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THE EFFECTIVENESS OF WEB-BASED RECITATION PROGRAM ON IMPROVING STUDENTS' CONCEPTUAL UNDERSTANDING IN FLUID MECHANICS

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ABSTRACT

A web-based recitation program has been developed to improve students' conceptual understanding of some fundamental concepts of fluid mechanics. The program consists of multiple-choices conceptual questions followed by immediate feedback for each option. This study aimed to examine the effectiveness of the program and whether the program can be used by students without any assistance of instructor. If so, the program could be used by instructor to serve recitation program outside the classroom. To address the objectives, this study employed a non-randomized control group pretest-posttest design involving three groups of students. The first group (E-1) used the program accompanied by teaching assistant, the second group (E-2) used the program by his/herself without assistance, and the third group (C) learned by his/herself without the program. The study involved 73 students enrolling the introductory physics course in physics education department, State University of Malang, as the subject. The effectiveness of the program was analyzed by comparing N-gain scores of the three groups and the responses of the E-1 and E-2 students to the program. Pretest was administered after the three groups of students have learned fluid mechanics through regular lecture sessions, and the posttest was administered after the E-1 and E-2 groups have finished learning with the help of the program. The results showed that the N-gain of group E-1, E-2, and C was 0.51 (upper medium), 0.58 (upper medium), and 0.12 (low), respectively. The ANOVA test showed that the three N-gain values were statistically different (p = 0.000). The LSD post hoc test showed that the N-gain of group C was significantly different from that of group E-1 and E-2 (p = 0.000), whereas the N-gain between group E-1 and E-2 was not significantly different (p = 0.244). It can be concluded that the web-based recitation program was effective to improve the students' conceptual understanding of fluid mechanics and can be used equally well with or without direct assistance from instructor or teaching assistant. The students that used the program also gave quite positive responses to the program, that the program could help them to reflect on the appropriateness of their understanding, was easy to use, and had attractive features.

Keywords: conceptual understanding; fluid mechanics; web-based recitation program

INTRODUCTION

Mastery of some fundamental concepts is one of the main objectives of learning physics. Students are considered to have mastered a concept if they fully understand the concepts and are able to apply them to solve problems (Docktor et al., 2015; Kustusch, 2016) or explain daily physical phenomena in both natural or designed world (Lin & Singh, 2011; NRC, 2012). However, researches show that many students have difficulty in mastering concepts (Shishigu et al., 2018), even hold misconceptions (Docktor et al., 2015).

There are two main theoretical viewpoints that explain students fail to solve a problem or make scientific explanations about a natural phenomenon, i.e. misconception theory and

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resource theory (Docktor & Mestre, 2014; Wood et al., 2014). Misconception theory believes that students' failure to solve physics problems due to misconceptions or naïve theories that are firmly embedded in their knowledge structure (long term memory). Students' misconception is believed to be stable and will consistently be activated in various but similar problems. Misconceptions are also difficult to change because they have been constructed by students through long experiences and often succeed in explaining many natural phenomena, at least according to the students themselves. Misconceptions also tend to interfere new scientific knowledge that students learn. Therefore, followers of this theory suggest the importance of removing misconceptions from students' long-term memory and replacing them by new scientific knowledge. The appropriate learning strategy to remediate misconception is cognitive conflict as suggested by Posner and colleagues about four decades ago (Posner et al., 1982; Strike & Posner, 1982). Theoretically, this strategy will be effective in overcoming misconceptions such as many researcher works (Diyana et al., 2020; Hadjiachilleos et al., 2013;Wartono et al., 2018). However, our experience shows that the strategy is quite difficult to be implemented. A phenomenon we believed to be effective to generate high cognitive conflict often does not produce any reasonable conflict in students' mind (Gal, 2019; Pyun et al., 2019). As a result, further learning activities will be not effective to remove students' misconceptions and replace them with scientific conceptions.

