

CUSTOMIZABLE WEB SIMULATION FOR DYNAMIC FLUIDS LEARNING USING VISUAL STUDIO CODE

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Abstract :

This study aims to create and assess simulation-based learning media utilizing Visual Studio Code for creating dynamic fluid materials at the high school level. This development is centered on students' misconceptions and the shortcomings of pre-built simulation platforms such as PhET and discontinued technologies (e.g., Adobe Flash). In contrast to previous studies, this research focuses on the development of an entirely customizable web-based simulation, created with HTML, CSS, and JavaScript. The simulation allows for teacher customization, access on multiple devices (responsive design), and offers the integration of interactive worksheets. The development of the simulation learning media was performed through the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation). Construct validity analysis showed that most items were positively correlated with the total score, while reliability testing yielded a Cronbach's Alpha of 0.576, indicating the need for further instrument refinement. The evaluations made by students and teachers were classified as very good, indicating high acceptance and high practicality. This study is limited to evaluating media feasibility and media practicality, without evaluating the effect of media on student's learning outcomes and conceptual understanding. The results of this study concluded that the media is feasible and practical to provide support for interactive conceptual visualization in physics learning. Future studies are needed to evaluate the effectiveness of the media through an experimental or quasi-experimental design.

Keywords: ADDIE, Learning Media, Dynamic Fluids, Physics Learning, Visual Studio Code

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INTRODUCTION

Physics is a subject that has significance for students in understanding natural phenomena and the basic principles that govern the world (Harefa, 2019). Physics contains many abstract concepts that is difficult for many students to understand, even though the curriculum emphasized student-centered learning (Delvia et al., 2021; Safriana & Fatmi, 2018). One such complex topic is fluid dynamics, and

research has found that many students hold misconceptions (Aprita et al., 2018; Putri et al., 2023; Sholihat et al., 2017). For instance, only 27% of students fully understood Bernoulli principle concepts and 72% for continuity, while the majority experience partial understanding, misconceptions, or a complete lack of comprehension, particularly for Bernoulli's principle and continuity (Putri et al., 2023).

To address these difficulties, simulation-based learning media has emerged as an effective solution to enhance student understanding (Astuti & Djudin, 2017). Previous research supports the advantages of simulations; for example, Adobe Flash-based media increased understanding by up to 81.36% (Yusuf et al., 2022), and positive student responses were reported for virtual simulations (Fauji & Nuryantini, 2022). However, previous studies have several limitations, such as the fact that Adobe Flash-based media is now outdated and support for Adobe Flash Player was discontinued in 2020, meaning these media can no longer be accessed or function properly on modern devices. Furthermore, off-the-shelf simulation tools like PhET, while interactive, do not offer sufficient flexibility within the context of the Indonesian high school curriculum and also include some paid. Many of these resources do not offer flexible real-time parameter controls or integrated investigations, often leading to misunderstandings of concepts such as Bernoulli's principle and continuity (Asnita et al., 2023; Yusuf et al., 2022).

Advances in information and communication technology have made simulations more feasible and relevant in the digital age (Anisa et al., 2020). Therefore, this medium was implemented as a web-based simulation using open standards (HTML5/CSS/JavaScript). Development was carried out using Visual Studio Code, a cross-platform Integrated Development Environment (IDE) that supports debugging and local deployment. This workflow enables offline distribution and use while eliminating dependence on paid software (Rahmawati et al., 2023; Wardani et al., 2020). This facilitates students' active participation in virtual experiments, enhances visual and flexible understanding, and meets specific curriculum needs.

Therefore, this study aims to develop and evaluate a customizable web-based simulation for dynamic fluids learning, created using Visual Studio Code, that allows teacher-level code modification, supports responsive cross-device access, and integrates inquiry-oriented worksheets (LKPD) to address students' misconceptions in Bernoulli's principle and continuity at the high school level. Theoretically, this work contributes to the educational technology literature by demonstrating the use of modern coding tools within the ADDIE development model for physics simulations, while practically it offers an accessible instructional tool that aligns with the *Merdeka Curriculum* and supports more interactive, misconception-oriented physics learning in Indonesian schools (Hidayah et al., 2025).

