 12 |
| Archimedes’ law                 | 13, 14, 15, 16, 17, 18, 19, 20, 21 |
| Discharge and continuity        | 22, 23, 24, 25  |
| Bernoulli’s Principle           | 26, 27, 28, 29  |

3. Result and Discussion

3.1. result
The categorization of students' misconceptions can be determined by giving a four-tier test when given a preliminary test and a final test. The data obtained were then analyzed using a rubric and the categorization of students for each item was determined. To see how a decrease in the quantity of students' misconceptions can be determined using the equation contained in the appendix. Recapitulation of the decrease in the quantity of students' misconceptions can be seen in Table 2.
Table 2. Recapitulation of decreasing quantities of students’ misconceptions and N-gain

| No. | Average Score | N-gain | decreased misconception |
|-----|---------------|--------|-------------------------|
|     | Pre test      | Post test |                          |                          |
| 1   | 80            | 8       | 90,00                    | -72,00                   |
| 2   | 68            | 8       | 88,24                    | -60,00                   |
| 3   | 84            | 24      | 71,43                    | -60,00                   |
| 4   | 40            | 8       | 80,00                    | -32,00                   |
| 5   | 40            | 16      | 60,00                    | -24,00                   |
| 6   | 36            | 4       | 88,89                    | -32,00                   |
| 7   | 76            | 8       | 89,47                    | -68,00                   |
| 8   | 64            | 4       | 93,75                    | -60,00                   |
| 9   | 76            | 36      | 52,63                    | -40,00                   |
| 10  | 68            | 20      | 70,59                    | -48,00                   |
| 11  | 48            | 28      | 41,67                    | -20,00                   |
| 12  | 40            | 32      | 20,00                    | -8,00                    |
| 13  | 52            | 8       | 84,62                    | -44,00                   |
| 14  | 56            | 12      | 78,57                    | -44,00                   |
| 15  | 52            | 4       | 92,31                    | -48,00                   |
| 16  | 80            | 12      | 85,00                    | -68,00                   |
| 17  | 64            | 12      | 81,25                    | -52,00                   |
| 18  | 76            | 8       | 89,47                    | -68,00                   |
| 19  | 72            | 48      | 33,33                    | -24,00                   |
| 20  | 44            | 8       | 81,82                    | -36,00                   |
| 21  | 60            | 0       | 100,00                   | -60,00                   |
| 22  | 76            | 0       | 100,00                   | -76,00                   |
| 23  | 52            | 8       | 84,62                    | -44,00                   |
| 24  | 52            | 12      | 76,92                    | -40,00                   |
| 25  | 36            | 8       | 77,78                    | -28,00                   |
| 26  | 76            | 4       | 94,74                    | -72,00                   |
| 27  | 64            | 24      | 62,50                    | -40,00                   |
| 28  | 76            | 16      | 78,95                    | -60,00                   |
| 29  | 68            | 20      | 70,59                    | -48,00                   |

Table 2 shows the percentage of students who experienced misconceptions on the initial and final tests. It can be seen in table 4.3 that all students on the topic of static and dynamic fluids have decreased the quantity of misconceptions. This shows that the development of 5E-POW (Predict-Observe-Write) that has been applied to students can mediate students’ conceptions from misconceptions to true concepts.
3.2. Discussion

Based on data analysis, the category of decreasing misconceptions can be divided into five major topics. The following will describe the misconceptions obtained by students in terms of sub topics as in Table 3.

