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# the Effect of Website-Based Formative Assessment to Improve Students' Conceptual Understanding in Dynamic Fluid Topic

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**ABSTRACT**

*Conceptual understanding is an important goal in learning because it is required to develop a deep understanding of how the concepts inter-relate with each other. However, students' conceptual understanding, especially in dynamic fluid topics, are still relatively low. One of the reasons behind this issue is the limited time for teachers to provide direct feedback to each student. This research focused on analyzing the effect of website-based formative assessment (Fortion) to improve students' conceptual understanding in dynamic fluid topics. This research is a quasi-experimental study with One Group Pretest-Posttest Design. The sample in this research were 66 students of 11th grade from Public School in Banjarmasin City. The instruments used in this research was learning achievement tests. Data analysis was carried out through the Wilcoxon test. This research showed that there was an effect of website-based formative assessment (Fortion) in order to improve students' conceptual understanding in dynamic fluid topics. Thus, the exploration of website-based formative assessment on different topics needs to be held in future research so that Fortion can be more effectively used by students to enhance their conceptual understanding.*

**Keywords :**conceptual understanding; dynamic fluid; website-based formative assessment; Fortion.



## I. INTRODUCTION

Physics is commonly known as the fundamental science as it studies the natural phenomena of the world around us. However, physics is perceived as a difficult subject and it always comes with students' alternative conceptions and difficulties which are contradictory with physics concepts [1]. Students have difficulty understanding and applying physics theory that they have learned. Before students learn any new concept in physics, they have already experienced the concept or phenomenon in their daily life. Students tend to believe in their logical thinking and ideas which they think to be the explanation for what they have experienced. However, that thought is not verified and it is not necessarily correct and is the explanation for what they believe.

As stated by Ornek, Robinson, and Haugan that students feel physics is a difficult subject because they have to understand various kinds of representations, such as physical equations, graphs, and conceptual explanations [2]. Students must also have the skills to get used to understanding and moving from one representation to another, for example from a graphical representation to a mathematical representation, so that a good conceptual understanding is needed. One of the physics materials that is closely related to conceptual understanding is fluid dynamics. Arifin, Sukarmin, and Sarwanto stated fluid mechanics as a material related to nature and technology, So the properties of dynamic fluids are very important to study and understand because the concept of dynamic fluid materials is widely applied in everyday life [3]. In line with this, Diyana, Sutopo, and Sunaryono stated that the basic concept that students need to master in dynamic fluid material is the application of the concepts of continuity and equality, and Bernoulli's principle [4]. However, not a few students have difficulty describing concepts from existing equations as well as explaining and understanding phenomena based on fluid dynamic concepts [5]. Brown states that fluid mechanics has several concepts that are difficult to understand, because they require a good understanding of the concepts [6]. Many students find it difficult to distinguish between fluid mechanics and solid mechanics concepts they studied before [7], fail to integrate

continuity equations and Bernoulli's law [8], do not understand Bernoulli's principle and its applications [9], and assume that the greater the fluid velocity, the greater the pressure, and the pressure is equal to the force [8].

Based on the results of the initial study, students stated that they were reluctant, embarrassed, and even confused to ask questions because they did not know what made them confused. The teacher also stated that students still had difficulty moving terms and often made mistakes in mathematical signs and division of equal variables. Students also stated that they did not understand the equations in fluid dynamic material because while studying the material they were only presented with equations and asked to memorize the equations. On the other hand, teachers also face obstacles or difficulties when providing feedback to students. These obstacles include the large number of students in the class so that it is difficult for teachers to interact individually with each student [10]. This is related to the characteristics of feedback which must pay attention to the content (substance) and delivery methods according to the needs of students. As stated Hatziapostolou & Paraskakis, the components in feedback include the content of the feedback and the methods used to deliver the feedback. Based on this background, the researcher is interested in studying the effect of website-based formative assessment to improve conceptual understanding of dynamic fluid material [11].

