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Development of Website Media Based on Google Sites to Improve Students' Conceptual Understanding on Dynamic Fluid Materials

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ABSTRACT

This research aims to produce a website media based on Google Sites to improve students' conceptual understanding on dynamic fluid materials. The research method used is Research and Development (R&D) using the ADDIE development model. The feasibility of teaching materials is measured using media expert validation sheets analyzed using Aiken validity. The validation results show that the aspects assessed, including software engineering, visual communication, substance, and language, are declared completely valid. The increase in conceptual understanding can be seen from the pre-test and post-test results which are analyzed using the normalized average gain (N-Gain). The analysis results showed that the average N-Gain was 0.44, which is included in the medium criteria. The results of the student response questionnaire show that the media developed as a whole is in very good criteria in terms of website use, website appearance, writing and grammar, understanding of the material, and interest.

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1. INTRODUCTION

The current rapid development of information and communication technology has had a significant impact on the education sector (Alt & Raichel, 2020). Students can now utilize technology such as computers, smartphones, and the internet to access extensive and varied learning resources. Teachers not only act as educators and sources of knowledge but can also act as developers of learning programs that can help students achieve the required abilities or competencies (Pribadi, 2017).

Learning media can provide concrete experiences and also act as intermediaries that help student learning (A. P. Wulandari et al., 2023). Learning media is a very important part so teachers must be aware of the importance of media in facilitating learning activities (Miftah, 2013). The choice of media must be truly appropriate in order to support effectiveness, efficiency, and attractiveness in learning so teachers need to plan carefully. Well-designed learning media is expected to increase student involvement and active participation during the learning process, helping students understand important concepts, one of which is physics.

Physics is a branch of natural science that studies natural phenomena and their interactions (Sastra & Samsidar, 2023). Students consider physics to be one of the subjects that is quite difficult and challenging, one of which is fluid dynamics material. Nurul (2022). Suherly et al. (2023), Ilhami et al. (2022), and Putri et al. (2023) stated that students' conceptual understanding of fluid dynamics material is categorized as low. Lack of student participation during the learning process is one of the factors that causes a low understanding of fluid dynamics concepts (Maulana et al., 2018).

The factor that causes students to have difficulty understanding dynamic fluid material is that students are unable to visualize fluid flow to understand flow patterns, pressure, and changes in fluid flow velocity. Students' lack of experience in implementing concepts in real life is also another factor that causes students to have difficulty understanding fluid dynamic material (Wacanno et al., 2023). This happens because experiments or demonstrations that can clarify concepts are often difficult to do in class. In line with the results of research conducted by Solehudin et al. (2016) which states that the majority of students still understand fluid dynamics only to the extent of mathematical equations without understanding in depth of the basic concepts which makes a dynamic fluid material difficult. To overcome students' difficulties in visualizing fluid flow and the lack of student experience in implementing the concept of fluid dynamics in real life, the use of digital-based interactive learning media is expected to be an effective solution.

Interactive learning media is a digital-based learning media that facilitates the learning process by presenting learning materials in text, animation, audio, and video (Mahardika et al., 2022). One of the technologies in learning media that can be utilized today is a website that can be easily created using Google Sites. Google sites are practical and straightforward because, on one integrated website, students do not need additional applications to open documents given by the teacher (Salsabila & Aslam, 2022). Google sites can contain various kinds of information and various multimedia elements such as videos, illustrations, audio, simulations, games, and so on (Adzkiya & Suryaman, 2021; Mukti et al., 2020). Various existing media types can make it easier for students to visualize fluid flow to understand flow patterns, pressure, and changes in fluid flow velocity in dynamic fluid material so that students can understand the material more easily (Rosiyana, 2021).

2. METHODS

This research uses the Research and Development (R&D) method. According to Borg and Gall (2003), research and development methods are methods used to develop an existing product or to produce a new product and then validate the product so that it can be used in the learning process. The model design used in this research is the ADDIE model which consists of 5 main stages, namely; Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009).

This research uses the Research and Development (R&D) method. According to Borg and Gall (2003), research and development methods are methods used to develop an existing product or to produce a new product and then validate the product so that it can be used in the learning process.

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The model design used in this research is the ADDIE model which consists of 5 main stages, namely; Analysis, Design, Development, Implementation, and Evaluation.