Table 3. The average score of the decrease in the quantity of students' misconceptions by sub-topic

| No | Sub topic                     | Average score | Decrease misconception |
|----|-------------------------------|---------------|------------------------|
|    |                               | Pre test      | Post test              |
| 1  | Hydrostatic pressure          | 60.57         | 10.86                  | -49.71                 |
| 2  | Pascal's Law                  | 59.20         | 24.00                  | -35.20                 |
| 3  | Archimedes' Law               | 61.78         | 12.44                  | -49.34                 |
| 4  | Discharge and continuity      | 54.00         | 7.00                   | -47.00                 |
| 5  | Bernoulli's Principle         | 71.00         | 16.00                  | -55.00                 |

On hydrostatic pressure material with a total of 7 items four-tier diagnostic test. The percentage of misconceptions in the initial test was 60.57, the final test was 10.86 and it had a decrease in the quantity of misconceptions by -49.71. In the Pascal legal material with a total of 5 items four tier diagnostic tests. The percentage of misconceptions in the initial test was 59.20, the final test was 24.00 and had a decrease in the quantity of misconceptions by -35.20. In Archimedes legal material with a total of 9 items four-tier diagnostic test questions. The percentage of misconceptions in the initial test was 61.78, the final test was 12.44 and had a decrease in the quantity of misconceptions by -49.34. On the material discharge and continuity with the number of questions as many as 4 items four tier diagnostic test. The percentage of misconceptions in the initial test was 54.00, the final test was 7.00 and had a decrease in the quantity of misconceptions by -47.00. In the Bernoulli principle material with a total of 4 items four-tier diagnostic test questions. The percentage of misconceptions in the initial test was 71.00, the final test was 16.00 and had a decrease in the quantity of misconceptions by -55.00.

If reviewed according to chapter, the topic of fluid is divided into 2 chapters, namely the topic of static fluid and dynamic fluid. Based on data analysis different results are obtained. On the topic of static fluid with a total of 21 items four-tier diagnostic test items. The percentage of misconceptions in the initial test was 60.52, the final test was 15.77 and had a decrease in the quantity of misconceptions by -44.75. On the topic of dynamic fluid with a total of 8 items four tier diagnostic tests. The percentage of misconceptions in the initial test was 62.50, the final test was 11.50 and had a decrease in the quantity of misconceptions by -51.00. For more details, can be seen in Figure 4.19.

Table 4. The average score of the decrease in the quantity of students' misconceptions is based on the subject matter

| Subject          | Average score | Decrease misconception |
|------------------|---------------|------------------------|
| Static fluid     | 60.52         | 15.77                  | -44.75                 |
| Dynamic fluid    | 62.50         | 11.50                  | -51.00                 |

Based on the explanation of the paragraphs above, it can be seen that when viewed from each item, the material and chapters have decreased the quantity of misconceptions. Application of the 5E-POW (Predict-Observe-Write) model assisted by virtual simulations can reduce the quantity of misconceptions held by high school students on fluid topics because it can facilitate students to explore knowledge and concepts and be able to provide cognitive conflict situations to students so as to enable students to build knowledge new by changing the initial concepts that are owned by students.
4. Conclusion
Based on research, management and data analysis regarding the development of a 5E-POW (Predict-Observe-Write) learning model assisted with virtual simulations to reduce the quantity of high school students’ misconceptions on the topic of fluid, it can be concluded that: (1) Has successfully developed a 5E-POW learning model (Predict-Observe-Write) aided by virtual simulations has its own characteristics in remediating misconceptions. These characteristics are seen in the steps of learning undertaken when learning. The 5E-POW syntax is: engage, explore (Predict-Observe-Write), explain, elaborate and evaluate; (2) The scientific conception of students on the topic of fluids before the 5E-POW (Predict-Observe-Write) learning model is assisted by a low category virtual simulation. After applying the 5E-POW (Predict-Observe-Write) learning model aided by virtual simulation of a high-category scientific conception of students. The improvement of students' scientific conceptions is in the medium category. (3) Students' misconceptions on the topic of fluids before applying a simulated simulation model of 5E-POW (Predict-Observe-Write) have a high percentage. After applying the 5E-POW (Predict-Observe-Write) learning model aided by virtual simulation of students 'misconceptions the percentage is decreasing. The decline in students' misconceptions is in the medium category. The improvement of students' scientific conceptions is in the medium category.

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