RESEARCH METHOD

Research Design

This study employs a research and development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) to develop and evaluate simulation-based learning media for dynamic fluid material at the high school level. The ADDIE model provides a systematic and iterative framework for producing educational products with continuous refinement based on feedback (Branch, 2009). This research was conducted during the 2023/2024 academic year at SMAN 1 Gowa, South Sulawesi, Indonesia. Therefore, the study does not incorporate pre-test and post-test measures of learning outcomes, and its conclusions are limited to feasibility and perceived practicality of the developed media.

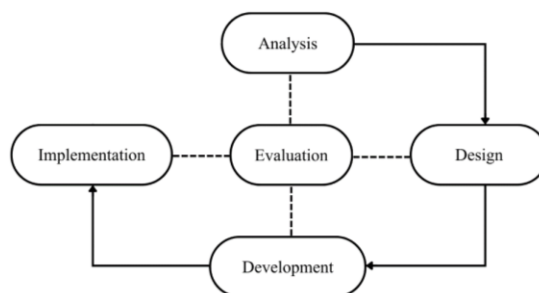


Figure 1. ADDIE model stages

Research Target/Subject

This research was conducted at SMA Negeri 1 Gowa during the 2023/2024 academic year. The population consisted of all students enrolled in the eleventh-grade science program (IPA), distributed across three classes with total of 102 students. The sample in this study comprised 33 students from one XI IPA class and their physics teacher, selected through purposive sampling (Creswell, 2014). The class was selected because of two main reasons. Firstly, the topic of dynamic fluids was a formal subject at that level and thus the students would be more relevant for the use of this media, and secondly, diagnostic tests showed a high prevalence of students holding misconceptions about Bernoulli's principle and continuity equation. In addition, focus group discussion and classroom observation revealed that physics instruction was highly teacher-centered, involving mostly frontal lecturing and little integration of interactive digital media. These specific learning environments suggested that the class would be relevant for the implementation of the finalized simulation-based learning media.

Research Procedure

The development followed the five stages of the ADDIE model:

1. Analysis
Barriers to learning, including misconceptions about the physics of fluid flow and the possession of digital devices to be used in simulation activities, were identified through unstructured interviews and teacher and student observations. It was identified that students had access to mobile phones and computers.
2. Design
Media was created that offered the capability of direct manipulation of parameters (velocity and viscosity) along with embedded student worksheets, and was designed in accordance with the *Merdeka Curriculum* (Phase F).
3. Development
To ensure responsiveness and interactivity, the program was designed using Visual Studio Code (HTML, CSS, and JavaScript). Media industry experts' approval was obtained and then incorporated into the last revision of the program.
4. Implementation
The media was introduced to a class at SMAN 1 Gowa. The media was passed out to the class during a tutorial period, and teachers and students were given questionnaires to obtain feedback on the ease of use and practicality of the media. The feedback indicated that the media was engaging and successful.
5. Evaluation
Formative evaluation was used at every step of the product development process, including suggestions from validators to adapt the user interface (for instance, the addition of a fillable LKPD to the simulation section)

Instruments, and Data Collection Techniques

This study used several tools to gather data and then tested the simulation-based learning media to determine whether they were feasible and useful. The tools used were the media validation sheet, instrument validation sheet, and teacher and student answer sheets. With regard to the media validation sheet, four aspects were examined usability, functionality, visual communication, and content to determine whether the media was useful. The media validation was conducted through the validation by two experts: a physics education lecturer as an expert in teaching, learning, and implementation of senior high school physics curriculum, and a learning media expert as an expert in the development and evaluation of digital learning media.

The aspects are outlined in Table 1, which summarizes the indicators for each. For the usability factor, we examined how easily it was accessible, its compatibility with various devices, and how efficient it was. Aspects related to functionality concerned the functioning of the main menu, buttons, and interactive controls, as well as overall functional stability across devices. Visual communication addressed the clarity of instructional communication, simplicity and attractiveness in the display, visual quality (e.g., colors, icons, images), and layout organization/consistency. The content factor reviewed the quality and accuracy of the material, suitability and fit to the current curriculum, scope of content coverage, and depth of conceptual explanation for dynamic fluids. Items on the media validation sheet were rated on a four-point Likert scale.

