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Development of Dynamic-Fluid Online Website (D-FLOW) based on cognitive conflict to reduce students' misconceptions

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Abstract
The Dynamic-Fluid Online Website (D-FLOW) is developed to reduce students' misconceptions. The method used is Research & Development (R&D) with the ADDIE model. The study subjects consisted of 58 students (30 in the experimental and 28 in the control classes) selected through purposive sampling and physics lecturers and teachers as the website's validators. Instruments included a website feasibility test and a four-tier diagnostic test as a pretest and a posttest. The findings indicate that D-FLOW is feasible and effective in reducing misconceptions, with an average decrease of 20.3%. The experimental class showed an N-Gain of 0.61 (medium category) and the control class 0.36 (medium category), while the effect size showed a value of 1.66 (large category). Overall, D-FLOW effectively reduces misconceptions. For future research, it is recommended to investigate the long-term impact and its application to a wider sample.

Keywords: cognitive conflict, concept understanding, web teaching materials,

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I. Introduction

Concept understanding is an inseparable element in physics learning [1]. One of the problems that often arises in understanding physics concepts is misconceptions [2], [3]. Students are classified as having misconceptions if they hold beliefs about a concept that contradict scientific understanding [1], [4], [5]. Suparno [4] explains that misconceptions can be in the form of initial concepts, incorrect relationships between concepts, intuitive ideas or naive views of something. These misconceptions can be triggered by various factors, such as learners' experiences, teachers, textbooks, learning contexts, or methods used in teaching [1], [2], [4]. Misconceptions occur when students' mental models, formed from their life experiences, conflict with new concepts taught in the classroom [3]. This process occurs when students attempt to connect new facts with pre-existing beliefs, giving rise to misconceptions and hindering learning [3]. In physics learning, concepts are interrelated and form a network of knowledge [2], so students' prior knowledge before starting learning can affect their understanding of other physics concepts. Therefore, misconceptions become a crucial problem that needs research because they can hinder students' understanding of more complex physics concepts.

Misconceptions in physics are spread across various topics, including mechanics. So far, mechanics is the most researched topic in physics related to misconceptions [4]. One of the materials discussed in the topic of mechanics is dynamic fluid. Compared to static fluid, dynamic fluid is a more difficult material because it involves more complex physics concepts that are prone to causing misconceptions [6]. One of the misconceptions found in dynamic fluid material is related to the concept of discharge, where students believe that the discharge of fluid flow changes as the cross-sectional area changes [7], [8]. Research on misconceptions in dynamic fluid material has been carried out by [7], [8], [9], [10], the results of which show that misconceptions are scattered in several sub-materials, such as the principle of continuity, Bernoulli's principle, and Torricelli's theorem. In line with these findings, a preliminary study conducted at one of the public high schools in Bandung City also showed that as many as 30% of students still experienced misconceptions in dynamic fluid material. The distribution of students' misconceptions on dynamic fluid material is shown in Table 1.

Table 1. Distribution of students’ misconceptions based on preliminary study results

No	Concept	Percentage of Misconceptions (%)
1.	Principle of Continuity	30.3
2.	Bernoulli's Principle	40.9
3.	Torricelli's Theorem	15.2

According to the findings of the preliminary study in Table 1, it is known that students still experience misconceptions in dynamic fluid material. In fact, after participating in classroom learning, students should gain an understanding that is in accordance with scientific conceptions. This shows that misconceptions are a crucial problem to research because students who experience misconceptions tend to resist change, so it is difficult to accept new understandings that are not in accordance with their initial conceptions [2]. In addition, misconceptions are also a condition that is difficult to change because they are embedded in students' minds, especially if the misconceptions can help solve certain problems [2], [4].

The main goal in learning physics is to master the concept of physics well, so misconceptions are something that is not expected [1]. To achieve this goal, learning is needed that is able to facilitate students in constructing concepts well. But in reality, current learning is still dominated by conventional teaching materials such as textbooks and student worksheets (LKS) that focus on formulas and practice questions, so physics concepts are increasingly abstract for students [11]. Therefore, new teaching materials are needed, which can cause confusion and doubt in students' minds about the initial concepts they hold [4]. One solution that can be done is to develop teaching materials based on cognitive conflict that encourage students to engage in deeper thinking [12].

Cognitive conflict-based learning is a process in which students are faced with a condition in which they realize the discrepancy between the understanding they previously held and the new knowledge they acquire [13]. In essence, cognitive conflict-based learning involves the process of discovery and conceptual change in students [12]. Through this approach, students can reconstruct their knowledge by choosing which concepts need to be changed or improved and which need to be maintained [14]. Thus, the development of teaching materials based on cognitive conflict is expected to be a solution in helping students correct misconceptions and build conceptual understanding properly.