Contrast to the misconception theory, resource theory believes that students' failure to solve problems or explain phenomena is more caused by students' failure to activate cognitive resources that are appropriate to the context of the problem (DiSessa, 2018; Docktor & Mestre, 2014; Hammer, 2000; Sabo et al., 2016; Wood et al., 2014). The term resource was first introduced by Hammer (2000) to describe a unit of thought, or "seed of science" (Sabo et al., 2016), which is used by students in explaining phenomena. The scientific truth of a resource depends on the context. That is, it can be true in certain context but it can be false in other contexts. According to this theory, students' knowledge structure is not as robust as the misconception theory believes; but it is quite fluid and easily changes according to the context at hand. The task of educators is to provide students the learning opportunities to build as many as possible patterns of resource-context associations that are proven to be true, while, at the same time, weakening the incorrect pattern of resource-context associations. Throughout frequent activation of such productive pattern of association, students' knowledge structure will be improve where the patterns of association that are proven to be true will be compiled into a stable scientific knowledge (Docktor & Mestre, 2014; Wood et al., 2014). We believe that the resource theory is a viable alternative framework to help students master physics concepts well. In this study we apply the framework to help students master fundamental concepts on fluid mechanics.

One branch of physics that deals with many natural phenomena and technology in everyday life is fluid mechanics (Serway & Jewett, 2010). Fundamental concepts that students need to master on this topic include hydrostatic pressure, Pascal's principle, Archimedes' principle, continuity equation, and the Bernoulli's equation. Some previous studies have revealed students' difficulties in applying fluid concepts. Student difficulties related to hydrostatic pressure have been revealed by Goszewski et al. (2013), Berek et al. (2016), and Wijaya et al. (2016). Difficulties related to Archimedes' principle have been revealed by Loverude et al. (2003), Wagner et al. (2013), and Kusairi et al. (2020). In the context of dynamic fluid, Suarez et al. (2017) revealed students' failure to integrate the continuity equation and Bernoulli's law. This indicates that facilitating students to master essential concepts of fluid is not an easy matter.

In order to successfully use fluid concepts in solving problems and explaining everyday phenomena, students need to understand the interrelationship of these concepts, as well as their relation to other physics concepts such as Newton's law of motion, the principle of conservation of volume, and conservation of mass. In accordance with resource theory, students need considerable experiences to use these scientific concepts as the appropriate resource in solving problems. The is quite challenge because most students also have several resources they built intuitively through daily experience, which Hammer (2000) called phenomenological primitive (p-prime). For example, experience shows that the stronger a person pushes an object from underwater, the more fraction of that object appears on the surface. If this resource is applied to the context of floating and sinking objects, the students will think of the more fraction of an object that is on the surface mean the greater the upward force exerted by the liquid on the object—a claim which contradicts to the Archimedes principle.

To provide students with opportunities to develop as much as possible the appropriate pattern of resource-context association, it requires so considerable time that might not be handled in a lecture section. Lecturer needs to pay attention to any kind of student thinking and give appropriate feedback individually (Richards et. al., 2018). For some universities that employ teaching assistant, it can be handled by providing recitation, that is a small group discussion led by teaching assistant to facilitate students deepen their understanding of the concepts exposed in the lecture section (Koenig et al., 2007 Finkelstein & Pollock, 2005). For universities that do not employ teaching assistant, it needs another innovation to address the problem. However, by utilizing computer or online tutorial, it is possible to develop web-based recitation program that can replace the role of teaching assistant. The work of Ryan et al. (2016) utilized this possibility to provide students with guided repetition and feedback in practicing problem solving.

Research on the field of resource theory typically focus on the exploration of resources that students activate during problem solving or understanding new knowledge. For example, Tuminaro & Redish (2007), based on their exploration on students' resources in problem solving, proposed a framework they called epistemic games to understand how students solve physics problems. Harrer et al. (2013) revealed some resources that students tend to use in learning energy and suggested the resources need to be used by teachers as bridging in teaching energy. Similarly, Farlow (2019) revealed students' resources when the students try to understand mathematical representation of kinematical vectors in non-Cartesian coordinate system and suggested its implication on teaching non-Cartesian coordinate system. Some others research compared teaching strategy developed based on resource theory with that developed based on misconception theory (Scherr, 2017). Other research explored the role of dialogue with peers in the activation of new resources (Wood et. al., 2014). There is limited work concerning on the implication of resource theory on recitation program.

This research has tried to develop a web-based recitation program by adapting of some relevant findings of previous research on the field of resource theory. It is reasonable to develop computer program that plays out the role as of peer, that provides immediate feedback or new perspective to student thinking and stimulates students to activate relevant resources (Wood et al, 2014). This work also accommodates the suggestion of Richards et. al. (2018) of the importance of stimulating students to activate multiple type of their understandings, and explicitly allowing students to reflect on how their understanding fits into scientific understanding of the world. The program is briefly described in the next section.