Table 1. Media evaluation instrument

No.	Aspect	Indicator	Item count	Item numbers
1.	Usability	Ease of access	1	1
		Device compatibility	1	2
		Media usage efficiency	1	3
		Ease of navigation menu	2	4-5
		Recency and relevance of media content	1	6
2.	Functionality	Operation of the main menu	1	7
		Operation of buttons and interactive controls	4	8-11
		Overall functional stability across devices	1	12
3.	Visual communication	Clarity of instructional communication	2	13-14
		Simplicity and attractiveness of the display	2	15-16
		Visual quality (colors, icons, images)	2	17-18
		Layout organization and consistency	2	19-20
4.	Content	Quality and correctness of the material	1	21
		Relevancy and responsiveness to modern curriculum	2	22-23
		Breadth of concept coverage	2	24-25
		Depth of conceptual explanation of dynamic fluids	1	26

Data Analysis Technique

This research uses quantitative data obtained from the validation and testing of learning media. Product feasibility is assessed by experts using a quantitative scale, which is then analyzed to determine product quality (Gregory, 1992). The content validity of the product is tested using Gregory's analysis, calculating the internal consistency coefficient to ensure that the product is valid and ready for use in learning.

Table 2. Validation criteria

No.	Validation score	Validation level
1	1	Not relevant
2	2	Fair
3	3	Relevant
4	4	Highly relevant

The analysis technique used is based on the agreement between two experts on Gregory's formula, which is written in a cross-tabulation as shown in the table below.

Table 3. Gregory's formula

Gregory's table		Validator 1	
		Score 1-2 (Poor relevance)	Score 3-4 (Highly relevance)
Validator 2	Score 1-2 (Poor relevance)	A	B
	Score 3-4 (Highly relevance)	C	D

The calculation for the validity results of the two experts used Gregory's formula, namely.

$$\text{Gregory's internal consistency coefficient} = \frac{D}{A+B+C+D}$$

Table 4. Scoring scale

Category	Response scale
Strongly agree	4
Agree	3
Disagree	2
Strongly disagree	1

In addition to validity testing, reliability analysis was performed to assess the internal consistency of the instrument used in this study, which includes the questionnaire responses from the teacher and students. Cronbach's Alpha was computed to measure the extent to which all items in the questionnaire consistently measure the same construct (Cronbach, 1951). The reliability analysis was conducted using IBM SPSS Statistics version 25 to ensure accurate statistical computation and standardized data processing procedures. The resulting alpha coefficient was interpreted based on established reliability criteria, as presented in Table 5.

Table 5. Cronbach's Alpha reliability criteria

Cronbach's Alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor

Then, the ideal score can be obtained using the following formula:

$$S_{ideal} = S_{max} \times N$$

- S_{ideal} = Score Ideal
- S_{max} = Score Maximum
- N = Number of Respondents

After that, the percentage value of the scoring results can be calculated using the formula:

$$P = \frac{\sum x}{\sum i} \times 100\%$$

Description:

- P = Score percentage
- $\sum x$ = Number of respondent answers in the category
- $\sum i$ = Maximum value in category

As for the percentage score scale category according to (Arikunto, 2010), it can be matched in the following table:

Table 6. Media assessment percentage scale

No	Score	Category
1.	81% - 100%	Very good
2.	61% - 80%	Good
3.	41% - 60%	Fair
4.	21% - 40%	Not good
5.	≤20%	Poor

RESULTS AND DISCUSSION

Analysis Stage

During the analysis stage, observations and interviews were conducted at SMAN 1 Gowa to identify and understand the needs in developing simulation-based learning media. The results of the observation showed that physics learning in schools was still centered on the lecture method by teachers, with the use of textbooks and projectors as teaching aids. Because of this, students still had difficulty understanding the abstract and complex concepts of fluid dynamics, which often led to misconceptions. In general, virtual simulation media greatly assist both practical and non-practical learning processes because virtual simulations enable students to easily learn and understand the material that has been taught (Dewi et al., 2017).

Needs analysis in a study serves as a basis for researchers to develop teaching materials or learning media. In addition, needs analysis can also be used as reference material for researchers who will conduct further research (Ummah et al., 2020). The results of the needs analysis also identified that almost all students have access to digital devices such as cell phones or laptops that can be utilized in the learning process. Based on content analysis, the dynamic fluid material at SMAN 1 Gowa includes Bernoulli's principle and the principle of continuity, which require dynamic visualization so that these concepts are easier for students to understand. Therefore, the development of simulation-based learning media is seen as a solution that can bridge this gap by utilizing the digital technology already available in schools.