The analysis stage consisted of needs analysis, student analysis, and material analysis which was carried out by reviewing literature studies and semi-structured interviews with high school physics teachers in Bandung. The design stage is an activity carried out to determine the media design that will be developed in the form of flowcharts and storyboards. The Development Stage is an activity to realize the website media design by creating and compiling content first before entering it into Google Sites.

The media website based on Google Sites version 1 that has been developed is then tested for validity and suitability by media experts. The results of media feasibility validation are used to improve media from version 1 to version 2 until the media is ready to be implemented. Media feasibility is measured using a validation sheet which is analyzed using Aiken validity. Whether an assessment aspect is valid or not, the V coefficient value from the calculated results will be compared with the minimum value of Aiken's V coefficient (Aiken, 1985). Aiken's validity is calculated using the formula:

$$V = \frac{s}{[n(c-1)]} = \frac{\Sigma(r-l_o)}{[n(c-1)]}$$

Description:
V = Aiken's V coefficient
n = number of raters
c = number of rating categories
r = value by the validator
l_o = smallest scale value

The implementation stage is an activity carried out to implement media that has been developed and revised. Media use is carried out in school learning on dynamic fluid material using a one-group pretest-posttest design with treatment in the form of the media developed. The level of understanding of students' concepts will be measured using a test instrument in the form of pre-test and post-test questions in the form of a description of dynamic fluid material which refers to "Understanding by Design" (UnD) developed by Wiggins & McTighe (2005) which includes explaining, interpreting and apply. The increase in students' conceptual understanding after treatment can be seen from the N-Gain, taken from the students' pre-test and post-test results.

Table 1. N-Gain Value Criteria

N-Gain Value	Criteria
$\langle g \rangle < 0.3$	Low
$0.7 > \langle g \rangle \geq 0.3$	Medium
$\langle g \rangle \geq 0.7$	High

(Hake, 1998)

The evaluation stage is an activity to assess and improve products developed from previous stages. Based on the results of the student response questionnaire data, improvements to the final product were carried out. The data is analyzed and then concluded to improve the media as a whole to produce better final media. The student response questionnaire used a Likert scale, which was analyzed using score conversion.

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Table 2. Percentage Criteria for Student Response Questionnaire

Presents	Criteria
< 26%	Very Bad
26% - 50%	Bad
51% - 75%	Good
76% - 100%	Very Good

(Hadi, 1991)

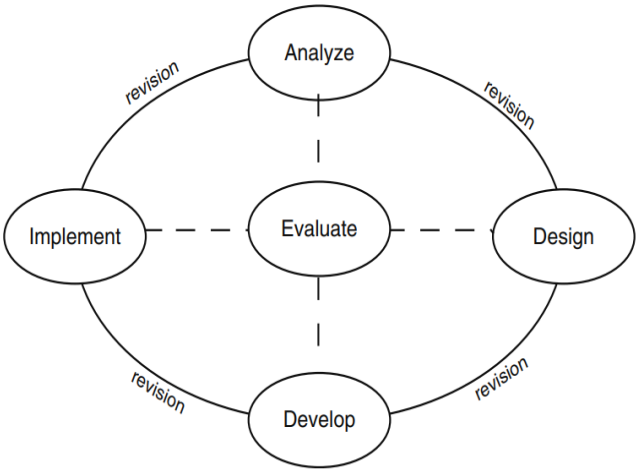

Figure 1. ADDIE Model (Branch, 2009)

3. RESULTS AND DISCUSSION

3.1 Results

A validity test by media experts selected based on relevant background and expertise in information technology and physics studies determines the suitability of a Google Sites-based media website. The media experts involved consisted of 5 physics education study program lecturers and a physics teacher at one of the state high schools in Bandung. The validity test consists of four aspects: software engineering, visual communication, material substance, and language. Each aspect consists of indicators assessed using an assessment score of 0=Not Appropriate; 1=Not suitable; 2=Suitable; 3=Very Appropriate, and includes a comments/suggestions column.

Then, the media validity test assessment results were analyzed using Aiken validity to determine the Aiken validation coefficient (V). The minimum value of Aiken's V coefficient with four ratings involving six raters is 0.78. The assessment item is declared valid if the Aiken V coefficient value obtained is ≥ 0.78 (Aiken, 1985).