Several cognitive conflict-based teaching materials that have been developed in previous studies include pocket books [15], teaching modules [16], e-modules [17], and teaching materials integrated with software tracker [18], [19]. However, most of these teaching materials are still limited to static formats that lack flexibility and are difficult for students to access. Pocket books and teaching modules require a physical format that limits their use outside the classroom. At the same time, e-modules and tracker software-based teaching materials often require special devices that cannot be accessed by all students. To optimize cognitive conflict learning, teaching materials that emphasize accessibility and flexibility are needed. One solution offered in this research is to develop web-based teaching materials for cognitive conflict.

The developed cognitive conflict-based teaching material web is named "D-FLOW," which is an acronym for "Dynamic-Fluid Online Website". D-FLOW is a web teaching material that will contain a set of learning tools, such as materials, student worksheets, virtual simulations, and practice questions presented with interactive multimedia. This teaching material web integrates a cognitive conflict approach, so that the features contained in this teaching material web are tailored to the needs of cognitive conflict learning. Although as a learning supplement, D-FLOW provides opportunities for students to learn independently with materials that can be accessed anytime and anywhere, supporting distance learning as well as in the classroom. The cognitive conflict approach also provides an opportunity to improve students' concept understanding so as to minimize the occurrence of misconceptions.

Thus, this research aims to develop Dynamic-Fluid Online Website (D-FLOW) as a web teaching material based on cognitive conflict. This step is expected to be a solution in reducing students' misconceptions in dynamic fluid material, and reconstructing these misconceptions into scientific concepts.

II. Methods

Research Design

The research method applied in this study is the Research & Development (R&D) method, which is utilized to develop a product and evaluate its effectiveness [20]. The product developed in this study is a cognitive conflict-based teaching material web on dynamic fluid material named D-FLOW, which is an acronym for "Dynamic-Flow Online Website".

The research design used in this study is the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation [21]. The research procedure based on the five stages of the ADDIE model is shown in Figure 1.

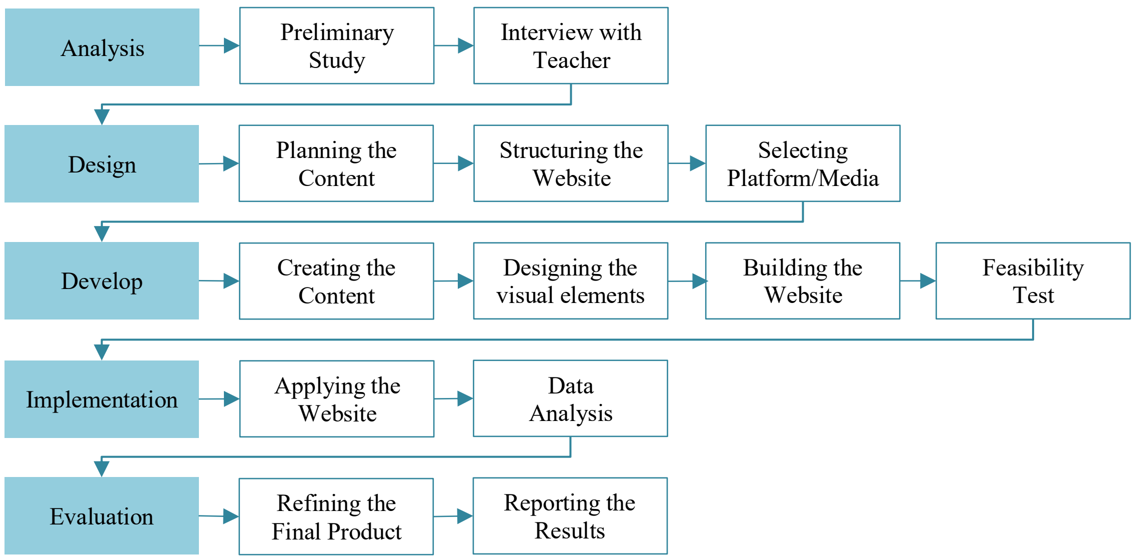


Figure 1. Research procedures

Although evaluation is the last stage, it is also done formatively at the end of each ADDIE stage. This is done to ensure that each phase, from analysis to implementation, goes well and meets the expected goals. Formative evaluation aims to identify the strengths and weaknesses of each stage and allow for any necessary improvements before moving on to the next stage.

Participants

This study was carried out in one of the public high schools in Bandung City. The participants involved in this study included five validators, physics teachers, and students. The research sample was chosen using purposive sampling, namely 11th-grade high school students who have not studied dynamic fluid material and have electronic devices such as handphones, tablets, or laptops. This criterion was chosen to ensure that learners had adequate access to use D-FLOW during the study. The research subjects selected were 30 experimental class students and 28 control class students. Feedback and suggestions obtained from all participants were used to improve the quality of the final product for the better.