Brief Description of the Program

Web-based recitation program is a recitation program that is designed as a personal learning assistance and is expected to be used by students without any assistance form instructor. The program consists of some multiple-choices conceptual questions followed with immediate feedback for both the correct and incorrect options. Problems covered in the program are that most students answer incorrectly due to the inaccuracies of the resources they activate. Feedback for the incorrect option is designed so that the students can analyze the inappropriateness of the resources they activate and help the students to use the appropriate resources. Feedback on the correct option is designed to reinforce students' understanding. Because not all students who answer correctly have the correct understanding, feedback also aims to provide an explanation and confirm answers according to the right concept. Feedback on each question is given immediately so that students immediately evaluate their thinking. Correct resources are provided repeatedly to build strong associations about these resources.

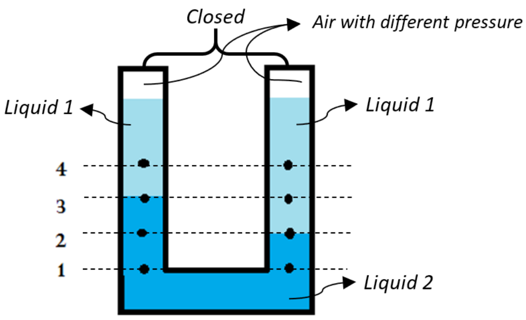
One example of the problem and the feedback is presented in Table 1. This problem is intended to help students develop correct pattern of association related to the prime principle of hydrostatics, i.e. any points on one horizontal line parallel to the surface of the Earth have the same pressure as long as they are in the same fluid and the fluid is directly connected. There are three kinds of resources that students tend to use inappropriately so that lead the students to incorrect claim. *First*, the hydrostatic pressure depends only on the depth. The resource refers to the Hydrostatic pressure equation ($P = \rho gh$). Students who activate this resource will choose option D. *Second*, any points that are at the same depth in any U pipe have the same pressure. The resource is correct when applied to a U pipe containing one type of liquid. However, it is wrong in the context where the U pipe contains two different types of fluid, and these two points are in one type of fluid but are not directly connected, as in line number 4. Students who activate this resource tend to choose option B. *Third*, any pair of points that are in a horizontal line parallel to the surface of the earth will have the same pressure as long as the points are in the same fluid that is directly connected, the points are not in the border of two fluids (as in line 2). This resource leads the students to incorrect option A.

The program covers three topics, each packaged in one package. Package 1 about Hydrostatic pressure and Pascal's law, Package 2 about the principle of Archimedes, and Package 3 about the equation of Continuity and Bernoulli. The program is presented in a website format so that it can be used online by students wherever and whenever.

The Aim of Study

The aim of this study is to examine the effectiveness of the program to improve students' understanding of some fundamental concepts of fluid mechanics and examine whether the program can be used by students without any assistance of instructor. If so, the program could be used by instructor to serve recitation program outside the classroom.

Table 1. Example of a Problem and the Feedbacks

Problem	Here is a picture of a closed vessel filled with two types of fluid. Pay attention to the pairs of points connected by horizontal lines 1 through 4 in the figure.  Pairs of points that have equal pressure are pairs of points connected by lines ... A. (1) B. (1) and (4) C. (1) and (2) D. (1), (2), (3), and (4)
Feedback for option A	Do you think that at the points connected by line (1) have the same pressure because the points are in line, the fluid is the same and connected? If true, then your understanding is correct regarding the main law of Hydrostatics. But if you think that only at line (1) has the same pressure, try again to consider line (2). Do the points on the line meet the main legal requirements of Hydrostatics? Because it coincides and is on the border it can be on two liquid so it is also connected to the left side of line 2. So that the points connected by line 2 also have the same pressure. The main law of hydrostatics states that points that line horizontally parallel to the surface of the earth have the same pressure as long as they are in the same fluid, and the fluid is connected. Thus, the points connected by line (1) meet the main laws of hydrostatics as well as points connected by line (2). Remember! If one of the conditions (in line, same fluid, connected fluid) is not met, then the pressure is not necessarily the same.
Feedback for option B	In certain contexts, your understanding of two points in line and in the same fluid having the same pressure is true. For example, in the context of fluid pressure at two points in the U-pipe which only contains 1 type of fluid. However, this does not apply if the fluid is not connected as two points connected by line (4). For fluid that is not connected the pressure does not have to be the same. The main law of hydrostatics states that points that line horizontally parallel to the surface of the earth have the same pressure as long as they are in the same fluid and the fluids are connected. Thus, the points connected by line (4) do not have the same pressure, while the points connected by lines (1) and (2) have the same pressure. Remember! If one of the conditions (in line, same fluid, connected fluid) is not met then the pressure is not necessarily the same.