Table 3. Result of Media Website Analysis

No.	Aspects	V	Description
1.	Software Engineering	0.90	Valid
2.	Visual Communication	0.90	Valid
3.	Substance	0.86	Valid
4.	Language	0.87	Valid

The Aiken V coefficient value was more than 0.78 in the aspects of software engineering, visual communication, substance, and language, so the four assessment aspects were declared valid.

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Table 4. N-Gain of Conceptual Understanding

Value	Pre-test	Post-test	N-Gain
Minimum	0.00	3.33	-
Maximum	56.67	100.00	-
Average	5.93	47.78	0.44
St Deviation	9.38	28.17	-

The increase in concept understanding can be seen from the pre-test and post-test results, which are analyzed using the normalized average gain (N-Gain). The average N-Gain is in the range $0.7 > \langle g \rangle \geq 0.3$, so the overall increase in the student's conceptual understanding is included in the medium criteria.

Table 5. Criteria N-Gain of Conceptual Understanding

Criteria	Number of Students	Percent
Low	20 Students	37%
Medium	19 Students	35%
High	15 Students	28%

Of the 54 students involved in the research, the increase in conceptual understanding of students with low criteria was the greatest, while the increase in conceptual understanding of students with high criteria was actually the least.

Table 6. N-Gain of Conceptual Understanding Aspect

Aspect	<pre-test>	<post-test>	N-Gain
Explanation	7.96	43.15	0.38
Interpretation	6.85	55.00	0.52
Aplication	2.96	45.19	0.44

Judging from each aspect of understanding the concept, which consists of explanation, interpretation, and application, the N-Gain value is in the range $0.7 > \langle g \rangle \geq 0.3$. This shows that students' conceptual understanding falls into the medium criteria, with the explanation aspect showing the lowest improvement and the interpretation aspect showing the highest improvement compared to the other aspects.

Table 7. Analysis of Student Response Questionnaire

No.	Aspects	Percent	Criteria
1.	Website Use	88%	Very Good
2.	Website Appearance	90%	Very Good
3.	Writing and Grammar	90%	Very Good
4.	Understanding of the Material	89%	Very Good
5.	Interest	87%	Very Good

The results of the student response questionnaire on aspects of website use, website appearance, writing and grammar, understanding of the material, and interest are in the range of 76% - 100% so they are included in the very good criteria.

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3.2 Discussion

The analysis stage was carried out by reviewing literature and interviewing physics teachers at a high school in Bandung City. The results showed that there were still many obstacles to physics learning activities in schools. One of the obstacles experienced was the use of learning media that was not optimal, such as only sending YouTube video links and studying them independently so that some students did not understand the material. Links sent via WhatsApp groups were scattered and not appropriately collected, so students had difficulty finding the link again when they wanted to open it again at another time. In addition, students who have specific learning styles are constrained in understanding the material because they are not well facilitated. Teachers cannot only use one method or media to teach continuously without paying attention to students' learning styles (Latifah, 2023). Implementing the independent curriculum should give teachers many opportunities to adjust their teaching methods to the abilities and characteristics of students so that students become more active because learning is designed to be more attractive for them (Permendikbudristek, 2024). Teachers can design learning that is more interactive and easily accessible to students, such as providing learning materials in the form of a structured online platform (Nurlatifah & Suprihatiningrum, 2023).

Fluid dynamics material is one of the important topics in physics lessons. Fluid dynamics discusses the behaviour of fluids in motion. Fluid dynamics material is included in the learning outcomes in phase F in the Independent Curriculum. The expected competencies from the material are that students can apply the concepts and principles of fluid dynamics in solving problems, including understanding the concept of ideal fluids, water discharge, continuity equations, Bernoulli's principle and their applications in everyday life.

The second stage, namely the design stage, begins with creating a flowchart. Flowcharts clearly illustrate the flow of interactions and processes involved in learning from the main page to the material pages, and so on.