Instruments

The instruments used in this study include interview guidelines, website feasibility test sheets, and four-level diagnostic tests. The rating scale used in the interview guidelines is the Gutmann scale with a range of 1-2, where 1 = No, and 2 = Yes. Meanwhile, the rating scale used in the website feasibility test sheet is a Likert scale with a range of 1-5, where 1 = Strongly Disagree, 2 = Disagree, 3 = Less Agree, 4 = Agree, and 5 = Strongly Agree. Furthermore, the test instrument used is a four-tier diagnostic test consisting of 10 items. It has received validation from experts with an average validity index of 0.93, placing it in the valid category. The test items cover the following topics: items 1-3 address the principle of continuity, items 4-7 address Bernoulli's principle, and items 8-10 address Torricelli's theorem. Additionally, the test instrument was empirically validated using Rasch analysis, with all items fitting the model, demonstrating good validity and reliability, with a person reliability of 0.68 (sufficient) and an item reliability of 0.87 (good).

Data Analysis

The data analyzed in this study included website feasibility, students' misconception profile, changes and reduction of students' misconceptions, and the effectiveness of D-FLOW in reducing misconceptions. The website feasibility test was carried out through judgment from validators on the aspects of content/material, media, and language. The feasibility test results were evaluated using Aiken's V formula, as presented in Equation 1 [22].

$$V = \frac{\sum(r - I_0)}{|n(c-1)|} \tag{1}$$

Furthermore, the website is considered valid if the obtained V index value is greater than the minimum V index. Five validators were involved in this study, and the rating scale used ranged from 1 to 5. Therefore, the minimum V index was set at 0.80. Data was also analyzed on the students' pretest and posttest results. This analysis begins by identifying the students' misconception profile based on the category and conception score shown in Table 2 [1].

Table 2. Categories and scores of students' conceptions

Category	Tier-1	Tier-2	Tier-3	Tier-4	Score
Sound Understanding (SU)	C	S	C	S	3
Partial Understanding (PU)	C	S	C	NS	2
	C	NS	C	S	
	C	NS	C	NS	
	C	S	IC	S	
	C	S	IC	NS	
	C	NS	IC	S	
	C	NS	IC	NS	
	IC	S	C	S	
	IC	S	C	NS	
	IC	NS	C	S	
	IC	NS	C	NS	
Misconception (MC)	IC	S	IC	S	1
No Understanding (NU)	IC	S	IC	NS	0
	IC	NS	IC	S	
	IC	NS	IC	NS	
No Coding (NC)	If student do not fill in one or more items				-

Description: C = Correct, IC = Incorrect, S = Sure, and NS = Not Sure

Students are categorized as misconceptions if they give wrong answers in tier-1 and tier-3, but they believe the answer by choosing the "sure" option in tier-2 and tier-4. The categorization of misconceptions in Table 2 was carried out based on the pretest and posttest results, so that the percentage of students' misconceptions in the pretest and posttest was obtained. In cases where students only completed either the pretest or posttest, missing data were handled using mean imputation. This ensured that the analysis remained representative, allowing for the accurate categorization of misconceptions despite the incomplete data.

Further analysis was conducted to determine changes in students' misconceptions by calculating the difference between the pretest and posttest misconception scores. Changes in misconceptions are interpreted as Un-Great Change (U-GC) if the percentage of students' misconceptions increases after treatment, Not Change (NC) if the percentage of students' misconceptions before and after treatment is the same, and Great Change (GC) if the percentage of students' misconceptions decreases after treatment [23] Additionally, to determine the quantity of students conception improvement, the pretest and posttest results can be processed using the N-Change formula shown in equation 2 [24].

$$\langle c \rangle = \begin{cases} \dfrac{\text{post} - \text{pre}}{100 - \text{pre}}, \ \text{post} > pre \\ \text{drop, post} = \text{pre} = 100 \text{ or } 0 \\ 0, \ \text{post} = \text{pre} \\ \dfrac{\text{post} - \text{pre}}{\text{pre}}, \ \text{post} < \text{pre} \end{cases} \tag{2}$$

The N-Change score obtained is then interpreted based on Table 3 [24].

Table 3. Interpretation of N-change score

⟨*c*⟩	**Interpretation**
0.70 < ⟨*c*⟩ ≤ 1.00	High
0.30 < ⟨*c*⟩ ≤ 0.70	Medium
0.00 < ⟨*c*⟩ ≤ 0,30	Low

The last analysis was the effectiveness of the application of D-FLOW in reducing students' misconceptions. The effectiveness of D-FLOW can be analyzed by calculating the effect size, which is obtained from comparing the posttest scores of students in the experimental and control classes using Cohen's d in equation 3 [25].

$$d = \frac{\left| \bar{X}_E - \bar{X}_C \right|}{\sqrt{\dfrac{(n_E - 1) S_E{}^2 + (n_C - 1) S_C{}^2}{n_E - n_C - 2}}} \tag{3}$$

The effect size (*d*) score obtained is then interpreted based on Table 4 [25].