Feedback for option C	If you think that the points connected by lines (1) and (2) have the same pressure because it is in a horizontal line, at the same fluid and the fluid is connected, then you are right. This is in accordance with the main legal statement of hydrostatics. Remember! If one of the conditions (in line, same fluid, connected fluid) is not met then the pressure is not necessarily the same.
Feedback for option D	Your understanding of Hydrostatic pressure ($P = \rho gh$) is correct that all points at the same depth (in line) have the same pressure. But if you consider the points connected by lines (1), (2), (3), and (4) have the same pressure because they are at the same depth, that understanding is not quite right. Note that the pair of points is indeed horizontal line parallel to the surface of the earth, but are the fluids connected by each line the same? Are the fluids on each line connected? Remember! The main law of hydrostatics states that points that line horizontally parallel to the surface of the earth have the same pressure as long as they are in the same fluid and the fluids are connected. If one of the conditions is not met, then the pressure is not necessarily the same. So, the points that have the same pressure are the points connected by lines (1) and (2).

METHODS

Research Design and Instruments

To evaluate the effectiveness of the program, this study employed a nonrandomized control group pretest-posttest design (Paul et al., 2014). The students were grouped into three groups, two groups as the experimental group and one group as the control group. The three groups have learnt fluid mechanics through the regular lecture section on the introductory physics course. The first experimental group (E-1) used the program accompanied by an instructor for three meetings, each for different package. The second experimental group (E-2) used the program independently without an instructor. The instructor only held one meeting to give direction about how to use the program. The control group (C) learns independently without using the program.

The effectiveness of the program is analyzed based on differences in the N-gain of pretest-posttest score (Coletta & Steinert, 2020) between the experimental and the control groups, and the response of the experimental class students to the program. Pretest was administered after the three groups of students have learned fluid mechanics through regular lecture sessions, and the posttest was administered after the experimental groups have finished learning with the help of the program. Pretest and posttest used the same test, which consisted of 17 multiple-choices questions (Table 2).

Based on the piloted test to 165 students, the test has the following statistics. The average value of item difficulty level is 0.6 (range 0.3 - 0.8), the average values of item discrimination index is 0.42 (range 0.1 - 0.6), and the average of point biserial coefficient is 0.42 (range 0.02 - 0.79). Overall, the instrument has a Cronbach's Alfa coefficient of 0.63. Based on these statistical features, the instrument is feasible to measure students' mastery of concepts (Leech et al., 2014).

Table 2. Description of the Test

Topics	Item's Description	Number
Hydrostatics pressure	Comparing fluid pressure at several points in a shipyard	1
	Determining the pressure of the fluid in the U pipe containing two different types of fluid with the right pipe left open while the left pipe is tightly blocked	2
	Determining the equilibrium formation if two different fluids are filled into a U pipe	3
	Comparing fluid pressure at several points in vessels with irregular upper surface	4
Pascal's Law	Comparing fluid pressure at several points in a vessel filled with water that is closed with a piston and an object placed on a piston	5

Archimedes Principle	Determining the normal force of a coin that sinks to the bottom of a container filled with water	6
	Comparing the volume of beams immersed in fluid at two places with different gravitational accelerations	7
	Determining the tension of the rope on the lifting cable of a statue that is submerged in water	8
	Comparing the density of three different fluids	9
	Comparing the weight of two measuring cups containing fluid and a beam	10
	Determining the weight of a boat if the volume of displaced pool water is 1 m3	11
	Determining the mass of two passengers riding a water game	12
Equation of Continuity and Bernoulli	Determining the rate of flow and blood pressure flowing in a person's blood vessels that have plaque deposits during sleep position	13
	Comparing the speed of flow of water at several points in a vessel that flows steadily through a hose	14
	Comparing the speed of water flow at several points in a series of vertical pipes that flow steadily	15
	Comparing the pressure of water at several points in a series of vertical pipes that flow steadily	16
	Determining the speed of flow and depth of fluid flowing in a pipe that flows steadily	17