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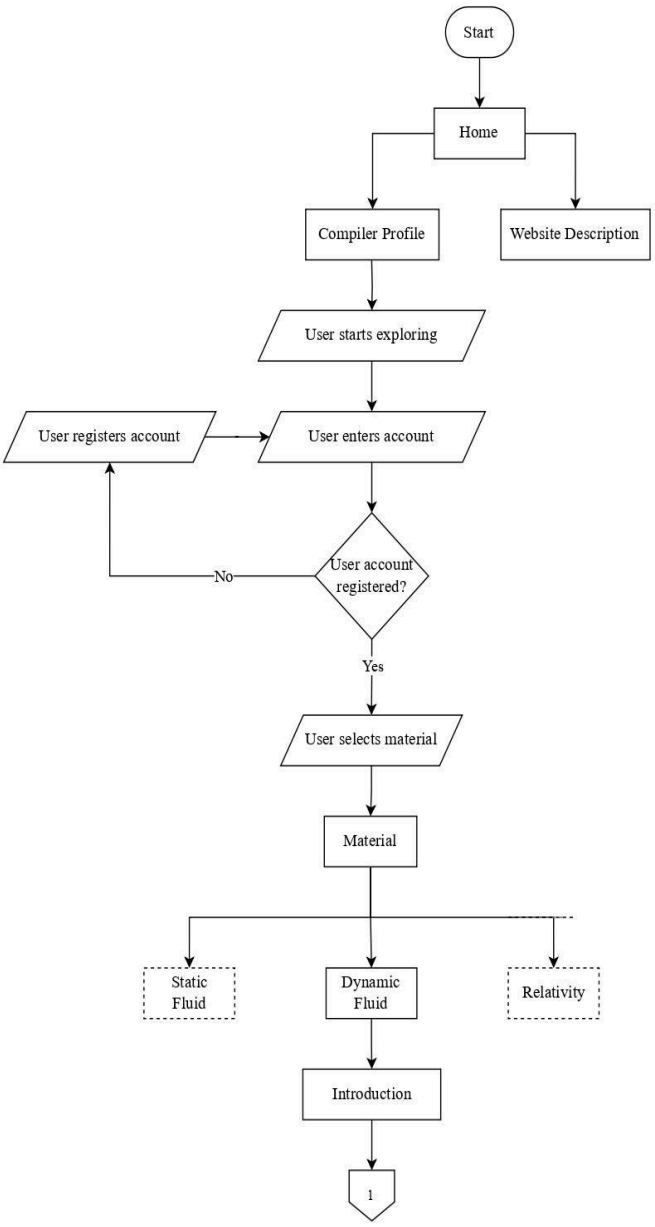

Figure 2. Footage of Media Website Flowchart

Then create a storyboard that is adapted to the flowchart that has been created. Storyboards are created to describe the structure and sequence of content on each page.

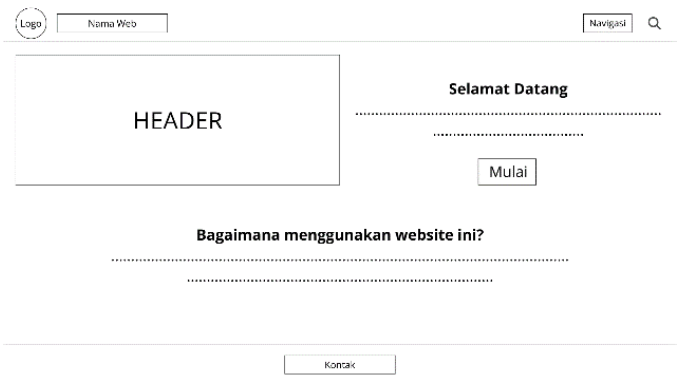

Figure 3. Main Page Storyboard

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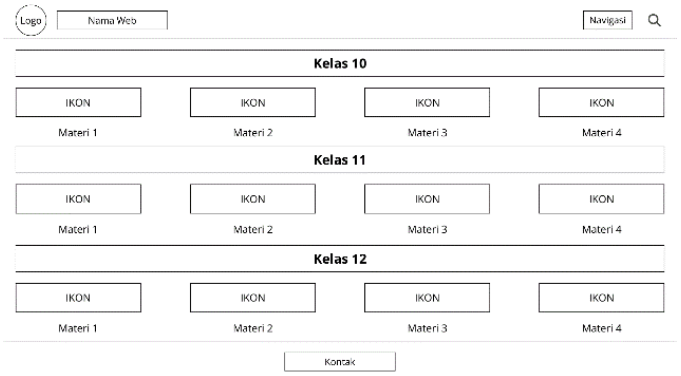

