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Development of Virtual Reality Learning Media Based on the Kuula Platform Assisted by ClassPoint on Fluid Material to Improve Cognitive Learning Outcomes of Grade XI High School Students

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Abstract

Background: The rapid advancement of ICT (information and communication technology) during the Fourth Industrial Revolution offers great potential to transform physics learning, especially for abstract topics such as fluid matter. Limited laboratory facilities and suboptimal learning schedules in many schools can hinder students' understanding and cognitive learning outcomes.
Objectives: This research seeks to: (1) ascertain the viability of the developed media, (2) measure the improvement in high school students' cognitive learning outcomes, and (3) determine students' responses to the learning media.
Method: The ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) was used in this research and development (R&D) study. The learning media developed was a 360° Virtual Reality video based on the Kuula platform integrated with ClassPoint. The trial was conducted on 39 eleventh-grade students utilizing a pretest-posttest approach in a single group. Data were collected through media and subject matter expert validation sheets, cognitive learning outcome tests, and questionnaires for student responses. Validation and student response data were subjected to descriptive and quantitatively analysis, while improvements in cognitive learning outcomes were analyzed using N-Gain scores.
Results: Expert validation produced an average feasibility score of 90.16% (highly feasible). Students' cognitive learning outcomes improved significantly, with a high category N-Gain score of 0.83. The media received a highly favorable response from students, with an average score of 91.37% (very good).
Conclusion: The virtual reality learning media based on the Kuula platform assisted by ClassPoint that was developed was declared highly feasible and effective in raising high school students' cognitive learning outcomes on fluid material, particularly Archimedes' Principle. This media is an innovative alternative for schools with limited laboratory facilities.

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INTRODUCTION

A number of industries, most notably education, have been profoundly impacted by the Fourth Industrial Revolution's development of information and communication technology (ICT). The Fourth Industrial Revolution is distinguished by swift technological advances, including digitization, automation, and the use of the Internet of Things (IoT) (Mahendra et al., 2023). This technology has not only changed the way we interact with information, but also transformed teaching and learning methods as a whole. With digitalization, education can take advantage of various forms of learning media that are more interactive and engaging, such as digital libraries, audio-visual learning

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materials, and e-learning platforms that assist in the instruction and learning process of students (Dito and Pujiastuti, 2021).

The use of ICT and the internet has grown dramatically in Indonesia, giving students and teachers more access to digital learning materials and interactive learning environments. ICT advancements have made it possible to construct "Education 4.0," or curricula that are more responsive to the demands of society and industry. In order to do this, technology-based learning must be integrated with the growth of critical thinking, digital literacy, and creativity (Putriani and Hudaidah, 2021). Furthermore, the integration of technology into teaching methods offers a chance to completely transform physics instruction. Virtual labs, interactive software, and simulations are examples of advanced technologies that have the ability to create a more dynamic and immersive learning environment (Faresta et al., 2024).

As an abstract and conceptual subject, physics has special learning and teaching qualities. In addition to comprehending theory, physics students must be able to apply these concepts in practical settings (Banda and Nzabahimana, 2021). In order for students to understand complicated concepts, fluid material in education, particularly at the high school level, requires a high degree of spatial and visual awareness. Research indicates that using visual media can be quite helpful in boosting students' grasp of fluid dynamics content, which many students find challenging (Oktavia et al., 2023). One of the physics teaching resources for eleventh-grade high school students is static fluid in the odd semester. Static fluid refers to fluids in liquid form that do not flow. These static fluid materials often cause students to have misconceptions about their application in everyday life. This is because they only learn the material and the application of formulas without any application in everyday life (Husniah, 2020).

Student learning outcomes are academic achievements attained through examinations and assignments, as well as active participation in posing and responding to inquiries that aid in achieving these learning objectives. There is a common perception in academic circles that a student's cognitive success may be assessed by looking at their learning outcomes rather than their marks on report cards or diplomas. Low student learning outcomes in fluid mechanics are a complicated issue that can be impacted by a number of variables. Learning outcomes are mostly determined by internal factors, including learning motivation, interest, and students' fundamental comprehension of the subject matter (Yanti et al., 2021). According to Mohamad and Mahmud's (2023) research, learning media are crucial to the process of learning because learning is basically a communication process that takes place within a system. The use of appropriate learning media enables effective communication between teachers and students, so that learning materials can be conveyed more clearly. This has a direct impact on enhancing student learning outcomes because educational media facilitates conceptual understanding, lowers misunderstandings, and improves students' assimilation of the subject matter. Additionally, using relevant material helps boost students' enthusiasm and focus to learn, which ultimately contributes to the achievement of optimal learning outcomes.