At the end of the study, the perception survey was conducted on groups E-1 and E-2 to find out students' responses regarding the program's usefulness. The survey was given immediately after the posttest. The survey was conducted online using Google form. The instrument consists of 12 questionnaires with a Likert scale of 1-5, developed from several previous researchers (Choy et al., 2016; Cigdem, Harun, 2015; Gerritsen-van et al., 2018; Koenig et al., 2007; Nielsen, 2018). Based on the results of principal component analysis (PCA), the 12 questionnaires are grouped into three domains, namely usefulness consisting of 6 items, easy to use consisting of 3 items, and attractiveness consisting of 3 items (Table 3).

Table 3. Student Perception Questionnaire for the Web-based Recitation Program

Aspects	Questionnaire
Usefulness	U1 The recitation program can help me follow the stages of learning fluid material easily U2 The recitation program can make it easier for me to understand fluid material U3 The recitation program can help me strengthen the understanding of concepts in fluid material U4 Feedback on the recitation program can help me find out the concept errors and difficulties I experienced. U5 Feedback on the recitation program can help me correct my misconceptions U6 Feedback on the recitation program can help me understand the correct concept
Easy to use	E1. A good quality picture on recitation with Moodle has made it easier for me to join the recitation program E2 The pictures used to support the explanation have made it easier for me to join the recitation program with Moodle E3 The recitation program with Moodle is easy to use / operate
Attractiveness	A1. I am interested in this recitation program A2. I prefer to learn to use a recitation program rather than a lecture method A3. Font size makes it easy for users to read (attractive appearance)

Participants

Participants in this study were students of the Physics Education Study Program at the State University of Malang, Indonesia. Participants are first-year students who are taking the Basic Physics course I in 2019. Total participants are 73 students with details of 24 students in the E-1 group, 24 students in the E-2 group and 25 students in the C group.

RESULTS AND DISCUSSION

Students' Conceptual Understanding

All groups of students, the experiment groups (E-1 and E-2) and control group (C) get improve in pretest to posttest scores (Table 4). But the average N-gain of the experimental group (E-1 and E-2) seemed higher than the N-gain of the control group. The experimental group got N-gain of 0.51 (upper medium) for E-1 and 0.58 (upper medium) for E-2. The N-gain of the control group, on the other hand, was 0.12 (low).

Table 4. Descriptive Statistics of the Pretest, Posttest, and N-gain Scores

Statistics	Group E-1			Group E-2			Group C		
	Pre-test	Post-test	N-gain	Pre-test	Post-test	N-gain	Pre-test	Post-test	N-gain
N	24	24	24	24	24	24	25	25	25
Minimum	4.00	9.00	0.00	5.00	10.00	0.13	4.00	5.00	0.00
Maximum	11.00	17.00	1.00	12.00	17.00	1.00	11.00	13.00	0.45
Mean	8.79	13.08	0.51	8.87	13.67	0.58	7.16	8.28	0.12
SD	1.72	1.56	0.21	1.82	1.97	0.24	1.95	2.23	0.18
Skewness	-1.161	-.075	-.380	-.407	-.383	-.271	.086	.576	0.106

The ANOVA test showed that the three N-gain values were statistically different ($p = 0.000 < 0.05$). The LSD post hoc test (Table 5) showed that the N-gain of the control group was significantly different from the N-gain of the two experimental groups ($p = 0.000$), while the N-gain between the two experimental groups was not different statistically ($p = 0.244$). We conclude that the web-based recitation program was effective to improve the students' conceptual understanding of fluid mechanics and can be used equally well with or without direct assistance from instructor.

Table 5. Post Hoc LSD Test Results in N-gain Differences between Groups

Groups	Mean Difference	p
E2 – E1	.07188	.244
E2 – C	.47100	.000
E1 – C	.39912	.000

Based on the results of the analysis of the data obtained above has provided evidence that the web-based recitation gives a good effect on improving students' mastery of concepts in the topic of fluid mechanics. These results are supported by several previous studies which stated that mastery of students' concepts increased through the use of recitation programs (Koenig et al., 2007) one of them is because there is feedback on each option for conceptual answers to verify the truth of the concept (Oliveira & Oliveira, 2013) and sharpen the concept that has been owned (Fakcharoenphol et al., 2011; Schroeder et al., 2015) and has a positive effect on learning (Butler & Roediger, 2008). It is also supported by several other researchers who stated that the provision of conceptual questions could improve students' mastery of concepts (Guo et al., 2014; Rosenblatt & Heckler, 2011; Sornkhatha & Srisawasdi, 2013). Mastery of concepts is the most important aspect in learning physics, namely how students are able to master and apply these concepts in the process of solving problems (Docktor et al., 2015; Kustusch, 2016) mainly in solving several types of problems (Lin & Singh, 2011).