Design Stage

In the learning media construction process, a detailed design was specified, taking into account the analysis of students' learning problems and the issues related to learning dynamic fluids. One observable issue was the challenge students face in learning the abstract details of the general solution of the differential equations and the principles of fluid flow equations, as they have to rely on explanations in the textbooks or on the discourse in the lectures. Hence, in the construction of the simulation and the learning media, the design was aimed to ensure that the learning media remained focused on the students' learning problems and illustrated how to simplify the learning process towards a profound understanding of the simulation principle of the dynamic fluid.

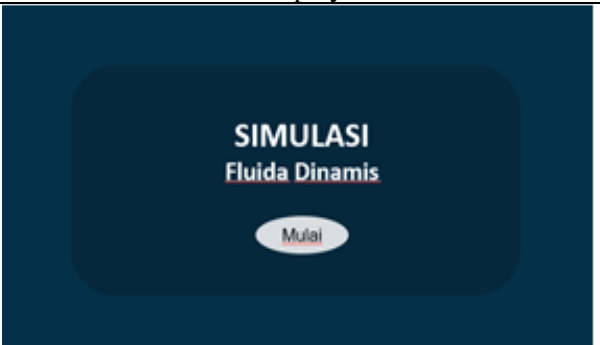
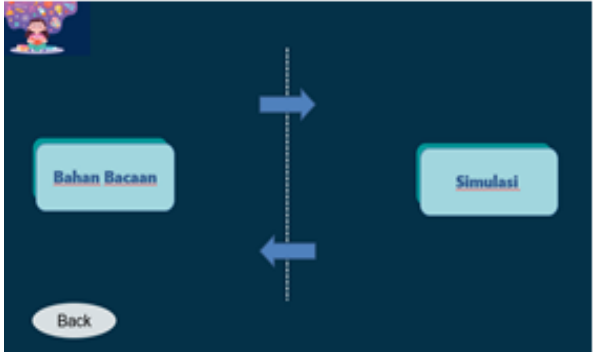
The media was built as an interactive website and developed using Visual Studio Code. With this technology, the learning media can be developed in a range of styles so that it is interactive and adaptable to the device it is accessed on, be it a computer, tablet, or mobile phone. This is critical, as the learning media is designed to be accessed by the students at their convenience and in the device they have at their learning environment.



The main sections of this website include Home, Menu, Materials, and Simulation and are constructed to support students studying in a systematic and engaging way. The Home section provides a brief glimpse of the learning media, and the Menu section is the primary means of navigating to the various functions. The theory of the materials is presented in a manner conducive to learning. The simulation section is a unique and essential feature that empowers students to virtually manipulate different conditions of the fluid so that they can see and understand the physics of the fluid in the virtual world.

Table 7. Description of main section

No	Main section	Description	Function
1.	Homepage	The home page displays the titles of the learning materials and a brief guide for users explaining how to use it.	This section serves as an introduction to the platform and familiarizes users with its structure and features.
2.	Menu	Offers navigation alternatives for reaching various segments of the content or simulations.	Facilitates user selection of desired learning content, whether material or simulations.
3.	Materials	Contains structured explanations of fluid dynamics concepts, complete with illustrations, sample questions, and interactive exercises.	Offer a fundamental comprehension of fluid dynamics prior to students engaging with the simulation directly.
4.	Simulation	Contains a structured explanation of fluid dynamics concepts, accompanied by illustrations, example problems, and interactive exercises.	Strengthens students' understanding through hands-on experience in manipulating variables in fluid dynamics problems.
5.	User guide	A section that explains how to use the learning materials in a structured manner, covering the content and simulations.	Helps users understand how to navigate and make the most of the learning materials' features.

Table 8. Wireframe of learning media

No.	Main section	Display
1.	Homepage	
2.	Menu	

No.	Main section	Display
3.	Simulation	
4.	Materials	

In the design section, the media to be developed will have to be educational, while at the same time effective, interesting and easy accessible. The Visual Studio Code platform was selected so that media can be developed in a more flexible way, based on the curriculum demands. As demonstrated by Wardani et al (2020), media that is responsive and capable of interaction has been proved to facilitate effective student centric engagement and learning. This correlates with their findings that the success of the media implementation hinges on its design.