The Problem-Based Learning (PBL) model is a cutting-edge approach to education that starts the learning process by placing students in authentic settings, thereby creating active conditions. In this model, problems derived from everyday life are used as a means for students to build knowledge and understand learning materials. Through the application of PBL, students are anticipated to get a more profound comprehension of concepts, rather than simply relying on rote learning (Kurniawan, 2023). The PBL learning model can aid students in developing their creativity. In this context, PBL is seen as having enormous potential to be applied in various learning situations because it encourages students to solve problems using various strategies while practicing important skills needed in the learning process (Nurmahasih, 2023). PBL is very suitable for physics learning because it focuses on contextual problem solving. Through PBL, students are given the space to express ideas, relate learning experiences to prior knowledge, and play an active role as subjects of learning in solving physics problems encountered in everyday life (Melinda et al., 2024).

Virtual Reality (VR) technology has developed into one of the most popular educational support media in various fields of science. This technology provides opportunities for teachers and students to engage and directly experience learning phenomena instantly, which is difficult or even impossible to achieve in a physical environment. The use of VR allows for the simultaneous engagement of various senses, such as touch, heat sensation, and smell, during the learning process. Thus, this technology has the potential to raise the level of activity and mental readiness of students and teachers in learning activities (Oyelere et al., 2020). VR, with its ability to visualize abstract concepts, is becoming an increasingly interesting topic in physics education. VR technology can serve as an effective medium for conveying complex physics concepts through a more interactive and engaging learning process. VR has great potential in providing an engaging educational experience for students, thereby increasing learning effectiveness and motivation. In addition, the development of various digital devices that support VR-based immersive learning opens up new opportunities for learning, both remotely and face-to-face in the classroom (Budi et al., 2021).

Based on interviews with the eleventh-grade physics teacher and five students, it was found that the school does not yet have a physics laboratory, so students have not had any hands-on practical experience, making it challenging for them to comprehend abstract physics concepts. In addition, physics lessons are often held in the afternoon or at the end of the school day, which causes students to lose focus and motivation to learn, resulting in low cognitive learning outcomes. Fluid material was chosen because it has characteristics that require visualization and concrete learning experiences, such as the ideas of Archimedes' principle, hydrostatic pressure, and fluid flow, which are difficult to observe without practical activities. Therefore, innovative educational materials that might offer a virtual practical experience are needed. The creation of educational materials in the form of 360 VR videos based on the Kuula platform combined with ClassPoint is considered suitable for fluid material because it is able to present three-dimensional visualizations and a 360° viewing angle, making learning more interactive, interesting, and able to improve concept understanding and cognitive learning objectives for high school students in the eleventh grade.

The choice of Kuula, ClassPoint, and PhET Simulation platforms was based on the necessity of learning media in this discipline that are adaptive to the limitations of school facilities and the characteristics of fluid material that requires high visualization and interactivity. The Kuula platform was chosen because it is capable of presenting web-based 360° Virtual Reality videos that are easily accessible via mobile devices without the need for special hardware or high costs. This makes Kuula relevant for use in schools that do not yet have physics laboratory facilities, as it can provide an initial exploration experience of the practical environment virtually as a substitute for direct observation in the laboratory. Meanwhile, ClassPoint is used to support learning interactions because it is directly integrated with PowerPoint and allows for real-time quizzes, questions, and feedback. The use of ClassPoint is particularly important for maintaining student engagement and focus, especially in physics classes, which often take place during the afternoon or last period. With these interactive features, learning is no longer one-way, but encourages active student participation in the discussion and reflection process.

The integration of PhET Simulation is important because it gives students the chance to explore liquid concepts virtually through variable manipulation and observation of buoyancy phenomena, which are difficult to do without actual practical activities. PhET acts as a bridge between the visual experience of VR videos and a deeper conceptual understanding, so that students not only observe, but also analyze and draw conclusions independently. The combination of these three platforms forms a complementary learning ecosystem, from initial exploration and interaction to concept reinforcement, making it relevant and urgent to apply in high school fluid physics mechanics learning.

The findings of bibliometric analysis indicate that the health and higher education sectors continue to dominate research on VR-based learning media. 62% of VR-based learning research was carried out in higher education, and 21% in the health sector, according to a bibliometric study of articles from 2020 to 2025. On the other hand, less than 4% of research directly addresses physics topics, especially fluids, and just 9% of studies focus on high school students. These results suggest that there is still a lack of widespread use of virtual reality in high school physics instruction. By creating 360° VR learning materials on fluid material that are connected with the Kuula platform and supported by ClassPoint, this project seeks to close this gap. This learning media can be accessed online without the need for expensive devices, making it suitable for schools with limited resources.

The purpose of this study is to develop and determine the feasibility of VR educational materials, determine the improvement in students' cognitive learning outcomes, and determine students' responses to VR learning materials' application in fluid material for eleventh-grade high school students.

METHODS

This study used research and development (R&D) as its research methodology. According to Okpatrioka (2023), R&D is an approach that seeks to create specific products as solutions to existing problems. In the realm of education, R&D is used to produce learning innovations through a systematic research process, so that it can produce products that are effective, efficient, and applicable in the context of education. The five primary phases of this paradigm are Analysis, Design, Development, Implementation, and Evaluation. This approach helps developers of learning media or tools to make the process more focused and systematic, from identifying learning needs to evaluating the results achieved. Figure 1 shows the stages in the ADDIE paradigm (Dwitiyanti et al., 2020).