Another finding of this research is that the Web-based recitation program that has been developed can be used equally well through mentoring or not. This shows that the program can be given without the need for direct assistance from the instructor. In other words, assistance in the form of feedback, as outlined in the program, has been able to replace the physical presence of the instructor. In addition, the feedback acts as a "peer" because it can actively provide feedback that triggers students to activate relevant resources (Wood et. el., 2014). This is in accordance with the results of other studies related to the use of computers in learning (Belland et al., 2019; Schroeder et al., 2015; Tuan et al., 2017). The claim is also in line with students' responses to the program, as will be described in the next section.

As an illustration of the effectiveness of the program in improving students' mastery of concepts, the following are presented by students' pretest and posttest results on one of the items (Figure 1). The context of the items is related, but different, with examples of the contents of the recitation program as presented in Table 1.

Note the pair of dots connected by horizontal lines 1 through 4 in the following figure. The right pipe is left open while the left pipe is tightly blocked. The pair of points on both tubes that have equal pressure is the pair of points connected by a line...

a. 1
b. 4
c. 1 and 4
d. 1, 2, 3 and 4

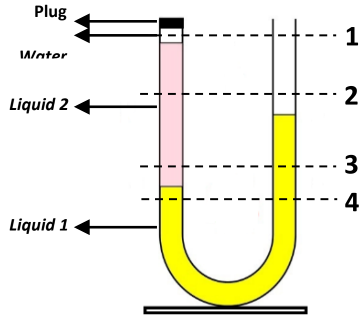


Figure 1. Example Items about Mastery of Concepts

Cross-tabulation of students' answers in the experimental and control class are presented in Table 6 and Table 7.

Table 6. Cross-tabulation of Students' Answers in Experiment Class

		Posttest		Total
		B*	C	Pretest
Pretest	**A**	7	2	9
	B*	23	1	24
	C	9	3	12
	D	3	0	3
Total Posttest		42	6	48

*The correct option

In the experimental class, there was a significant increase in the number of students who answered correctly from pretest to posttest, from 24 students (50%) to 42 students (88%). Meanwhile, in the control class, there were no significant changes, from 15 students (60%) to 14 students (56%). This data provides evidence that the web-based recitation program developed was effective in helping students improve their understanding of concepts.

Table 7. Cross-tabulation of Students' Answers in Control Class

		Posttest				Total
		A	B*	C	D	Pretest
Pretest	**B***	2	11	2	0	15
	C	1	1	3	0	5
	D	2	2	0	1	5
Total Posttest		5	14	5	1	25

*The correct option

Editorial thoughts of students who deliver wrong choices are quite varied. But substantively it can be summarized as follows. The reason students chose the wrong option A was: *"The pair of points connected by line 1 are both in the air so the pressure is the same, which is 1 atm".* The reason students choose the wrong option C is*: "Both lines 1 and 4 connect two points at the same depth and on a similar fluid".* The reason students choose the wrong option D is*: "All lines (1, 2, 3 and 4) connect two points at the same depth, so that according to the main law of hydrostatics (P = ρgh) the pressure is the same".*

Based on the results of the analysis above has provided claim that the statistic results are also in line with students' responses to the program. In addition, the web-based recitation program gives a good effect on improving students' mastery of concepts in the topic of fluid mechanics. So, to provide students with learning experience to develop as much as possible appropriate pattern of resource-context association (DiSessa, 2018; Sabo et al., 2016), a web-based recitation program can be one alternative strategy which can be used equally well through mentoring or not.

Students' Perceptions

The responses of the experimental group students after using this web-based recitation are summarized in Table 8. As mentioned earlier, the questionnaire used uses a Likert scale of 1-5 with the following meanings (Chyung et al., 2017; Joshi et al., 2015). Scale 1 means Strongly Disagree (SDA), scale 2 Disagree (DA), scale 3 Neutral (N), scale 4 Agree (A), and scale 5 Strongly Agree (SA).