Table 4. Interpretation of the effect size (*d*) score

Effect Size (*d*)	**Interpretation**
0.8 ≤ d < 2.0	Large
0.5 ≤ d < 0.8	Medium
0.2 ≤ d < 0.5	Small

III. Results and discussion

Dynamic-Fluid Online Website (D-FLOW)

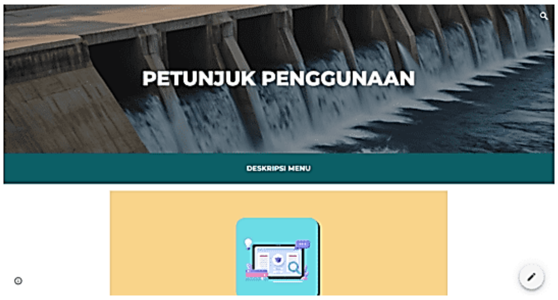
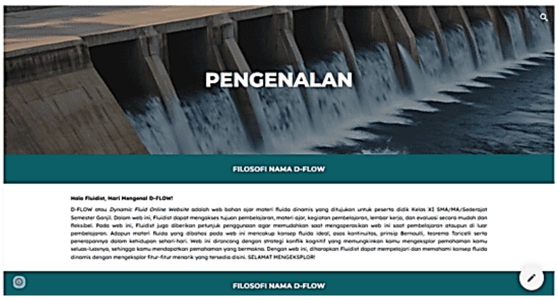
Dynamic-Fluid Online Website (D-FLOW) is a web teaching material developed using the Google Sites platform. The development of this website is based on the syntax of cognitive conflict learning proposed by [12], namely: (1) activation of preconceptions and misconceptions, (2) presentation of cognitive conflict, (3) discovery of concepts and equations, and (4) reflection. Cognitive conflict is a learning strategy that encourages Students to change concepts, from initially wrong concepts (misconceptions) to scientific concepts that are raised through a conflict that contradicts their understanding [17], [26], [27]. Therefore, the media or platform used in D-FLOW must be able to facilitate cognitive conflict-based learning. Media or platforms used in the development of the website are shown in Table 5.

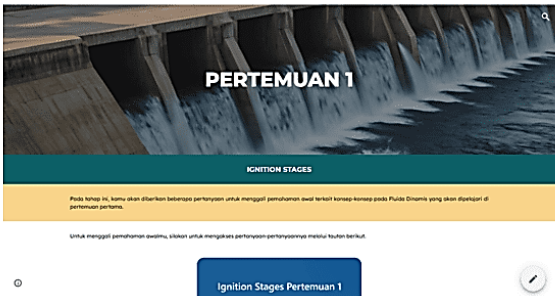
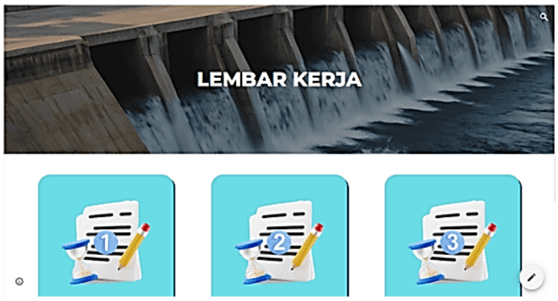
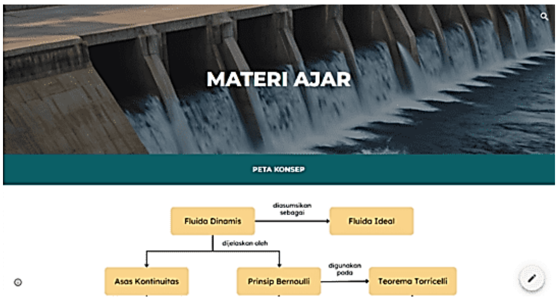
Table 5. Media or platform used in web development

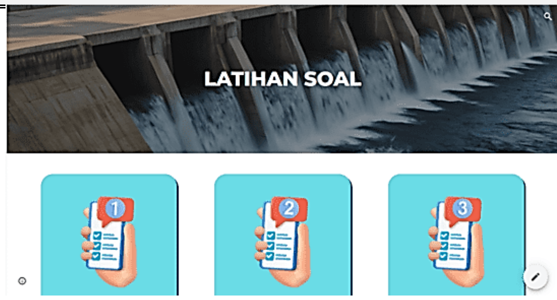
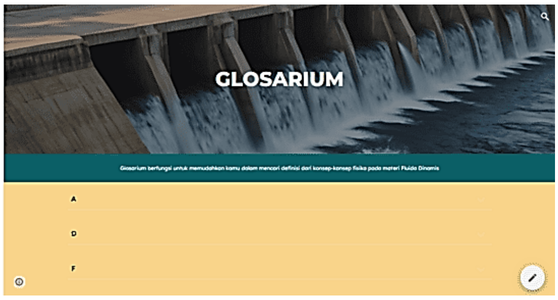
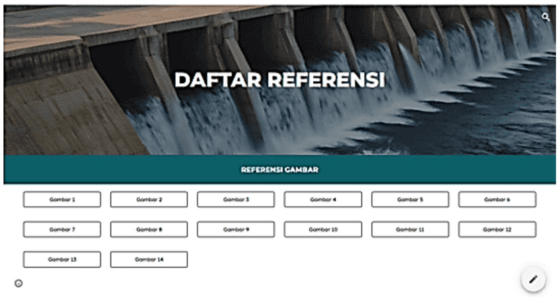
No.	Menu	Functions in Web Development
1.	Google Sites	Used to develop and manage D-FLOW web.
2.	Canva	Used to create logo designs and graphic elements used in D-FLOW web.
3.	Microsoft Form	Used for *Ignition Stages* (activation of preconceptions and misconceptions) and reflection at the end of learning.
4.	Live Worksheets	Used to create student worksheets and practice questions.
5.	PhET Interactive Simulations	Used to facilitate Students in conducting virtual simulations in the *Exploration Stages*.