Development Stage

In the development stage, simulation-based learning media for dynamic fluid materials were developed according to the designs made in previous stages. This development was performed in Visual Studio Code, and the three primary codes, geo. html, style. css, and script. js, were used to build responsive media supported by different devices.

In this development process, we created the main pages contained in the learning media, namely, home, menu, material, and simulation. Each page is designed with interactive elements that facilitate active fluid learning in a more hands-on and thorough capacity. We developed simulations in which users can alter the parameters of a fluid, such as flow velocity and viscosity, and observe the results in real-time (Teutscher et al., 2022).

Once development is finished, this learning media product was subjected to technical testing, which involved verifying the functions of all features and whether each simulation can be accessed from any device with Visual Studio Code. The media pages were initially evaluated to ensure their proper functioning and suitability for learning needs.

Table 9. Display of learning media

No.	Main section	Display																																				
1.	Homepage																																					
2.	Menu																																					
3.	Simulation	<thead> <tr> <th>t (s)</th> <th>v (m/s)</th> <th>p (Pa)</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td><td>0</td></tr> <tr><td>1</td><td>0</td><td>0</td></tr> <tr><td>2</td><td>0</td><td>0</td></tr> <tr><td>3</td><td>0</td><td>0</td></tr> <tr><td>4</td><td>0</td><td>0</td></tr> <tr><td>5</td><td>0</td><td>0</td></tr> <tr><td>6</td><td>0</td><td>0</td></tr> <tr><td>7</td><td>0</td><td>0</td></tr> <tr><td>8</td><td>0</td><td>0</td></tr> <tr><td>9</td><td>0</td><td>0</td></tr> <tr><td>10</td><td>0</td><td>0</td></tr> </tbody>	t (s)	v (m/s)	p (Pa)	0	0	0	1	0	0	2	0	0	3	0	0	4	0	0	5	0	0	6	0	0	7	0	0	8	0	0	9	0	0	10	0	0
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| 4. | Materials | |

Two validators used a validation sheet containing 26 questions in four aspects of the assessment: usability, functionality, visual communication, and content material. The consistency of the assessments among validators was measured using the Gregory model, and the validation results were analyzed.

$$\text{Gregory's internal consistency coefficient} = \frac{26}{26} = 1 \text{ (Highly Relevance)}$$

Table 10. Analysis aspect validation

No.	Aspect	Average	Description
1	Usability	4,0	Usability indicates ease of access and consistent use with a high average score, reflecting good accessibility and simplicity.
2	Functionality	4,0	Functionality is excellent because all the menu options work as expected. This demonstrates reliability.
3	Visual communication	3,625	Visual communication received a slightly lower score, such as simplicity and appearance. This means it needs to be improved in terms of looks.
4	Content of materials	4,0	The content of the material is consistent in quality and relevance. This confirms that the content is suitable, for what's being learned.

The results of this study are organized in terms of the three stages of validation, reliability testing, and analysis of user responses and will offer the reader a critique rather than a descriptive analysis by incorporating learning theory, previous studies, and statistics.

To carry out validation by an expert, the purpose of this evaluation was to determine the level of feasibility of the simulation-based learning media developed in terms of usability, functionality, visual communication, and content of the simulation media (Anggreini et al., 2024; Wulandari & Hamdi, 2021). Out of the four aspects of validation, it was concluded that all the media had a high rate of usability and reliability to be used in the classroom; thereby, the web-based simulation could be used in all devices. Additionally, the content aspect was in great harmony with the learning objectives of the dynamic fluid materials in Phase F of *Merdeka Curriculum* (Herliana et al., 2025; Hidayah et al., 2025).

The high validation results achieved warrant caution in terms of analysis. In educational studies, very high validation results are perceived to show uniformity on the part of the evaluators or a rather one-dimensional approach to the evaluation criteria (Cook & Hatala, 2016). Therefore, rather than interpreting such results as perfection, they should be viewed as evidence that the developed media is of a minimum standard of feasibility for the implementation of instructional media (Weinfurt, 2021).