The aspect of usefulness describes the benefits felt by students from the program being developed. This includes whether the program helps improve the mastery of the concept, can strengthen the understanding of the concept, can facilitate learning, and the existing feedbacks can correct the concept errors. The average student response to the six questionnaire items in the easy to use aspect was 59.38% strongly agreed, 38.89% agreed, and 1.74% neutral. That is, more than 50% of students think that the recitation program developed is useful as an aid in learning the topic of fluid mechanics. However, some students are neutral, so the program still needs to be developed so that it can provide greater benefits to students.

The easy to use aspect describes students' perceptions of the ease of operation of the program, including the benefits of adding images or illustrations to support the explanation. The average student response to the three questionnaire items in the easy to use aspect was 39.58% strongly agree, 58.33% agreed, 1.39% neutral, and 0.69% disagreed. That is, more than 50% of students think that the recitation program developed is easy to operate. Since there are still some students who are neutral and disagree, the program still needs to be developed so that it is easier to operate.

The attractiveness aspect describes students' interest in the program, both in terms of content and appearance and ease of learning through this program compared to other means such as listening to lectures from lecturers. The average response of students to the three questionnaire items on the aspect of attractiveness is 34.70% strongly agree, 54.90% agree, 6.90% neutral, and 3.50% disagree. That is, more than 50% of students are interested in the recitation program that was developed. However, because there are still some who are neutral and disagree, the program still needs to be developed so that it is more interesting for students to use it.

Table 8. Students' Responses to Each Questionnaire Item

Aspects	Items	SA		A		N		DA		SDA	
		N	%	N	%	N	%	N	%	N	%
Usefulness	U1	29	60.4	19	39.6	0	0.0	0	0.0	0	0.0
	U2	31	64.6	17	35.4	0	0.0	0	0.0	0	0.0
	U3	29	60.4	19	39.6	0	0.0	0	0.0	0	0.0
	U4	29	60.4	18	37.5	1	2.1	0	0.0	0	0.0
	U5	28	58.3	20	41.7	0	0.0	0	0.0	0	0.0
	U6	25	52.1	19	39.6	4	8.3	0	0.0	0	0.0
	Average		59.4		38.9		1.7		0.0		0.0
Easy to Use	E1	16	33.3	31	64.6	0	0.0	1	2.1	0	0.0
	E2	19	39.6	27	56.3	2	4.2	0	0.0	0	0.0
	E3	22	45.8	26	54.2	0	0.0	0	0.0	0	0.0
	Average		38.6		58.3		1.4		0.7		0.0
Attractiveness	A1	18	37.5	30	62.5	0	0.0	0	0.0	0	0.0
	A2	17	35.4	20	41.7	10	20.8	1	2.1	0	0.0
	A3	15	31.3	29	60.4	0	0.0	4	8.3	0	0.0
	Average		34.7		54.9		6.9		3.5		0.0

In general, research findings regarding students' perceptions of web-based recitation program that have been developed are that this program is considered to be very helpful for them to learn, can improve their understanding of concepts, is easy to use, and have an attractive appearance. This shows that the web-based recitation program that has been developed effectively helps students in learning. Especially by giving immediately feedback for every option, whether it is correct or not, it could build students conceptual change (DiSessa, 2017). The results of this study are consistent with previous studies by Koenig et al. (2007) and Finkelstein & Pollock (2005) that students felt a great benefit from the existence of a recitation program using tutorials. In addition, some of the results of previous research are also in line with the findings of this study, that learning with the help of interactive programs (Kulkarni & Tambade, 2013; Mead et al., 2019), Web-based (Basitere & Ndeto Ivala, 2017; Muhametjanova & Akmatbekova, 2019) which is accompanied by an attractive visual appearance (Johan et al., 2018) is able to provide great benefits for increasing students conceptual understanding.

CONCLUSION

Based on the description above, it can be concluded that the Web-Based Recitation Program that has been developed is effective in helping students to improve their mastery of the concept of fluid mechanics, and can be used by students independently without the instructor's assistance. In addition, in the opinion of students, this Web-based recitation program helps them learn, can improve their understanding of concepts, is easy to use, and has an attractive appearance. Based on the results of this study, it is recommended to develop similar programs on other physics topics.

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