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THE FEASIBILITY AND PRACTICALITY OF SIMPLE FOUNTAIN DEMONSTRATION TOOLS ON BOYLE'S LAW MATERIAL

Dewi Yana Kurduka[1], Andi Reski [2],Ivylentine Datu Palittin [3] and Nguyen Nhu Le
[1] Senior High School Anugerah Boven Digoel, Papua, Indonesia
[2,3] Universitas Musamus, Merauke, Indonesia
[4] Hue University, Huế, VietNam
Corresponding author email: andireski_fkip@unmus.ac.id

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Abstract :
This study aims to test the feasibility and practicality of the developed product. The product developed is a simple fountain teaching aid related to the concept of Boyle's Law material. The product developed in the study uses a 4D model consisting of four stages, namely define, design, develop, and disseminate. The instruments used in collecting data are in the form of a feasibility questionnaire and a practicality questionnaire. The feasibility of the product is assessed by 3 experts while the practicality of the product is assessed by 3 validators. And based on the response test of 36 high school students in grade X to describe student responses to the product. The results of the validator's assessment show that the product developed is very feasible while the results of the student response test show that the product developed is very practical. So it can be concluded that the product developed in this study in the form of a simple fountain teaching aid is feasible and practical to use in the physics learning process of high school in grade X.

Keywords: Practical, Props, Simple Fountain, Worthwhile

INTRODUCTION

Physics is a branch of natural science that plays an important role in understanding natural phenomena and developing technology. As a basic science, physics studies various aspects of the universe, from subatomic particles to the very large structure of the cosmos (Nuning Tiastiti et al., 2024; Pujono et al., 2024; Hidayat et al., 2024). Knowledge of physics not only underlies many technologies used in everyday life but also plays a role in the formation of critical and analytical thinking in students (Halliday, Resnick, & Walker, 2018). However, learning physics is often a challenge for students. The main difficulty lies in the abstract nature of many physics concepts that require a deep understanding of mathematics and problem-solving skills (Amin et al., 2023; Purnomo et al., 2023; Eka et al., 2024). In addition, a learning approach that is less contextual and lacks interaction often makes it difficult for students to understand the relevance of physics concepts to everyday life. In this context, innovative physics teaching methods are needed to improve students' understanding and interest.

The use of simple teaching aids can help visualize complex physics concepts so that students can more easily understand and remember the material being taught (Madyan et al., 2024; Fitriani &

Erna, 2022; Almonia, 2024). The importance of effective physics learning is also reflected in various educational studies showing that students who engage in active and contextual learning tend to have better understanding and are more interested in participating in learning (Freeman et al., 2014). Therefore, the development and implementation of more interactive and contextual learning methods in physics teaching is a must to ensure that students not only master the basic concepts of physics but are also able to apply them in everyday life.

Physics concepts that are often abstract and mathematical can be a big challenge for many students (Fauziyah et al., 2023; Ramadhanti et al., 2022; Cahyani et al., 2024). One of the concepts included in this category is Boyle's Law which explains the relationship between pressure and volume of gas at constant temperature. Difficulty in understanding this concept can affect students' ability to apply physics principles to real contexts. One effort to overcome this challenge is to develop physics teaching aids. Where, teaching aids function as a bridge between theory and practice so that students can see directly how changes in one variable affect other variables in a physics system. The use of teaching aids, especially in Boyle's Law material, can help students visualize how gas pressure increases when volume decreases according to the mathematical equation underlying the law.

As stated by (Rushton, Lotter, & Singer, 2019) that one response to this challenge is to develop physics teaching aids that have been recognized as a strategy to improve conceptual understanding and student engagement in learning. In addition, well-designed teaching aids can increase student motivation and interest in physics. Studies show that a more interactive learning approach such as the use of teaching aids can increase engagement and encourage students to be more active in the learning process. This is important because student engagement is directly correlated with increased conceptual understanding and better learning outcomes (Blanchard, Southerland, & Granger, 2016; Habibi et al., 2024; Guzman, 2020). In addition, a more interactive and experimental-based learning approach such as the use of teaching aids can make students more interested in the material and more active in the learning process. This is very important because student engagement is the key to achieving better learning outcomes and deeper understanding (Aziz & Clefoto, 2024; Naimah et al., 2024; Fitriazmi et al., 2024). The use of teaching aids is also in line with the principles of inquiry-based learning. Where students are encouraged to be actively involved in the learning process through exploration and experimentation.