Construct validity of the student response instrument was assessed using Pearson's correlation between each item and total score. Most behaviors were positively and statistically significantly correlated with each other at both the 0.05 and 0.01 levels, indicating that they collectively contributed meaningfully to the overall construct being measured (Zahfa et al., 2025). However, some items had lower and nonsignificant correlations, indicating that few indicators did not work as intended for discriminating students' perceptions. This indicates that the tool needs to be refined further in future studies to improve its measurement.

Cronbach's alpha revealed a ten-item reliability of 0.576 and an estimated mean of 3.809. As per Tavakol & Dennick (2011), this lies in the range of "poor to questionable" indicating that internal consistency is not yet maximized. Although this is a relatively low coefficient, likely due to the menu of current limited sample size (N = 33), it reduces the power of the test. Moreover, the overall high mean scores also indicate homogeneity among responses, which reduces variance and suppresses the

Cronbach’s alpha coefficient. The statistical variance is reduced (resulting in distortion of reliability analysis when the pattern of responses is highly similar (Tavakol & Dennick, 2011). Finally, while the media does have a generally positive perception among respondents, the actual measurement instrument needs to be improved and reshaped for internal consistency. Future work will therefore either attempt to refine or remove poorly-performing items on the basis of what these corrected item-total correlations show, increase coverage of each construct by adding additional items for each individual component, and re-analyze internal reliability using larger sample sizes and appropriate reliability estimators pertinent to Likert data.

Using Visual Studio Code, the development process of learning media could be conducted to fulfil the technical and pedagogical aspects. This highlights that testing and validation are vital at this stage to ensure that the product meets the requirements outlined in the analysis/design stages. The validation scores were high, indicating that the media was purposeful and appropriate to students’ desires, which corroborates previous research on simulated-based learning tools (Fauji & Nuryantini, 2022).

Implementation Stage

a. Analysis of student responses

Table 11. Result of analysis student’s responses

No.	Category	Criteria	Frequency	Percentage
1.	Very good	33-40	33	100
2.	Good	25-32	0	0
3.	Fair	17-24	0	0
4.	Not good	9-16	0	0
5.	Poor	1-8	0	0
Total			33	100

Responses from students to the developed media were placed in the "Very good" level. Most students agreed with the usefulness, ease of operation, and as an aid to understanding the presenting dynamic flow of the liquid concept. Although the percentage score of response reached the highest, it should not be regarded as absolute in demonstrating perfect instruction. In practice, student responses should not be perfect and uniform; the high response score might be due to novelty effects, short observation time span, or the lack of neutral response in the given Likert instrument. The findings, therefore, characterize strong first-response acceptance rather than concrete demonstration of instruction, as said by Riduwan (2012) that a demonstration of student response in product assessment can be categorized as good if the assessment percentages obtained are more than or equal to 61%.

However, very high ratings across the board must be viewed cautiously. Research from Likert scales suggests that extreme positive responses may also be affected by response styles, social desirability, or satisficing behavior (Kusmaryono et al., 2022), and these effects can vary across school settings. Instruments without a neutral point or high levels of social desirability may result in this metric with very high means and low variance (Kankaraš & Capecchi, 2025).

b. Analysis of Teacher Responses

Table 12. Result of analysis teacher’s responses

No.	Respondents	Aspects											
		Organization of materials				Ease of operation		Visual display			Effect of learning		
		1	2	3	4	5	6	7	8	9	10	11	12
1.	R1	4	4	3	4	3	4	4	4	4	4	4	4

The media also scored "Very good" on the teacher evaluation regarding material organization, ease of use, and impression of learning. Pedagogically, this implies that the simulation fits naturally within existing class practices and curriculum expectations. This point is further cemented by the

integration of interactive worksheets (LKPD) as part of the simulation to structure the learning input and direct student inquiry (Pandiangan et al., 2025).

From a constructivist learning theory perspective, the use of visualizations is supported; in constructivist theory, learners actively construct their understanding through interaction and exploration (Piaget, 1970; Vygotsky, 1978). The ability to directly manipulate variables, such as fluid velocity in real time, is conducive to causal reasoning and would promote conceptual change on topics such as Bernoulli's principle and continuity. Given the *Cognitive Load Theory* perspective, the visualization of velocity dynamics may support learning by extruding causal relationships into a manipulable visual representation, perhaps reducing the cognitive load intrinsic to the learning task. These theoretical foundations demonstrate support for simulation-based teaching approaches.