## II. METHOD

This research is a quasi-experimental study with One Group Pretest-Posttest Design. The sample in this research were 66 students of 11th grade from Public Schools in Banjarmasin City. The instruments used in this research were learning achievement tests. The test in question is a cognitive ability test in the form of multiple choices questions that are carried out before using Fortion (pre-test) and after using Fortion (post-test). Data analysis was carried out through the N-Gain and Wilcoxon test. The test results data on student learning outcomes are then analyzed by calculating the difference between post-test and pre-test (normality test gain) to then be compared with the effectiveness criteria in Table 1.

$$<g> \equiv \frac{\%<G>}{\%<G>_{max}} = \frac{(\%<S_f> - \%<S_i>)}{(100 - \%<S_i>)} \quad (1)$$

$<g>$ : *N*-gain
$\%<S_f>$ : average value of *post-test*
$\%<S_i>$ : average value of *pre-test*

Table 1. Effectiveness Criteria

| *Gain Score* | Criteria |
|---|---|
| $(<g>) \geq 0{,}7$ | High |
| $0{,}7 > (<g>) \geq 0{,}3$ | Medium |
| $(<g>) < 0{,}3$ | Low |

[12]

Analysis of students' understanding of concepts is determined based on students' answers as follows the criteria are shown in Table 2.

Table 2. Students' Conceptual Understanding Analysis

| Students' Answers | Criteria |
|---|---|
| All answers all correct | *Understand* |
| One answer is wrong | *Moderate Understand* |
| One correct answer or all wrong answers | *Not Understand* |

[13]

Hypothesis testing in this research was carried out through parametric tests paired t-test (if the data is normally distributed) or the Wilcoxon non-parametric test (if the data is not normally distributed). The data is declared normally distributed if the significance value is ≥ 0.05. As for decision making, the results of the hypothesis test are H0rejected if the significance value obtained is <0.05.

$H_0$ There is no average difference between the pre-test and post-test learning outcomes of students' conceptual understanding abilities using Fortion.

$H_a$ There is an average difference between the pre-test and post-test learning outcomes of students' ability to understand concepts using Fortion.

## III. RESULTS AND DISCUSSION

Based on the research results, the average pretest and posttest results of students along with the N-gain score were obtained, as shown in Table 3.

Table 3. N-gain for Conceptual Understanding

| Pretest Average | Posttest Average | N-gain | Criteria |
|---|---|---|---|
| 24.75 | 64.48 | 0.53 | Medium |

Table 3 shows the average increase in student learning outcomes after using Fortion. An N-gain achievement of 0.53 was obtained in the medium (moderate) category. The categories or levels of students' understanding of concepts are divided into Understand (U), Moderate Understand (MU), and Not Understand (NU). The percentage distribution of concept understanding categories is presented in Table 4.

Tabel 4. Conceptual Understanding as Students' Learning Outcomes

| Pre-test (%) | | | Post-test (%) | | |
|---|---|---|---|---|---|
| U | MU | NU | U | MU | NU |
| 2.04 | 7.96 | 90.00 | 13.89 | 65.56 | 20.55 |

Table 4 shows that students' conceptual understanding during the pre-test was dominated by the NU category (Not Understand). Meanwhile, during the posttest, students' conceptual understanding was dominated by the Moderate Understand (MU) category. This achievement shows that after implementing Fortion in learning, students' conceptual understanding increased (better). The distribution of student scores for each question item is presented in Figure 1 (pretest) and Figure 2 (posttest).