The development of physics teaching aids must also consider aspects of feasibility. Practicality, effectiveness and availability of materials. Teaching aids designed to demonstrate the principles of Boyle's Law must be easy to make and use in various educational environments, including in schools with limited resources. For example, teaching aids can be made from inexpensive and easily found materials, but still effective in helping students understand the concepts taught (Helida et al., 2023; Anggraeni et al., 2023; Maymunah et al. 2023). Furthermore, the development of physics teaching aids is in line with the inquiry-based educational approach that emphasizes active learning (Huda et al., 2023;. Where students are involved in the process of exploring and discovering new knowledge (Mardiana et al., 2024; Sahban et al., 2024; Sriyono, 2024).

Previous research emphasized the importance of teaching aids in increasing interactivity and enjoyment in learning. The current research continues this theme by developing a simple fountain teaching aid that is relevant to the concept of Boyle's Law (Fikriya & Fajar, 2020). The product developed in the previous research was simpler and focused on simulating the dangers of smoking, while the current research developed a more complex teaching aid related to the concept of physics (Boyle's Law). The previous research was conducted at the junior high school level, while the current research was conducted at the high school level. This shows that the current research seeks to develop more complex teaching aids that are relevant to higher levels of education.

By using teaching aids, students can design and conduct their own experiments (Yunita, 2024; Syamsiah, 2024; Astuti et al., 2024). This is the core of the inquiry-based learning approach and is very important in modern physics education (Cam & Geban, 2017; Ningsih, 2024). Therefore, the integration of teaching aids in physics learning on Boyle's Law material not only helps improve students' understanding of the concept but also encourages the development of critical thinking skills and problem-solving abilities that are essential in science and technology. So that in this study, a product development was carried out in the form of a simple fountain teaching aid to help explain the concept in Boyle's Law material. The product was validated by two experts to assess its feasibility. After being declared feasible, it was then continued to be tested as well as tested the responses of students to assess

the practicality of the product. So the aim of this research is to produce a product in the form of a simple fountain demonstration tool that is feasible and practical for use in physics learning for class X high school students.

RESEARCH METHOD

This study uses research and development methods to produce a product. Where the process of developing teaching aids for Boyle's Law uses the 4D Model. This model consists of four stages, namely define, design, develop, and disseminate (Usmeldi et al., 2017).

- Define, at this stage, an initial analysis is carried out to identify students' needs for teaching aids in learning the concept of Boyle's Law. This needs analysis includes identifying students' learning difficulties and the material that most requires the assistance of teaching aids.
- Design, this stage involves designing an initial prototype of teaching aids that suits the needs that have been identified. The design of this teaching aid includes technical specifications, materials used, and how the tool will help visualize the concept of Boyle's Law.
- Develop, at the development stage, a prototype of the teaching aid is made and then validated by 3 expert validators to assess the feasibility of the product. After that, the teaching aid was tested on 36 high school students in grade X to measure its practicality in learning. The instruments used to collect data were a feasibility questionnaire and a practicality questionnaire with a 4-level assessment scale: strongly agree, agree, disagree, and disagree.
- Disseminate, after the teaching aid is declared feasible and practical, the product is disseminated or implemented on a wider scale. This stage includes the dissemination of research results through scientific publications or teacher training to ensure that teaching aids can be used in various schools.