Based on the content design that has been made, website development is carried out using all platforms or media that have been determined, and the final product is the teaching material web named Dynamic-Fluid Online Website (D-FLOW). A snapshot of the appearance of each menu contained in D-FLOW and its description are presented in Table 6.

Table 6. Menus contained in D-FLOW

No.	Menu	Description	Capture
1.	Home	Provides an overview of the website, making it easy for users to navigate features that help resolve misconceptions through clear and structured information.	
2.	Instructions for use	Offers practical guidelines to help users understand how to use the site to resolve cognitive conflicts and address misconception.	
3.	Introduction	Contains an introduction to the D-FLOW web as a cognitive conflict-based teaching material web, the philosophy of the D-FLOW logo, and an introduction to the developer's profile.	

No.	Menu	Description	Capture
4.	Learning Objectives	Offers clear objectives that guide users to focus on systematically addresing misconception.	
5.	Learning Activities	Contains learning activities consisting of three stages, namely: 1) Ignition Stages It is an introductory stage where students are given stimulus in the form of lighter questions to explore students' preconceptions and misconceptions. 2) Exploration Stages It is the core stage where students are given cognitive conflict through video, then they do a concept discovery discussion and virtual PhET simulation in groups. 3) Mastery Stages This is the final stage where Students reflect on the discoveries they have made, and confirm their discoveries through reinforcement by the teacher.	 
6.	Woksheets	Engages users to practice problem-solving, supporting the application of correct concepts and understanding in a structured manner. This worksheet begins with a cognitive conflict and ends with the discovery of concepts and equations.	
7.	Teaching Materials	Provides detailed, relevant content aimed at correcting misconception and reinforcing accurate knowledge, covering the concept of ideal fluid, principle of continuity, Bernoulli's principle, and Torricelli's theorem.	

No.	Menu	Description	Capture
8.	Practice Questions	Presents practice questions to assess students' understanding and help directly identify and correct misconceptions.	
9.	Glossary	Provides definitions of key terms that help users understand concepts correctly, reducing confusion caused by ambiguous terminology.	
10.	Reference	Offers additional resources to support further learning, deepening understanding and helping to overcome misconceptions.	

The final product that has been made is then tested for feasibility through the judgment of five validators, consisting of three physics lecturers and two physics teachers. The aspects assessed in the website feasibility test are content/material, media, and language. The results of the website feasibility test are shown in Table 7.

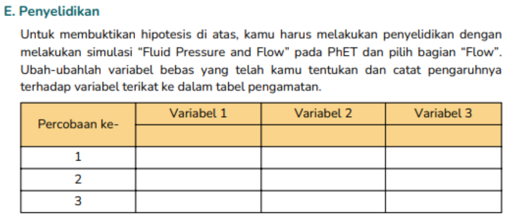
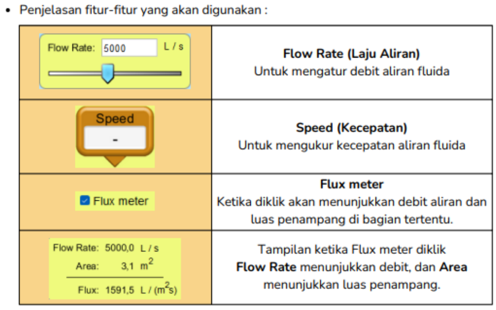
Table 7. Website feasibility test results

No.	Aspects	Aiken's V	Interpretation
1.	Content/Material	0.900	Valid
2.	Media	0.885	Valid
3.	Linguistics	0.933	Valid
	Average	**0.906**	**Valid**

Based on Table 7, Aiken's V values obtained for the content/material, media, and language aspects are 0.900, 0.885, and 0.933, respectively. The average validity index obtained from the three aspects is 0.906. The value has exceeded the minimum index value of validity, so that the website developed meets the criteria of "valid". Thus, it can be concluded that D-FLOW is feasible to use because it is valid in terms of content/material, media, and language. In addition, the validators also provided comments and suggestions on D-FLOW, which can be used as a reference to improve the quality of the product developed.

In general, the validators provided comments and suggestions for improvement of the worksheets, use of terms, web interface, and button functionality. For example, revisions related to the worksheet are presented in Table 8.