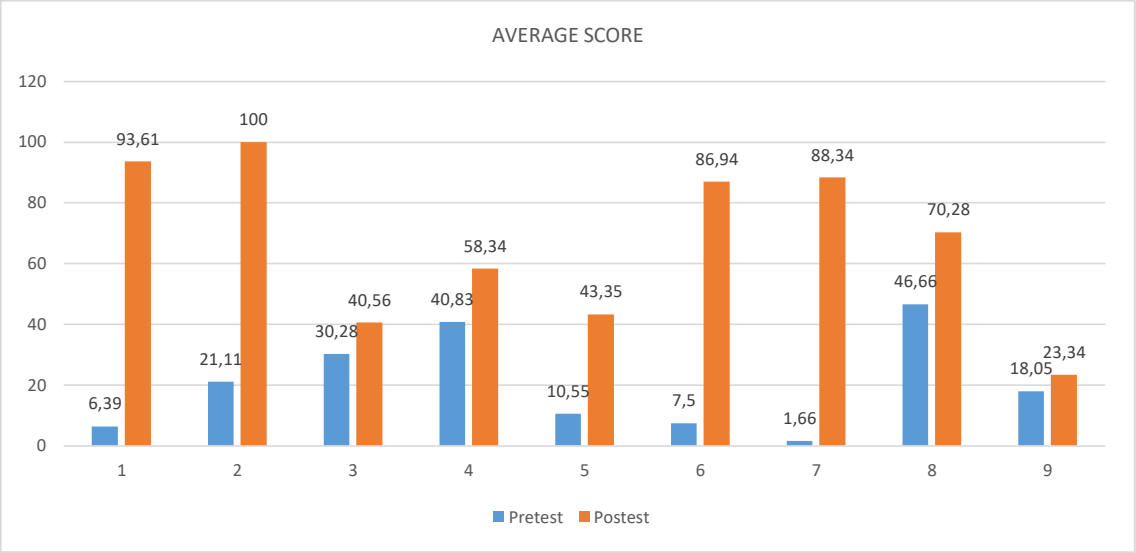


Figure 1. Average Score for Pretest and Postest on Students' Conceptual Understanding

The 9 multiple choice questions tested consisted of 3 questions in the sub-chapter Continuity Equations (numbers 1-3), 3 questions in the sub-chapter Bernoulli's Law (numbers 4-6), and 3 questions in the Torricelli Theorem (numbers 7-9). Figure 1 shows a comparison of the percentage of students' correct answers for each question item. Figure 1 also shows that the red bar chart has a larger (higher) percentage compared to the blue

bar chart; which indicates that the students' learning outcomes during the post-test were better than during the pretest.

The improvement in student learning outcomes after applying Fortion shows that Fortion helps their physics learning process. Fortion presents types immediate feedback with substance Informative tutoring. Informative tutoring is part of the feedback Elaborated who serves verification feedback, error flagging, and hints/cues/prompts, without giving a correct answer. This is based on the opinion of Hatziapostolou & Paraskakis which states that in order formative feedback to run effectively, several items must be considered, such as timely, constructive, motivating, and personal (shown individually) [11]. Criteria of formative feedback on Fortion is students get feedback shortly after answering the questions, addressed personally, and equipped with tutors who help personally in sustain (continuous) way, as shown in Figures 2, 3, and 4.