Similarly, additional research by Fauji & Nuryantini (2022) supports this idea, stating that virtual simulations can be enhanced and improve students' understanding, as well as produce favorable responses. In this research, the enhancement that incorporates LKPD that can be completed directly by the students was one of the positive improvements, in addition to respondents' responses.

Evaluation Stage

Each stage of research involves a test and the development and revision of the media based on the test results. This stage summarizes all comments and improvements from the validators based on the proceedings and respondents. The evaluation results are used as input for positive criticism and to determine whether the media developed is feasible for use. All inputs from validators or respondents indicate a positive result, suggesting that the learning media is feasible for use. Product evaluation, according to Stufflebeam & Shinkfield (1985) aims to determine the successes and failures of something that is applied to the program in maintaining the effectiveness of the process. Product evaluation can be used to measure the success of a program (Umam & Saripah, 2018).

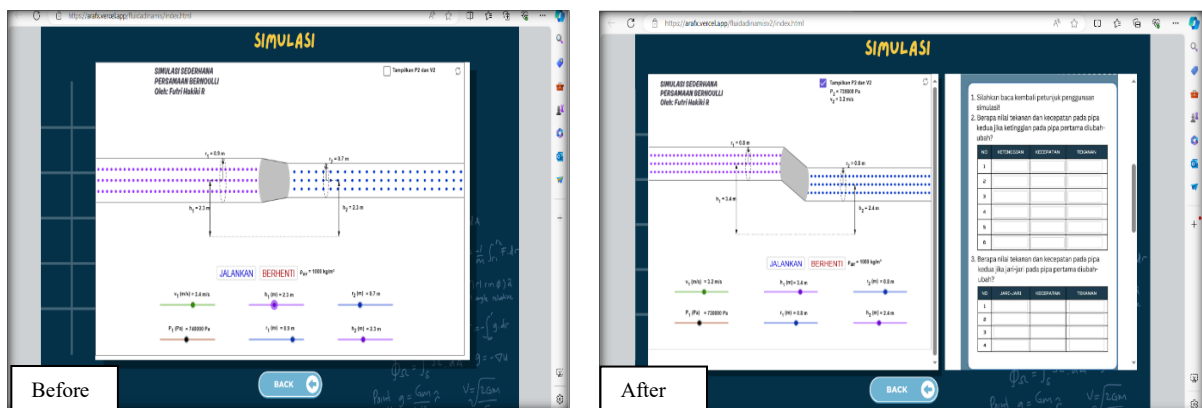


Figure 2. Simulation display before and after repair

During the product development stages, several aspects need to be improved, including the appearance and content of learning media. Based on the suggestions and input received, several improvements were made by students directly by filling in the worksheet on the simulation menu.

Finally, the findings agreed with earlier research, noting a gain in both class participation and concept learning following virtual simulations. In contrast, this study showed that the web-based visual simulation made with Visual Studio Code, as opposed to pre-existing or no longer available platforms (Adobe Flash), is a more flexible and autonomous tool for teachers, contributing to the ongoing development of digital physics education (Antonio & Castro, 2023).

This study also has some limitations that the researcher seeks to address in future research. To date, the sample was only drawn from one class in one school, which limits the generalizability of the results (Tipton et al., 2017). Additionally, the research was only concerned with development feasibility and user response and did not include pretest and posttest measures to establish learning gains. Consequently, no statements can be made at this point about improvements in learning gains (Alam, R., & Ghafour, 2019). Finally, the reliability coefficient suggests that the response instrument

needs modification. Future research might use a larger sample, a modified instrument, and a quasi-experimental design to assess conceptual change and retention.

CONCLUSION

This study developed a customizable web-based dynamic fluids simulation using Visual Studio Code through the ADDIE model and found it feasible based on expert validation and practical based on teacher and student responses. Nonetheless, the study focused on feasibility and practicality rather than on learning gains; therefore, no claims are made regarding the effectiveness of the media in improving students' conceptual understanding. Future research should employ quasi-experimental or experimental designs (e.g., pre-test post-test with comparison groups) with larger and more diverse samples to empirically test the impact of the media on conceptual understanding and the reduction of misconceptions.

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