Table 8. Website feasibility test results

Comment	Before Revision	After Revision
The LKPD should first explain the features of PhET.	 E. Penyelidikan Untuk membuktikan hipotesis di atas, kamu harus melakukan penyelidikan dengan melakukan simulasi "Fluid Pressure and Flow" pada PhET dan pilih bagian "Flow". Ubah-ubahlah variabel bebas yang telah kamu tentukan dan catat pengaruhnya terhadap variabel terikat ke dalam tabel pengamatan. Percobaan ke- / Variabel 1 / Variabel 2 / Variabel 3 1 2 3	 • Penjelasan fitur-fitur yang akan digunakan : Flow Rate (Laju Aliran): Untuk mengatur debit aliran fluida Speed (Kecepatan): Untuk mengukur kecepatan aliran fluida Flux meter: Ketika diklik akan menunjukkan debit aliran dan luas penampang di bagian tertentu. Tampilan ketika Flux meter diklik **Flow Rate** menunjukkan debit, dan **Area** menunjukkan luas penampang.

Students Misconceptions Profile

The students' misconception profile provides an overview of the number of students' misconceptions in each dynamic fluid sub-material. The five types of conceptions used in this study are: Sound Understanding (SU), Partial Understanding (PU), Misconception (MC), No Understanding (NU), and No Coding (NC). Students were categorized into Misconception (MC) if they answered incorrectly on tier-1 and tier-3 and answered "sure" on tier-2 and tier-4. The misconception profile was analyzed based on the pretest and posttest scores obtained through the four-level diagnostic test instrument. The percentage profile of students' misconceptions in the experimental and control classes based on pretest and posttest scores is presented in Figure 3.

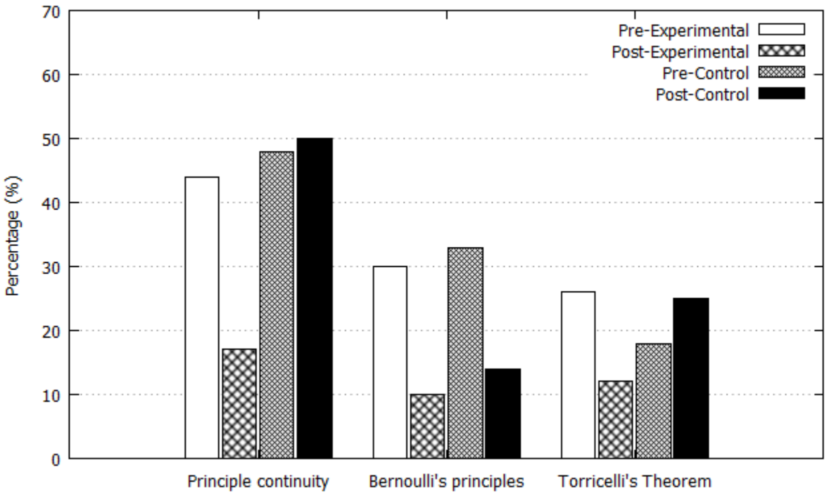


Figure 3. Misconception profile of students in experimental and control classes based on pretest and posttest scores

Among the 10 items that became the test instrument, the continuity principle sub-matter was represented by items 1-3, the Bernoulli principle sub-matter was represented by items 4-7, and the Torricelli theorem sub-matter was represented by items 8-10. Based on Figure 3, the continuity principle sub-matter has the highest percentage among other sub-matters before students are given treatment, both in experimental and control classes. This aligns with the findings of [8], which showed that the continuity principle has the highest level of misconception among other sub-matters. The next highest percentage of misconceptions was found in the Bernoulli principle sub-matter, which amounted to 30% in the experimental class and 33% in the control class. Furthermore, the lowest percentage of misconceptions was found in the Torricelli theorem sub-matter, which amounted to 26% in the experimental class and 18% in the control class.

After being given two different treatments, the students' misconceptions profile in both classes differed; the principle of continuity became the sub-matter with the highest percentage of misconceptions, accounting for 17% in the experimental class and 50% in the control class. This aligns with the previous pretest results, although the quantity is different. The Torricelli Theorem sub-topic showed the next highest percentage of misconceptions, with 12% in the experimental class and 25% in the control class. Meanwhile, the lowest percentage of misconceptions was found in the Bernoulli principle sub-matter, which amounted to 10% in the experimental class and 14% in the control class.

Overall, misconceptions were still found in the sub-matter of the continuity principle, Bernoulli’s Principle, or Torricelli's theorem, even though both classes had gone through the learning process. This shows that misconception is a difficult problem to eliminate because it is resistant to change, so it requires a long process to change it [2], [23], [28].

Reduction of Students’ Misconceptions

Reducing students' misconceptions is characterized by a change in the percentage of students' misconceptions in the experimental class during the pretest and posttest. The change in students' misconceptions is declared as "Great Change (GC)" if the percentage of students' misconceptions decreases during the posttest. Changes in students' misconceptions from pretest to posttest are presented in Table 9.