The instruments used were a feasibility questionnaire and a practicality questionnaire. The product feasibility assessment was carried out by 3 validators. To assess the practicality of the product, it was carried out by lecturers and teachers totaling 3 validators. Meanwhile, the response test was carried out on 36 high school students in grade X to determine the practicality of the tool and student responses to the product. The grid for the feasibility, practicality and student response questionnaires is in table 1:

Table 1. Grid of instruments for feasibility, practicality and student responses to the developed product

Feasibility Aspect	Practicality Aspect	Student Response Aspects
Efficiency	Benefits in Learning	Benefits in Learning
Accuracy	Ease of Use	Suitability to Learning Materials
Aesthetics	Suitability with Learning Materials	Ease of Use
Durability		Student Engagement and Motivation
Security		Time Efficiency in Learning

The assessment scale in the feasibility and practicality questionnaire sheet consists of 4 levels, namely strongly agree, agree, disagree, and disagree. Furthermore, the collected data was analyzed using the following equation.

$$P = \frac{Total\ Scores\ Obtained}{Maximum\ Score} \times 100\%$$

The results of this data analysis are then interpreted according to Table 1 (Widoyoko, 2015) and Table 2 (Sa'adah & Wahyu, 2020) to determine the product's feasibility and practicality categories.

Table 2. Product Eligibility Criteria and Product Practicality

Eligibility		Practicality	
Score Range (%)	Category	Score Range (%)	Category
80-100	Very Eligible	81 – 100	Very Practical
60-79	Eligible	61 – 80	Practical
40-59	Quite Eligible	41 – 60	Quite Practical
< 39	Not Eligible	21 – 40	Less Practical
		0 – 20	Not Practical

The criteria or categories of the student response questionnaire regarding learning using products consisting of 14 questionnaire items will be presented in Table 3 below.:

Table 3. Categories of student responses for the student response questionnaire regarding the use of the Simple Fountain teaching aid.

Interval	Category
14 – 24.5	Not Good
24.6 - 35.0	Quite Good
35.1 – 45.5	Good
45.6 – 56.0	Very Good

The data analysis technique of this study uses descriptive statistics assisted by SPSS. Descriptive statistics used in this study include percentage, mean, median and frequency.

RESULTS AND DISCUSSION

This research produces a product, namely a Simple Fountain Teaching Aid related to Boyle's Law Material for class X of high school. The development process of this teaching aid follows several stages in accordance with the 4D development model. The stages of research carried out include Define, Design, Development, Disseminate.

At the define stage, the activities carried out include needs analysis through interviews with physics teachers of class 10 of State Senior High School 2 Merauke and distributing questionnaires to 36 class X students. From the results of the needs analysis, information was obtained that the school already had teaching aids. Students have also used some of the teaching aids and find it easy to understand the material when using teaching aids in physics learning. However, for Boyle's Law material, the school does not yet have teaching aids. Most students also consider this material difficult so teaching aids are needed to help students understand the material. In addition, teachers have never used teaching aids in learning Boyle's Law. The results of the analysis are then used as a reference for conducting research and product development. At the design stage, activities are carried out to design patterns or models that are commonly used for simple fountains.

The design of a simple fountain is generally with slight modifications to the frame of the container containing water. The steps taken in designing the pattern can be explained as follows. 1) designing a simple fountain support stand consisting of container stand 1, container stand 2, and container stand 3 as in Figure 1; 2) designing a container or tube that will function as a water reservoir; 3) designing a pipe that functions as a water channel and air channel; 4) designing a pipe from tube one to tube 3 that functions as a water channel that is moved from tube 1 to tube 3; 5) designing a pipe from tube 1 to tube 2 that functions to produce a simple fountain that is moved from container 2 to container 1; 6) designing a pipe from tube 2 to tube 3 with the function of an air path produced from air pressure in tube 3, then channeled to tube 2 so that the air pressure pushes water from tube 2 to tube 1.