Figure 4. Material Page Storyboard

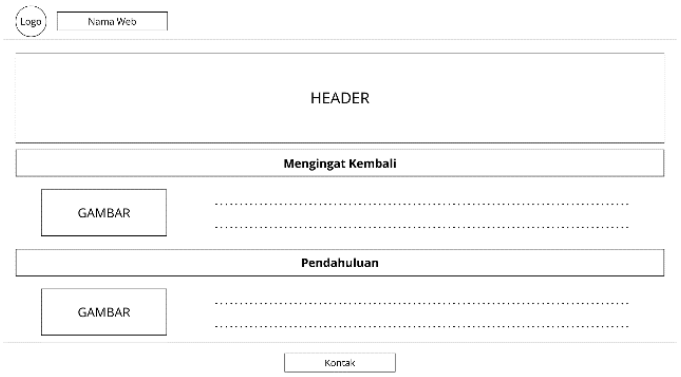

Figure 5. Introductory Page Storyboard

The third stage, the development stage, is to realize the website media design by creating and arranging the content and assets that will be used on the website. Some content and assets are created specifically by developers and others are ready-to-use content or assets whose sources will be listed. Then the content and assets are entered into Google Sites according to the previously designed flowchart and storyboard.

Figure 6. Website Favicon dan Logo

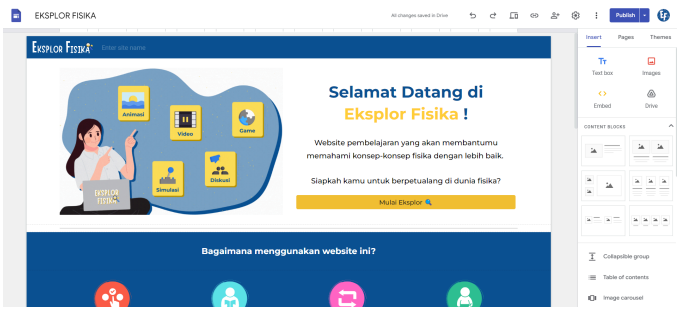

Figure 7. Main Page Display on Google Sites

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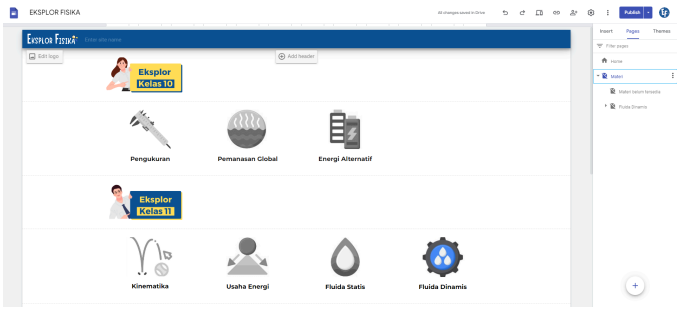


Figure 8. Material Page Display on Google Sites

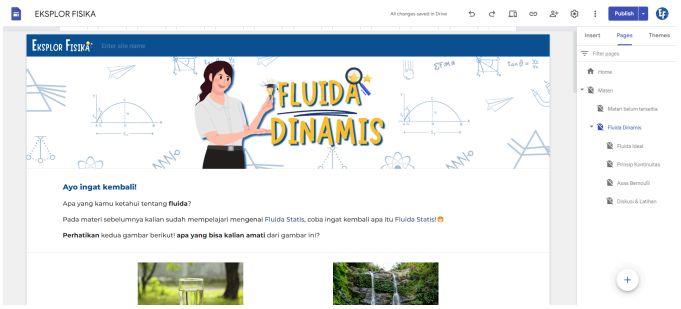
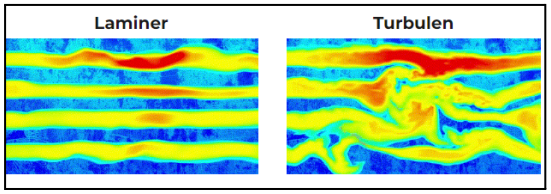
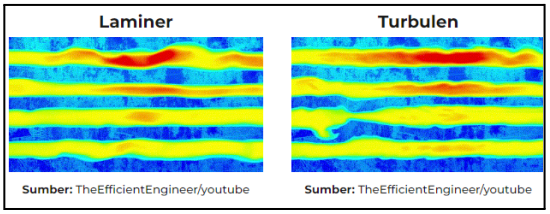
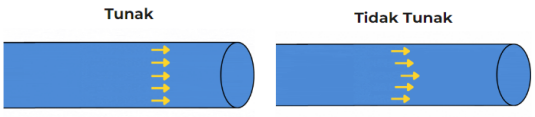
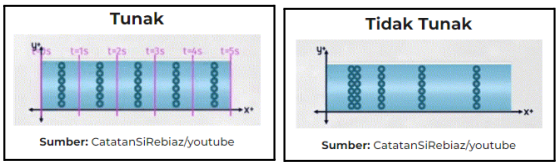