Table 9. Changes in students' misconceptions from pretest to posttest

Students’ Misconceptions		Pretest (%)	Posttest (%)	Type of MC	MC (%)	Intp.
MC1	The larger the cross-sectional ara, the faster the fluid flow speed.	S1, S5, S16, S22, S27, S28, S30 **(23.3)**	**- (0.0)**	-	-23.3	GC
MC2	The farther away from the water source, the speed of the water flow decreases so that the cross-sectional area decreases.	S2, S4, S6, S8, S10, S12, S15, S19, S22, S26, S28 **(36.7)**	S4, S16, S23, S24, S27, S29 **(20.0)**	-	-16.7	GC
MC3	The larger the cross-sectional area, the greater the fluid discharge.	S1, S2, S3, S4, S7, S8, S9, S10, S11, S12, S15, S16, S19, S20, S22, S23, S24, S25, S26, S27, S28, S30 **(73.3)**	S4, S13, S15, S19, S23, S24, S27, S29, S30 **(30.0)**	-	-43.3	GC
MC4	Fluid pressure is directly proportional to fluid flow velocity.	S3, S12, S19, S27, S28 **(16.7)**	**- (0.0)**	-	-16.7	GC
MC5	The great pressure around the nozzle causes the perfume liquid to be pushed out.	S1, S2, S5, S9, S10, S11, S16, S17, S19, S22, S26, S30 **(40.0)**	**- (0.0)**	-	-40.0	GC
MC6	The lifting force of an airplane occurs because the air speed under the wings of the airplane is greater than at the top.	S1, S5, S8, S13, S15, S16, S20, S21, S26, S30 **(33.3)**	S7, S14, S16, S19, S24, S27, S29 **(23.3)**	-	-10.0	GC
MC7	The fluid level in the venturimeter is always the same in all sections because the air does not pass through the venturi tube.	S1, S5, S6, S12, S13, S15, S16, S22, S28 **(30.0)**	S6, S14, S20, S21, S30 **(16.7)**	-	-13.3	GC
MC8	Closed vessels will still emit water.	S1, S13, S17, S26 **(13.3)**	S11, S14, S17, S19, S26, S27, S28, S30 **(26.7)**	+	13.4	U-GC
MC9	Vessels that have the highest position from the bottom (ground) drain water faster.	S1, S8, S13, S15, S19, S20, S25, S27, S28, S29, S30 **(36.7)**	S16 **(3.3)**	-	-33.4	GC
MC10	Half-filled tanks are lighter and easier to flow, resulting in a faster water flow rate.	S5, S6, S7, S16, S18, S19, S26, S27 **(26.7)**	S16, S30 **(6.7)**	-	-20.0	GC
Average		**33.0**	**12.7**		**-20.3**	

As seen in Table 9, most of the misconceptions experienced the expected change (GC). The highest percentage change in misconceptions was found in MC3 regarding the relationship between cross-sectional area and fluid discharge, which amounted to -43.7%. This shows that the number of students who experience misconceptions in MC3 is reduced by 13. Conversely, the lowest percentage change in misconceptions was found in MC6 regarding the application of Bernoulli's principle to the lifting force of an airplane, which was -10,0%. This indicates that there were 3 fewer students who had misconceptions about MC6. Meanwhile, unexpected changes (U-GC) were only found in MC8 regarding fluid flow in closed vessels. The increase in misconceptions found in MC8 was 13.4%, which indicates that the number of Students who experienced misconceptions in MC8 increased by 4 people. One possible cause of the increase in misconceptions is the learning method used. The concept of fluid flow in a closed vessel is learned through demonstration, while other concepts use simulation. Because the demonstration method relies on direct observation, the delivery of concepts tends to be uneven, so not all students can give full attention and understand the concept optimally. In addition, researchers also have limitations in controlling the psychological aspects of students, such as motivation, thinking, and contribution in group discussions, so that misconceptions can still occur [1].

Overall, the average percentage of changes in students' misconceptions is quite large, at -20.3%. The analysis showed that changes in students' misconceptions in the "Great Change" category occurred in questions 1-7, 9, and 10. Meanwhile, changes in students' misconceptions in the "Un-Great Change" category only occurred in question number 8. This shows that the application of D-FLOW as web teaching material based on cognitive conflict can help reconstruct students' misconceptions in a better direction. This finding is in line with the results of research [29], [30], [31], which show that the average change in misconceptions after treatment indicates that the application of cognitive conflict strategies in learning is effective in reducing students' misconceptions.

In addition to analyzing the reduction of Students' misconceptions, it is also important to ensure that they experience an increase in concept understanding after the treatment. To measure the extent of the improvement, students' pretest and posttest scores can be analyzed using N-Change. The results of the N-Change analysis in the experimental and control classes based on the pretest and posttest scores are presented in Table 10.