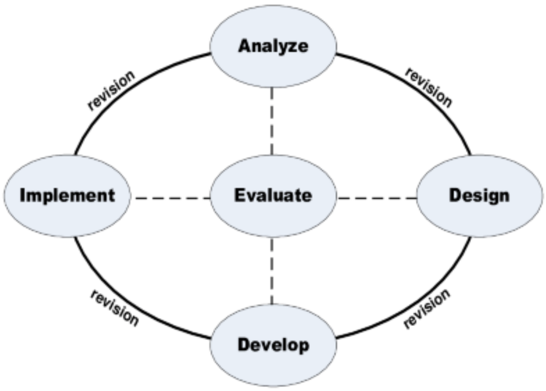

Figure 1. ADDIE Research Stages

This research was conducted by applying the five-stage ADDIE development paradigm. The evaluation stage was carried out through bibliometric analysis, structured interviews with teachers and students, and observation of the learning process. The design stage included the layout of educational materials that integrated the Kuula, ClassPoint, and PhET platforms into the Archimedes' Principle material. A 360° Virtual Reality (VR) video was designed as the main visual media to present physical phenomena in a contextual and immersive manner, then uploaded and managed through the Kuula platform. The VR content was then integrated into interactive presentations using ClassPoint to increase student engagement through quizzes, discussions, and direct feedback during learning. To reinforce students' conceptual understanding and scientific reasoning, PhET simulations were used as a supporting medium that allowed students to explore and manipulate physics variables virtually.

The integration of these three platforms was systematically designed to produce interactive, meaningful learning that is oriented towards mastery of physics concepts. The development stage included the creation of 360° VR videos using an Insta360 X3 camera, the editing and uploading process to the Kuula platform, and the development of interactive presentations using ClassPoint. The resulting products were then verified by subject matter experts, media specialists, and physics instructors. The implementation stage was carried out through limited trials with students by applying learning using 360° VR media assisted by ClassPoint, accompanied by pre-tests and post-tests to measure students' cognitive learning outcomes. The assessment phase aimed to evaluate the feasibility, efficacy, and quality of learning media based on expert validation results, improvements in students' learning outcomes as well as their reactions to the created media.

Students in the eleventh grade at a public high school in Bengkulu City made up the study's population. One particular class of 39 students made up the sample. Because the class was chosen based on particular research concerns, such as its feasibility for the application of VR learning media and the availability of supporting facilities, a purposive sampling technique was used. The research was carried out in the odd semester of the 2025/2026 academic year at a public high school in

Bengkulu City. The data collection techniques in this study included interviews, tests, and questionnaires. Tests (pretest and posttest), questionnaires, and interviews were used to collect the data. The research tools included student response surveys, learning outcome test instruments, interview sheets, and expert validation sheets to evaluate the appropriateness of the VR learning materials. Expert judgment was used to evaluate the test items' content validity prior to their administration as pretest and posttest instruments. The experts evaluated the items' clarity, relevance, and compatibility with the research indicators and learning objectives. To make sure the instrument was appropriate, changes were made in response to their input. Careful item construction, professional evaluation, and consistent administration practices throughout deployment all contributed to the instrument's reliability.

Virtual Reality Media Feasibility Analysis

In this study, the feasibility of VR learning media was determined through a validation questionnaire. The questionnaire covered various aspects that needed to be evaluated by experts. To determine the media feasibility category, the feasibility percentage was determined using Equation (1) (Fahrenda et al., 2025).

$$Media\ Feasibility\ Validation = \frac{Total\ Score}{Maximum\ Ideal\ Score} \times 100\% \quad (1)$$

To determine the suitability of the media, percentage values were used as a reference for data assessment. The suitability percentage values are shown in Table 1 (Rahmandita et al., 2022).

Table 1. Feasibility Percentage

Percentage	Category
>21%	Very Infeasible
21% - 40%	Not suitable
41% - 60%	Quite Adequate
61% - 80%	Feasible
81% - 100%	Highly Recommended

Analysis of Cognitive Learning Outcome Improvement

Students' cognitive learning outcomes were measured before (pretest) and after (posttest). Indicators of cognitive learning outcomes included understanding, applying, analyzing, and evaluating. The data collected from the Cognitive Learning Outcomes test was then analyzed using quantitative methods by converting quantitative data into qualitative data. The aim was to evaluate the enhancement of students' cognitive learning outcomes following the use of VR learning media. After that, the scores obtained from all students were calculated. The scores were obtained using the Normalized Gain equation in Equation (2) (Lolita et al., 2025).

$$N - Gain = \frac{Postest\ Score - Pretest\ Score}{Maximum\ Score - Postest\ Score} \quad (2)$$

Students' cognitive learning outcomes were evaluated using the N-Gain index criteria according to Table (2)'s provisions.