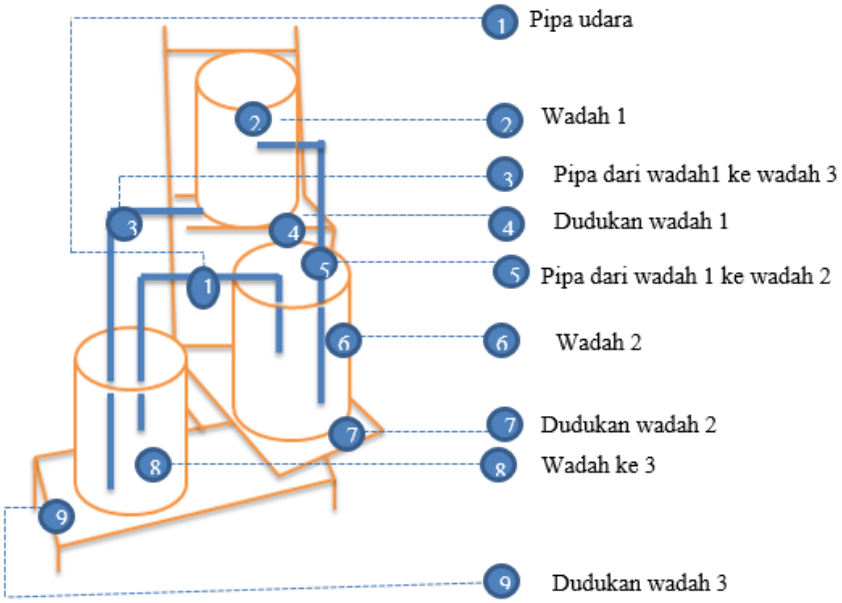

Figure 1. Simple Fountain Prop Pattern Design

Development stage, carried out with the aim of realizing the product design that has been designed in stage 2. The initial design includes the first part of a simple fountain prop stand with a height of 3 cm and a width of 1 cm. After being developed, a simple fountain prop stand design was produced as seen in Figure 2.

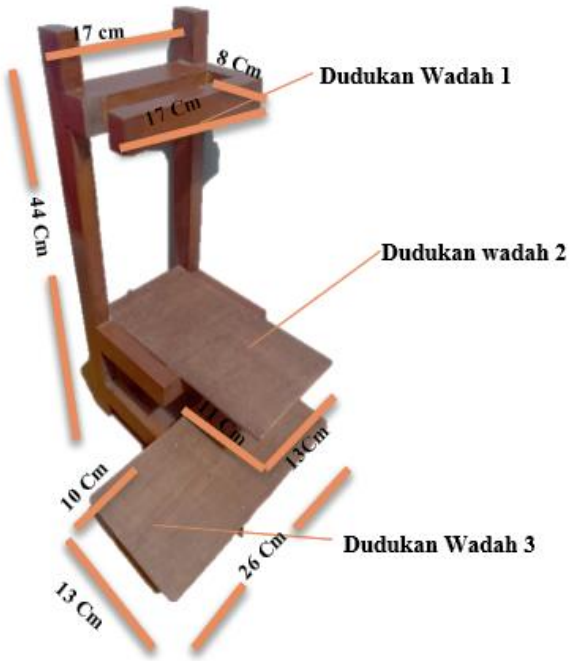

Figure 2. Simple Fountain Container Stand

Next, the second part of the design is to make a PVC pipe from container 1 to container 3, container 1 to container 2 and container 2 to container 3 as shown in Figure 3 below.

Figure 3. Installation of Pipes in Each Container

After being assembled completely from the stand to the containers that have been connected with PVC pipes, the following simple fountain design is produced..

Figure 4. Results of the Teaching Aid Design

Furthermore, the design results of this simple fountain prop were validated by 3 experts to assess the feasibility. The results of the product feasibility assessment are shown in Figure 5.