Table 10 compares N-Change values in the experimental and control classes based on both classes' pretest and posttest scores. The average of N-Change in the experimental class shows a value of 0.61 with the interpretation of "moderate". In contrast, the control class shows a value of 0.36 with the interpretation of "moderate". Thus, it can be said that students in the experimental and control classes experienced increased concept understanding after being given treatment. The number of students based on the interpretation of the N-Change score is shown in Table 11.

Based on Table 11, it is known that the experimental class tends to experience better conception improvement than the control class. In the experimental class, the interpretation that shows a dominant increase is "high", which is 60%. Meanwhile, the control class experienced a dominant increase in the interpretation of "medium," which amounted to 75%. This finding is consistent with the results of research [14], which shows that the cognitive conflict strategy increases students' understanding more than conventional learning.

Effectiveness of D-FLOW in Reducing Students' Misconceptions

The effectiveness of D-FLOW is determined based on the achievement of its development objectives, namely, to reduce students' misconceptions about dynamic fluid material. The effectiveness of D-FLOW in remediating students' misconceptions was analyzed using the effect size test. The effect size test was conducted to measure how much impact or influence the application of D-FLOW had on reducing students' misconceptions. The results of the effect size test are shown in Table 12.

Based on Table 12, the average score of students' *posttest* results in the experimental class is greater than that of the control class. The *Cohen's D* value obtained is 1.66, indicating that the application of D-FLOW in learning in the experimental class positively impacts a "large" category. Thus, the results of the effect test show that the application of D-FLOW as a web teaching material based on cognitive conflict effectively reduces students' misconceptions about dynamic fluid material. This aligns with the findings of [14] and [26], which reveal that implementing cognitive conflict strategies positively influences the reduction of misconceptions and increases students' conceptual understanding.

Table 10. N-Change Score in Experimental and Control Classes

Experimental Class			Control Class		
Students	**⟨*c*⟩**	**Interpretation**	**Students**	**⟨*c*⟩**	**Interpretation**
S1	0.93	High	S1	0.07	Low
S2	0.93	High	S2	0.18	Low
S3	0.75	High	S3	0.32	Medium
S4	0.38	Medium	S4	0.57	Medium
S5	0.80	High	S5	0.35	Medium
S6	0.77	High	S6	0.27	Low
S7	0.73	High	S7	0.36	Medium
S8	0.79	High	S8	0.46	Medium
S9	0.75	High	S9	0.60	Medium
S10	0.92	High	S10	0.21	Low
S11	0.80	High	S11	0.45	Medium
S12	0.79	High	S12	0.40	Medium
S13	0.70	Medium	S13	0.17	Low
S14	0.53	Medium	S14	0.08	Low
S15	0.64	Medium	S15	0.35	Medium
S16	0.15	Low	S16	0.50	Medium
S17	0.76	High	S17	0.33	Medium
S18	0.86	High	S18	0.36	Medium
S19	0.50	Medium	S19	0.33	Medium
S20	0.88	High	S20	0.45	Medium
S21	0.77	High	S21	0.64	Medium
S22	0.77	High	S22	0.57	Medium
S23	0.44	Medium	S23	0.42	Medium
S24	0.36	Medium	S24	0.35	Medium
S25	0.50	Medium	S25	0.37	Medium
S26	0.88	High	S26	0.50	Medium
S27	0.52	Medium	S27	0.20	Low
S28	0.89	High	S28	0.31	Medium
S29	0.44	Medium	-	-	-
S30	0.27	Low	-	-	-
Average	**0.61**	**Medium**	**Average**	**0.36**	**Medium**

Table 11. Percentage Interpretation of N-Change Score in Experimental and Control Classes

Interpretation	Experimental Class		Control Class	
	Number of Students	**Percentage (%)**	**Number of Students**	**Percentage (%)**
High	18	60	0	0
Medium	10	33	21	75
Low	2	7	7	25

Table 12. Effect size (d) test results

Class	Mean ($\bar{X}$)	Varians (S^2)	Cohen's D	Interpretation
Experiment	24.93	10.62	1.66	Big
Control	19.32	12.30		

IV. Conclusions

The findings of this study suggest that Dynamic-Fluid Online Website (D-FLOW) is feasible to use as a cognitive conflict-based teaching material, both in terms of content/material, media, and language. The application of D-FLOW in learning is able to reduce students' misconceptions with an average decrease of 20.3%. As measured by N-Gain, the increase in concept understanding showed a value of 0.61 (medium category) in the experimental class and 0.36 (medium category) in the control class. Although the effect size test shows a value of 1.66 (large category), which indicates a significant effect, the increase in concept understanding is still in the medium category.

Therefore, it can be concluded that the Dynamic-Fluid Online Website (D-FLOW) effectively reduces students' misconceptions on dynamic fluid material and shows the potential to improve concept understanding. However, the results are still in the moderate category. This finding can have implications for educators in providing alternative teaching materials to overcome students' misconceptions. However, this study has not yet measured the long-term retention of students' concept understanding and is still limited to a small sample size. For future research, it is recommended to investigate the product's long-term impact and its application to a wider range of samples.

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