Table 2. N-Gain Index Category

Score N-gain	Category
g> 0,7	High
0,3 ≤ g ≤ 0,7	Medium
g ≤ 0,3	Low

Questionnaire Response Analysis

This study included a survey designed to find out how students react to virtual reality instructional materials. The findings of this student response survey are crucial for determining the advantages and disadvantages of VR educational materials. Response data were analyzed by calculating the response percentage based on the scores received, as formulated in Equation (3) (Eka et al., 2025).

$$\% \; Response = \frac{Total \; Score \; obtained}{Maximum \; score} \times 100\% \tag{3}$$

The categories for analyzing student response percentages are displayed in Table 3 (Freccelia et al., 2024).

Table 3. Questionnaire Percentage Analysis Category

Percentage%	Category
0% - 20%	Very Poor
21% - 40%	Poor
41% - 60%	Fair
61% - 80%	Good
81% - 100%	Very Good

Normality Test

To determine whether the data distribution resembles or follows a normal distribution, a normality test was performed using Equation (4) (Ahadi et al., 2023).

$$W = \frac{(\sum_{i=1}^{n} a_i x_i)^2}{\sum_{i=1}^{n} (x_i - \bar{x})^2} \tag{4}$$

Equation 4 provides the decision criteria for the Shapiro–Wilk test output in SPSS:

If sig. < (0.05), then the data is not normally distributed.

If sig. > (0.05), the data is normally distributed.

Parametric Test (t-test)

With the aid of SPSS software, parametric statistical analysis was carried out in this study utilizing the t-test. When each sample group is unrelated to the others, the paired-sample t-test is used to evaluate hypotheses about differences between two or more populations, through Equation (5) below.

$$t = \frac{\bar{d}}{s_{d/\sqrt{n}}} \tag{5}$$

Use the following acceptance/rejection criteria for H_0:

If sig. < α (0.05), then H_0 is rejected, H_a is accepted.

If sig. > α (0.05), then H_0 is accepted, H_a is rejected.

Effect Size

In addition to conducting statistical significance tests using paired t-tests, this study also calculated the effect size to determine the magnitude of the treatment's influence. The t-test only shows whether or not there is a significant difference between the pretest and posttest scores, while the effect size provides information about how great the treatment's influence is in practical terms. In this study, the effect size was calculated using Cohen's d formula to measure the magnitude of improvement in student learning outcomes after the application of Virtual Reality (VR)-based learning media using Equation (6).

$$d = \frac{t}{\sqrt{n}} \tag{6}$$

The effect size calculation results will be interpreted using Table 4.

Table 4. Effect size calculation

Range of Values	Category
ES < 0.2	Small
0.2 < ES < 0.8	Medium
ES > 0.8	Large

RESULTS AND DISCUSSION

Research on the development of VR learning media based on the Kuula platform with ClassPoint support for fluid material five research phases in order to enhance the cognitive learning outcomes of high school students in the eleventh grade: analysis, design, development, implementation, and assessment.

Results

Analysis Stage

During the analysis stage, data was obtained through interviews and observations. The analysis's findings demonstrated that the limitations of physics laboratory facilities meant that students were not able to gain optimal practical experience, while the fact that physics lessons were often held in the afternoon or at the end of the day had a detrimental effect on students' concentration and will to learn. These findings are in accordance with the findings of Wati and Dewi (2024), which shows that learning in the afternoon tends to be followed by a decline in students' focus, concentration, and motivation to learn due to fatigue after attending classes since the morning. These conditions have the potential to affect the effectiveness of learning if not accompanied by appropriate teaching strategies. Therefore, physics lessons conducted during the afternoon have the potential to be less effective because students' cognitive conditions are not at an optimal level. Therefore, a learning medium in the form of a 360 VR video based on the Kuula platform was developed, combined with ClassPoint and integrated with PhET Simulation. This medium is expected to provide an interactive virtual experiment experience on fluid material, thereby improving the conceptual understanding and cognitive learning outcomes of high school students in the eleventh grade.

Design Phase

The second stage of this research was design stage. The design stage involves designing 360° virtual reality educational materials based on the Kuula platform, supported by ClassPoint and integrated with PhET Simulation using the PBL model. The media is designed to present fluid material visually and interactively through a virtual environment, while PhET Simulation is used to support the exploration and experimentation of fluid concepts. Interactive features such as questions and quizzes are presented through ClassPoint to increase student engagement. The media design is tailored to the PBL syntax and students' cognitive learning outcome indicators.