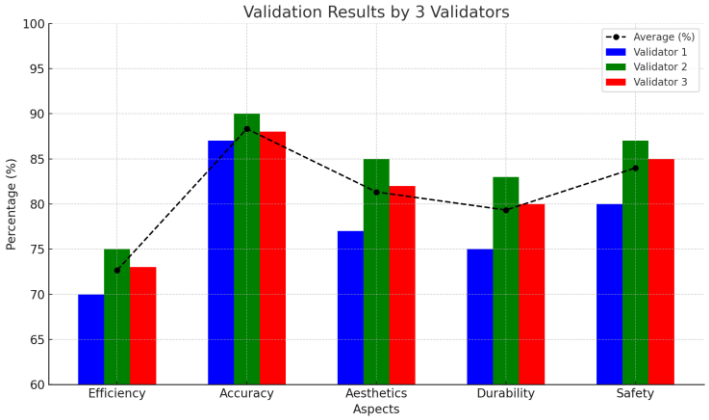

Figure 5. Feasibility Test Results

Based on Figure 5, information on the validation results by three validators was obtained, the Simple Fountain teaching aid developed for Boyle's Law learning showed very good results in various aspects.

The accuracy aspect received the highest rating with an average of 88.33%, indicating that this tool is able to represent the concept of Boyle's Law accurately. The efficiency aspect was considered quite good with an average of 73%, indicating that this teaching aid is effective for use in the learning process. The aesthetic, durability, and safety aspects also showed positive results with average values of 81.33%, 79.33%, and 84% respectively, indicating that this tool is not only functional but also attractive, durable, and safe for use by students. Overall, this teaching aid is considered feasible and can be implemented in physics learning in class X of high school. As stated by (Putri & Prabowo, 2020) that a teaching aid is suitable for use in learning after improvements are made according to the suggestions of the validator. Some suggestions from the validator include completing it with a simple fountain practicum guide and completing the guide with objectives, a summary of Boyle's Law material, usage procedures and analysis questions. The following Figure 6 shows a guide to using teaching aids according to the validator's suggestions.

Figure 6. Simple Fountain Practical Guide

After being revised and the product is declared suitable for use in the learning process. Furthermore, product dissemination was carried out with a limited trial to 36 high school students in grade X. At the same time, a student response test was also carried out on the practicality of the product. The results of the product practicality test are presented in Figure 7.

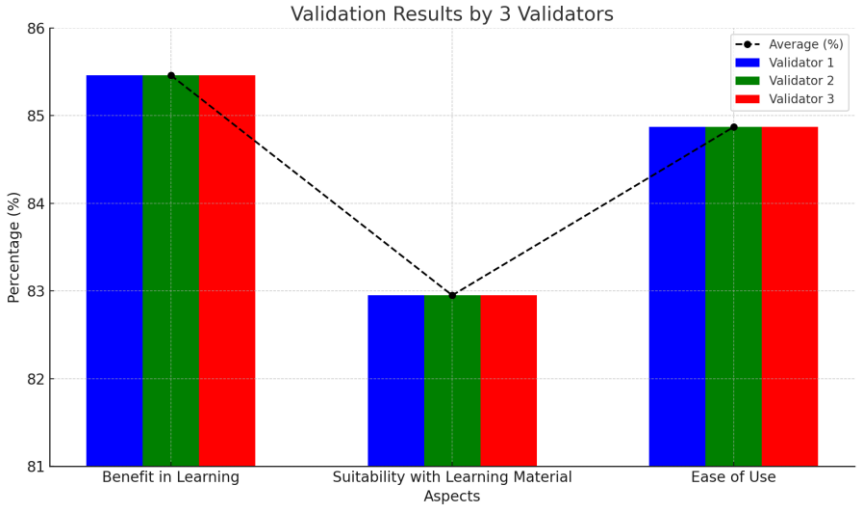

Figure 7. Results of Practicality Test by validator

Based on Figure 7, information is obtained that the average percentage of the practicality test is 84.43 and is included in the very practical category. Therefore, according to the results of the feasibility test and the results of the practicality test, the product developed is feasible and practical to be used as one of the learning media that supports learning effectiveness. As stated by (Alatas & Astuti, 2019) that

teaching aids can be used as a means to support the learning process. In addition, teaching aids can also be used as learning facilities. Where according to (Reski, 2018) that learning facilities can increase learning motivation. The results of student responses to the use of Simple Fountain teaching aids in Boyle's law learning are presented in the following descriptive statistical results.