Figure 9. Introductory Display on Google Sites

The media website based on Google Sites version 1 that has been created is then tested for validity and suitability by media experts. The results of media feasibility validation are used to improve website media from version 1 to version 2 until it is ready to be implemented. Based on comments and suggestions from experts, several components of the website media need to be improved.

Table 8. Improvement of Website Media from Version 1 to Version 2

Comments and Suggestions Media Expert	
Some animations do not include reference sources.	
Before	**After**
	
In steady flow animation, it is only a line with arrows, less harmonious and less interesting.	
Before	**After**
	
In the explanatory video, the hand writer's writing should have a font color that contrasts with the background.	
Before	**After**

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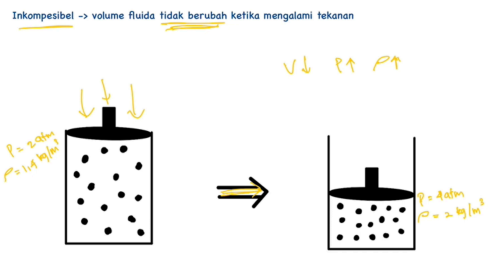
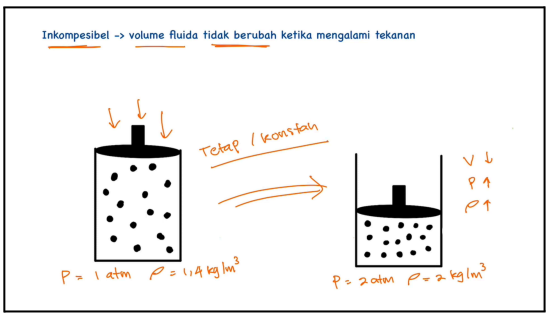




In the discharge section, the statement should be: Volume of flowing fluid (m^3)

Before

Keterangan:

Q : Debit (m^3/s)

V : Volume fluida (m^3)

t : Selang waktu (s)

After

Keterangan:

Q : Debit (m^3/s)

V : Volume fluida yang mengalir (m^3)

t : Selang waktu (s)

The color combination in the test section is a bit disturbing.

Before

No	Pipa Kiri			Pipa Kanan		
	$A_1(m^2)$	$v_1(m/s)$	$Q_1(m^3/s)$	$A_2(m^2)$	$v_2(m/s)$	$Q_2(m^3/s)$
1.						
2.						
3.						
4.						
5.						

Buatlah kesimpulan berdasarkan data hasil percobaan

After

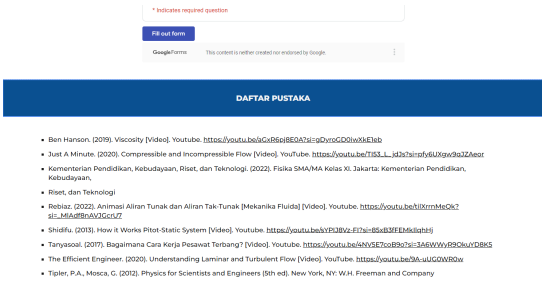
No	Pipa Kiri			Pipa Kanan		
	$A_1(m^2)$	$v_1(m/s)$	$Q_1(m^3/s)$	$A_2(m^2)$	$v_2(m/s)$	$Q_2(m^3/s)$
1.						
2.						
3.						
4.						
5.						