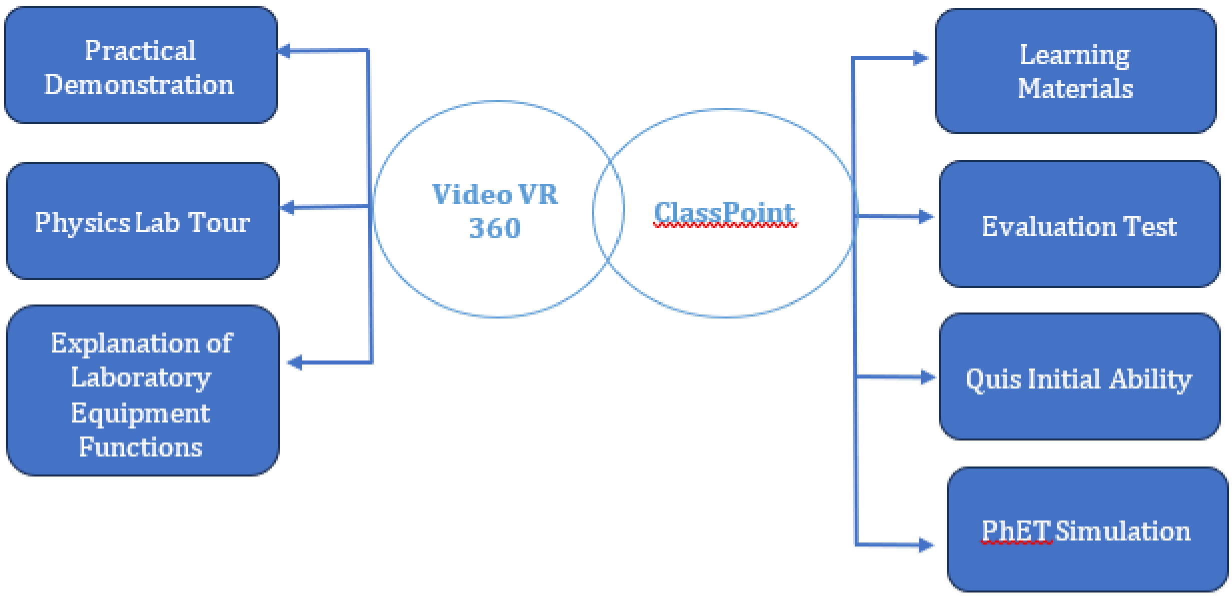

Figure 2. Virtual Reality Learning Media Design

Development Stage

After completing the design stage, the development stage comes next. At this stage virtual reality educational materials were carried out. During development, students can directly join the learning session by clicking the ClassPoint link via the ClassPoint Join class browser on their device, allowing them to access the Virtual Reality learning media that the instructor has prepared.

Figure 3. Slide Material on ClassPoint

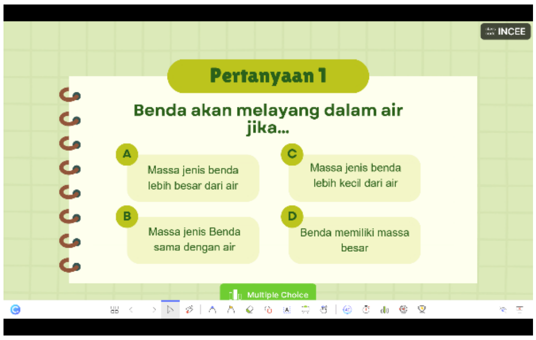

Figure 4. Quiz Feature in ClassPoint

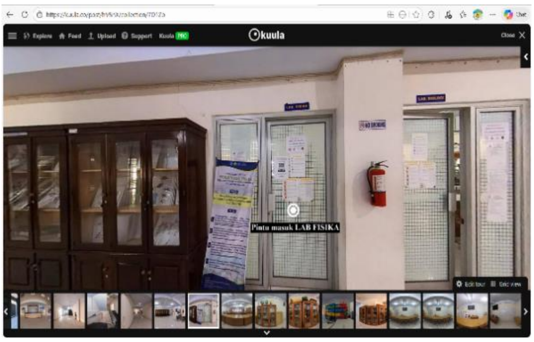

Figure 5. Physics Lab Entrance

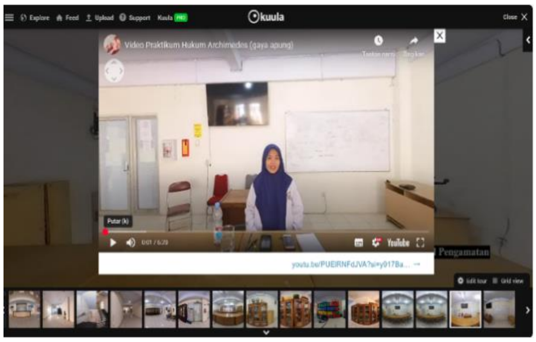

Figure 6. 360 VR Video Practical Demonstration

Figure 3 shows one of the learning material slides available on ClassPoint. ClassPoint provides various presentation support features, such as a drawing feature that allows teachers to mark or emphasize parts of the material directly during the learning process. This feature helps students focus their attention on the important concepts being explained. In addition, ClassPoint also offers additional interactive elements that encourage student participation throughout the educational process, making learning more active and less one-sided. The use of these features in the media development stage aims to improve the clarity of material delivery and students' understanding of Archimedes' principle.