Table 4. Student responses to the use of the Simple Fountain teaching aid

Category	Interval	Frequency	Percentage (%)	Mean	Median
Not Good	14 – 24.5	4	11.11%	40.5	41.0
Quite Good	24.6 - 35.0	10	27.78%		
Good	35.1 – 45.5	12	33.33%		
Very Good	45.6 – 56.0	10	27.78%		

The results of the analysis of student responses to the use of the Simple Fountain teaching aid showed that most students rated this teaching aid in the "Good" category with an average score of 40.5 and a median of 41.0. The highest frequency was in the "Good" (33.33%) and "Very Good" (27.78%) categories, indicating that this teaching aid was received positively and considered effective in learning. However, there were also 11.11% of students who rated it "Not Good" and 27.78% rated it "Quite Good", indicating that there were several areas for improvement. Overall, this teaching aid was quite successful but could be improved to meet the expectations of all students.

Previous research conducted by Pangestu & Perdana (2023) focused on the development of teaching aids in the form of simple fountains related to the concept of Boyle's Law. This shows continuity in efforts to improve students' understanding of physics concepts, especially Boyle's Law, through practical teaching aids. However, there is a gap in the focus of measurement and evaluation scale that indicates a gap. The current study is narrower in scope with a focus on feasibility and practicality, while previous studies cover broader aspects such as effectiveness in increasing students' interest and motivation to learn. The two studies complement each other, where the current study can be considered a continuation that deepens the practical aspects of the product being developed. The novelty of this study is the validation from experts and direct response tests from students to the products being developed. This approach provides comprehensive feedback, ensuring that the teaching aids are not only academically feasible but also well-received and considered practical by the end users, namely the students.

The novelty of this study lies in its comprehensive approach to developing and validating a simple fountain teaching aid specifically designed to illustrate Boyle's Law for high school students. Unlike previous research, which often focused on broader educational outcomes, this study narrows its scope to thoroughly assess both the feasibility and practicality of the developed teaching aid. The rigorous validation process involved not only expert evaluations but also direct feedback from students, ensuring that the product is both academically sound and well-received by its intended users. This dual-layered validation provides a more robust understanding of how the teaching aid functions in a real classroom setting, highlighting its practical utility in enhancing student comprehension of complex physics concepts. The study also introduces a novel combination of design modifications and detailed instructional guides, which were developed based on expert suggestions and student feedback, further enhancing the tool's effectiveness and user-friendliness. This iterative process of design, validation, and revision contributes to the development of a teaching aid that is not only innovative but also tailored to meet the specific educational needs of high school physics students.

The findings from this study have significant implications for the enhancement of physics education, particularly in the teaching of Boyle's Law, by demonstrating that well-designed teaching aids can substantially improve student comprehension and engagement. However, the study's limitation lies in its relatively small sample size and the specific focus on a single educational institution, which may affect the generalizability of the results. Additionally, while the teaching aid was validated and received positive feedback, its long-term impact on student learning outcomes was not assessed.

CONCLUSION

Based on the results of the feasibility test assessed by 3 experts, it was obtained that the product developed was very feasible. In addition, the results of the practicality test from the student response

test obtained information that the product developed was very practical. Therefore, it can be concluded that the simple fountain teaching aids developed in the study meet the criteria of being feasible and practical for use in the physics learning process of grade X high school. However, to complete this study, further research is needed to test the effectiveness of teaching aids on improving student learning outcomes. For future research, it is recommended to expand the study across multiple schools and regions, incorporating a larger and more diverse sample of students. Furthermore, future studies should investigate the long-term effectiveness of the teaching aid in enhancing conceptual understanding and retention, as well as explore the integration of similar tools in other challenging areas of physics to generalize its utility in broader educational contexts.

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