Buatlah kesimpulan berdasarkan data hasil percobaan

At the end of the material/task implementation, study sources/bibliography related to the source material used are provided.

Before

After



The fourth stage, namely the implementation stage. The media was tested on 54 students in XI class at one of the state high schools in Bandung, studying physics in dynamic fluid materials. Before students use website media version 2, students do a written pre-test first. Learning fluid dynamic material was carried out over two meetings. Website media is not only accessed when learning occurs at school but can also be accessed anytime, anywhere. Students are free to read and do the exercises repeatedly until they understand. Then, students carry out a written post-test and fill out a student response questionnaire via Google Forms.

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The average pre-test score of students was 5.93 while the average post-test score was 47.78, so the average N-Gain was 0.44, included in the medium criteria. The increase in conceptual understanding in the explanation aspect was the lowest compared to the interpretation and application aspects. This can happen because students' ability to explain is still not optimally trained, so students are less accustomed to expressing their understanding coherently and comprehensively. Although the increase in conceptual understanding is still in the moderate category, this finding indicates a significant increase in conceptual understanding after applying website media to learning. Using website media based on Google sites helps students receive material and increases their understanding of physics concepts. This is supported by the results of research by Haka et al. (2023), Sevtia et al. (2022), Johdi et al. (2024), A. Wulandari et al. (2022), dan Mahardika et al. (2022), which states that the use of website media based on Google sites can improve students' conceptual understanding. Google sites media can make it easy for students to understand the material being taught because of the renewal of the learning process, which can stimulate students' creativity so that the teaching material presented by the teacher is more accessible for students to conceptualize (Lutfiah, 2023; Mahardika et al., 2022).

Student responses to Google Sites-based website media can be known through student response questionnaires. Overall, student responses were very good criteria for website use, website appearance, writing and grammar, understanding of the material, and interest aspects. Students provided further comments regarding the website being easy to understand and access, the appearance being simple and attractive, the use of language that is not long-winded, and the presence of games and discussion columns that make learning even more exciting. However, some students access the website using smartphones, so the display becomes smaller, especially in the games section and discussion column.

Lastly, the evaluation stage assesses and improves the products developed from the previous stages. At this stage, the final product is produced from a media website based on Google Sites, namely version 3. Based on the data obtained in the previous stages, especially at the development and implementation stages, media development is validated by media experts and empirically validated by students. Based on the results of validation by experts, it is known that the media is declared valid and suitable for use. The results of empirical validation with students show increased students' understanding of concepts after using the media. The final improvements made to the media website from version 2 to version 3 were based on student comments and suggestions, namely adding pages for navigation to make it easier to move between pages and removing the header on the introductory page.

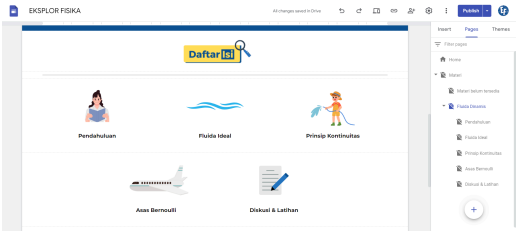

Figure 10. Material Navigation Page Display on Google Sites

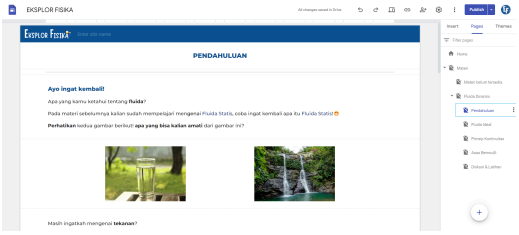

Figure 11. Introductory Display on Google Sites After Improvement

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4. CONCLUSION

The Google Sites-based website media that has been developed has been validated by media experts consisting of lecturers and physics teachers. The validation results show that the media is declared valid and suitable for use with several improvements made. Based on the results of the pre-test and post-test, which were analyzed using the average N-gain, website media can increase students' understanding of concepts in the medium category. Website media based Google sites also received a very good response from students based on the results of the student response questionnaire. As for suggestions for future researchers who will study a similar topic, it would be better to do a readability test on students and this website media can be further developed with other physics material.

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