Figure 4 shows the interactive quiz feature on ClassPoint that is used to assess students' comprehension of the content covered in the Archimedes' principle material. By way of this feature, students can provide answers directly using their own devices, so that teachers can obtain students' responses immediately. The use of the quiz feature in the development stage of this media aims to encourage active participation from students while providing immediate feedback during the learning process. Figure 5 shows the initial display of the physics laboratory in the Virtual Reality (VR) media that has been developed. This display serves as an introduction to give students a virtual overview of the physics laboratory. With this display, it is anticipated that students will familiarize themselves with the laboratory environment before carrying out practical activities, thereby increasing their readiness and initial understanding of practice-based learning.

Figure 6 shows the Archimedes' Law practical activity presented in the shape of a 360° Virtual Reality movie. This film allows students to observe the practical stages more clearly from various angles. The use of 360° VR videos in the media development stage aims to offer a more comprehensive and immersive educational experience, thereby helping students to understand the concept of Archimedes' principle more clearly. The next step is the expert validation process to ascertain the feasibility of the learning media that has been created. The expert validation scores for the media feasibility assessment are mentioned in Table 5.

Table 5. Findings of Expert Validation

No	Validator	Feasibility Percentage	Category
1.	Validator 1	77,14	Worthy
2.	Validator 2	93,33	Very Worthy
3.	Validator 3	100	Very Worthy
	Average	**90,16**	Very Worthy

Table 5 shows that the validation results by experts indicate that the created educational materials fall into the acceptable to very acceptable range according to Table 1 using Equation (1). The assessment of all validators indicates that the media has fulfilled the requirements for eligibility in terms of content, appearance, and use, so that it can be applied to the process of learning. The professional confirmation scores for each aspect are listed as shown in Table 5.

Table 6. The proportion of Feasibility for Each Aspect

No	Aspect	Feasibility Percentage	Category
1.	Content Suitability	90	Very Worthy
2.	Presentation	85	Very Worthy
3.	Language	92	Very Worthy
4.	Media	92,22	Very Worthy

Based on Table 6, the assessment results for each aspect show that the learning media has excellent quality in terms of content, presentation, language, and media. Each aspect is assessed to have met the feasibility standards, so that the developed media is declared ready for use as a supporting tool for physics learning in the classroom.

Implementation Stage

Figure 7. Student Activities Using VR Media

The research implementation stage was carried out by applying the PBL model to physics lessons on fluid dynamics, with an allocation of 5 teaching hours (5 TH). In the problem orientation stage, students first completed a preliminary knowledge quiz using ClassPoint to identify their initial understanding, after which the teacher presented questions related to fluid phenomena in everyday life. In the phase of setting up student for education, students are directed to watch a 360° VR video using VR glasses as shown in Figure 7 above. This VR video serves as an initial insight for students to explore the physics laboratory environment virtually, given that the school has limited physics laboratory facilities. Through an immersive visual experience, students can obtain a more concrete picture of the laboratory conditions and practical activities before investigating the concepts. Next, in the individual or group investigation stage, students explore concepts through PhET Simulation Buoyancy by observing changes in buoyancy phenomena based on the variations in conditions presented in the simulation, so that students can draw their own conclusions and fill out the provided student worksheets (LKPD). In the development and presentation level, learners were asked to present their investigation outcomes in front of the class. The learning activity then continues with the researcher reinforcing the material by presenting it using PowerPoint with ClassPoint to emphasize the important concepts that have been learned.

Considering the data from the pretest and posttest, it shows that student learning outcomes have improved. The average pretest score of students shows a low achievement, which is 29.49, indicating that students' initial understanding of Archimedes' principle is not yet optimal. After the learning process was implemented, the average post-test score increased significantly to 86.86. This increase was reinforced by an N-Gain score of 0.83, falling within the top range. These results show that the education process implemented not only improved learning outcomes quantitatively but also reflected a substantive improvement in students' conceptual understanding. Thus, the use of the PBL model supported by VR video media, PhET simulations, and ClassPoint demonstrated efficacy in assisting students in developing a more profound conceptual grasp. The findings of this study support those of Harnisa's (2024) research, which found that using VR-based learning materials can greatly enhance student learning outcomes. Students can better grasp abstract physics topics by using VR media, which offers an immersive and visual learning experience. Furthermore, using VR improves student interest and involvement in the learning process, which benefits learning results. Table 6 shows the improvement scores for learning outcomes per cognitive level aspect.

Table 7. N-Gain Results per Cognitive Level Aspect

No questions	Cognitive Level Aspect	*Pretest Score*	*Postest Score*	*N-Gain*	Category
1-4	Understand	37.82	96.15	0.93	High
5-8	Apply	25.64	88.46	0.84	High
9-12	Analyze	26.28	82.69	0.76	High
13-16	Evaluate	38.46	90.38	0.84	High

Table 7 shows the findings of the learning outcome analysis improvement founded on cognitive level aspects. It indicates that all aspects are in line with Table 2 using equation (2), with the higher categories ranging from understanding to evaluating showing consistent improvement.