Figure.2 First Feedback

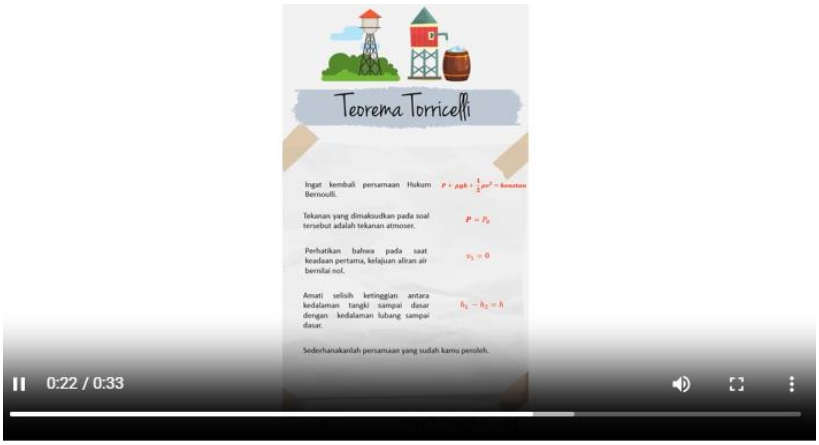


Figure 3. Second Feedback

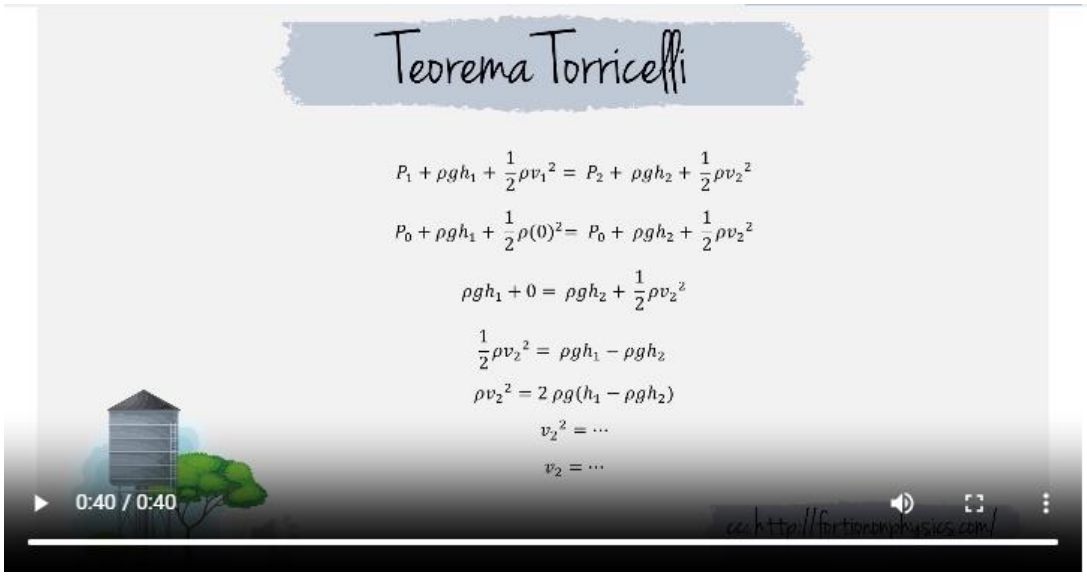

Figure 4. Thrid Feedback

Theoretical foundations in giving feedback or feedback on Fortion refers to Constructivist Theory of Learning which states that cognitive (or mental) activity of building knowledge is done by making meaning through the interaction between experience and ideas [14]. Feedback that provided on an ongoing basis (sustain) at Fortion is also expected to form a complete experience so that students can build their knowledge from substance feedback which he received. With various types of feedback provided, students can choose feedback that suits their needs feedback, in terms of visual, audio visual with limited, capacity hints/cues/prompts, and audio visual with more complete capacity hints/cues/prompts. These various types of feedback refer to Feedback Intervention Theory where students get feedback can give a variety of responses, such as (a) they can choose to study harder and earnestly, (b) they can lower their performance standards, (c) they can reject the feedback they receive, or (d) they abandon their efforts them to achieve targeted standards. Selection of response options depends on how committed students are to learning and achieving their goals [15].

Further analysis regarding the distribution of students' answers is reviewed through graphs in each subsection. Analysis of answers on the pre-test and post-test shows that some students' mistakes were repeated by choosing the same wrong answers during the post-test. In the sub-chapter of the Continuity Equation (no 1-3), it is known that the understanding of the average score of students at number 3 decreases. In item number 3 students are asked to determine the velocity of the fluid in a pipe in the second and third segments. In this item, there are not many students who make mistakes in changing millimeter units. Because of the mistake in changing the unit, not a few students are wrong in determining the speed of the fluid in the third segment. Furthermore, in the sub-chapter Bernoulli's Law (numbers 4-6), students show difficulty in question number 5. In question number 5, many students make mistakes in determining the relationship between speed and pressure. They assume that if the diameter of the pipe narrows (shrinks), the speed will increase, so the pressure will also be greater; the greater the fluid speed, then the pressure will be smaller. As for the Torricelli Theorem sub-chapter (numbers 7-9), students show difficulty in question number 9. In question number 9, students compare 5 vessels with different liquids and are asked to determine the vessel with the farthest horizontal distance by assuming that all the fluids in the five vessels are ideal fluids. In determining the farthest horizontal distance, students made a mistake between determining the depth of the hole and the height of the hole. To determine the farthest beam distance according to Torricelli's Theorem, the depth of the hole is used (which is measured from the point of the hole to the bottom of the vessel). Meanwhile, students use the height of the hole (which is measured from the point of the hole to the surface of the vessel).

The analysis then continues with statistical tests to answer the problem formulation that has been created by looking at the overall data from the pre-test and post-test results.

Table 5. Statistical Test Results for Conceptual Understanding Data

| Data | Sig. Shapiro-Wilk | Asymp. Sig. (2-tailed) Wilcoxon |
|---|---|---|
| Pre-test | 0,001 | 0,000 |
| Post-test | 0,001 | |

Based on Table 5, it is known that the significance of the pre-test and post-test data is <0.05, so the data is not normally distributed. Because one of the prerequisite tests was not fulfilled, a non-parametric test was carried out using the Wilcoxon test. Table 5 also shows that the significance obtained was 0.000 (<0.05), so that H0 was rejected and it was concluded that there was an average difference between the pre-test and post-test learning outcomes in students' conceptual understanding abilities using Fortion.

## IV. CONCLUSION

Based on the results of the analysis, it was concluded that there was an effect of website-based formative assessment (Fortion) towards students' conceptual understanding in dynamic fluid topics. 5.83 in the medium category. Based on the results of this research, recommendations are also given that Fortion can be used by adding a greater variety of questions, so that students' understanding of concepts can also improve better.

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