Student response is a crucial metric for evaluating the effectiveness of the learning process. Positive responses show how comfortable and accepting students are of the learning materials employed, but low responses can make learning less successful. Students' interest in education media contributes to increased focus and involvement of students during the learning process, thereby minimizing boredom (Purnama et al., 2025). To measure these responses, a student response questionnaire was used, covering five aspects, namely material presentation, VR media design, media benefits, ease of use, and language, as presented in Table 8.

Table 8. Student Responses to Virtual Reality Media

Aspects	Percentage (%)	Category
Presentation	91.92	Very Good
Media Design	90.46	Very Good
Media Benefits	90.87	Very Good
Ease of Use	91.54	Very Good
Language	92.05	Very Good
Average	**91.37**	**Very Good**

Based on Table 8, which was calculated using equation (3), the findings of the VR learning medium student response survey showed a rating that was categorized as very good according to Table 3, Questionnaire Percentage Analysis Categories, on all indicators assessed.

In addition to assessing the suitability of the media, improving students' cognitive learning outcomes, and measuring students' responses to VR learning media, this study also conducted statistical analyses in the form of normality tests to determine data distribution, paired sample t-tests to determine significant differences between pretest and posttest scores, and effect size tests to determine the extent of the influence of learning media on improving students' cognitive learning outcomes.

Table 9. Normality Test Results

	Kolmogorov-Smirnov			Shapiro-Wilk		
Variable	**Statistic**	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Pretest	0.122	39	0.148	0.965	39	0.252
Posttest	0.129	39	0.101	0.967	39	0.314

Based on Table 9, the results of the normality test conducted using the Kolmogorov-Smirnov and Shapiro-Wilk tests, the significance value (Sig.) for all data was greater than 0.05. In the Kolmogorov-Smirnov test, the significance value for the pretest was 0.148 and for the posttest was 0.101. Meanwhile, in the Shapiro-Wilk test, the significance value for the pretest was 0.252 and for the posttest was 0.314. Because all significance values were greater than 0.05, the null hypothesis (H_0) stating that the data were normally distributed was not rejected. This indicates that there is no significant difference between the distribution of the sample data and the theoretical normal distribution, so the data can be said to be normally distributed.

Given that the sample size in this study was 39 respondents ($n < 50$), the Shapiro-Wilk test was used as the main reference because it is more sensitive and has better statistical power for small samples. Based on these results, it can be concluded that the assumption of normality has been met. Therefore, further analysis can use a parametric test, namely the paired sample t-test, to determine the difference in means between the pretest and posttest scores.

Table 10. Hypothesis Test Results (Paired Samples Test)

Data Pair	Mean Difference	Std. Deviation	Std. Error Mean	95% CI Lower	95% CI Upper	t	df	Sig. (2-tailed)
Pretest – Posttest	29.667	18.709	2.996	23.602	35.732	9.902	38	< 0.001

The results in table 10 show that there is a significant difference between the pretest and posttest scores. The mean difference of 29.667 indicates an increase in scores after the treatment. This increase is not just a mere numerical difference, but has been statistically tested. The t (38) value = 9.902 with a significance of $p < 0.001$ indicates that the probability of error in concluding that there is a difference is less than 0.1%. Because the p-value is much smaller than 0.05, the null hypothesis (H_0), which states that there is no difference, is rejected. Thus, the alternative hypothesis (H_1) is accepted, namely that there is a significant difference between before and after treatment.

In addition, the 95% confidence interval is in the range of 23.602 to 35.732. The entire interval range is above 0, which means that the increase in scores is consistent and does not occur by chance. This means that, statistically, it can be believed that the treatment has a positive effect on improving learning outcomes. When viewed from the fairly large t-value (9.902), this shows that the difference in the mean is relatively large compared to the variation in the data. The standard deviation of 18.709 does indicate variation in scores between participants, but the difference in the mean is still strong enough to produce very high significance.

Table 11. Effect Size Test Results

Data Pair	Types of Effect Size	Value (Point Estimate)	95% CI Lower	95% CI Upper	Category
Pretest – Posttest	Cohen's d	1.586	1.107	2.055	Large
Pretest – Posttest	Hedges' g	1.554	1.085	2.014	Large

Based on the analysis results in Table 11, Cohen's d value of 1.586 and Hedges' g value of 1.554 were obtained for the pretest–posttest data pairs. Based on Cohen's criteria in Table 4 (0.2 = small; 0.5 = moderate; 0.8 = large), these values fall into the large category because they exceed the limit of 0.8. This indicates that the treatment provided had a strong effect on improving student learning outcomes. In other words, the difference that occurred was not only statistically significant but also had high practical significance in the context of learning.

The difference between Cohen's d and Hedges' g is relatively small. The value of Hedges' g is slightly lower because it has been corrected for sample size (n = 39) to reduce estimation bias. However, both measures still show the same effect size, which is in the large category, so the research conclusions remain consistent. In addition, the 95% confidence interval for Cohen's d is in the range of 1.107 to 2.055, while Hedges' g is in the range of 1.085 to 2.014. The entire interval range is above 0, indicating that the effect of the treatment is stable and does not occur by chance.

Evaluation Stage

The last phase of development is the evaluation step of learning media and was carried out in each phase of ADDIE through formative and summative evaluations. Formative evaluation was conducted during the analysis, design, development, and implementation stages to improve the quality of Kuula platform-based VR media assisted by ClassPoint, which is applied using the PBL model. Summative evaluation was conducted to assess the feasibility of the media in improving students' cognitive learning outcomes through pretest and posttest analysis using N-Gain.

Discussion

Discussion of learning media

Based on Table 5, the assessment results for each aspect show that the learning media has excellent quality in terms of content, presentation, language, and media. Each aspect is assessed to have met the feasibility standards, so that the created media has been approved for use as an instructional aid for physics classes. The created educational materials are categorized as very feasible because they have met various feasibility criteria required in physics learning. In terms of content suitability, the information offered is consistent with the basic competencies, educational indicators, and characteristics of fluid material, thereby supporting the achievement of the predetermined learning objectives. In terms of presentation, the media is designed systematically with a clear flow and is integrated with the PBL model, thereby increasing student activity in the learning process.

From a linguistic perspective, the use of simple, communicative words that are appropriate for the students' level of development makes the material easier to understand. Meanwhile, in terms of media, the use of Kuula platform-based VR videos combined with PhET and ClassPoint simulations provides visual, interactive, and contextual learning, particularly in overcoming the limitations of physics laboratories in schools. With all these aspects fulfilled, the developed learning media is deemed highly suitable and can serve as a teaching tool for physics lessons in the classroom. This is consistent with the study by Lubis et al. (2023), which claims that for learning media to be effective and raise the caliber of student learning results, it must satisfy the requirements of presentation, language, visuals, and topic compatibility.

Discussion on improving students' cognitive learning outcomes

Table 7 shows the results of the analysis of learning outcome improvement based on cognitive level aspects. It indicates that all aspects are in line with Table 2 using equation (2). The results of the study show a significant increase in students' cognitive learning outcomes, with an N-Gain value of 0.83 (high category). When analyzed based on cognitive level, the Understand aspect received the highest score (0.93), followed by Apply (0.84), Evaluate (0.84), and Analyze (0.76). The high increase in the Understand aspect can be explained by the characteristics of VR media, which emphasizes immersive visualization. 360° visualization allows students to observe fluid phenomena more concretely and realistically. This process helps students build accurate mental models of the concepts of buoyancy and hydrostatic pressure. From a cognitive theory perspective, strong visual presentation helps reduce cognitive load and accelerates the formation of initial concepts because students can connect verbal information with visual representations simultaneously.

In contrast, the Analyze aspect showed a relatively lower increase compared to the understanding aspect, although it remained in the high category. This is reasonable because analytical skills require higher-level thinking processes such as identifying relationships between variables, drawing logical conclusions, and evaluating specific conditions. These skills require more in-depth and repeated reasoning exercises. However, the integration of PhET simulation in learning helps to encourage analytical skills through the manipulation of variables and direct observation of changes in buoyancy conditions. Thus, it can be concluded that VR is very effective in strengthening the conceptual formation stage, which is the foundation for the development of higher-level thinking skills. These results show that PBL-based learning supported by immersive media can improve conceptual understanding while supporting the development of students' analytical skills.

VR videos serve as an initial exploration tool that provides a concrete picture of the laboratory environment and the phenomenon of Archimedes' principle, so that students are conceptually prepared before entering the analysis activity. PhET simulations allow students to independently explore and observe the concept of buoyancy, while ClassPoint encourages interaction through quizzes and class discussions. The combination of these media makes students more active, focused, and enthusiastic in education, which eventually has a major effect on raising students' cognitive learning outcomes and conceptual comprehension. These results are consistent with research by Georgiou et al. (2021), which demonstrates that students' conceptual readiness, engagement, and cognitive learning outcomes in physics learning can be enhanced by combining immersive virtual reality into learning experience design with problem-based learning

Discussion about students' responses to learning media

Based on Table 8 which was calculated using equation (3), The findings from the student response survey on VR learning media showed a rating that was categorized as very good according to Table 3, Questionnaire Percentage Analysis Categories, on all indicators assessed. In the presentation indicator, VR media was assessed as being able to present material in a coherent and interesting manner, facilitating students' understanding of the learning process. Within the media design indicator, the visual display of VR was assessed as clear and realistic, helping students to visualize abstract fluid concepts. The media benefit indicator shows that using VR improves students' comprehension of the learning material and increases student interest and engagement during the learning process.

VR media is considered easy to use, as it can be accessed via links without requiring additional application installation, has simple navigation, and can be operated using devices that are familiar to students. Meanwhile, on the language indicator, the language used in the media is considered clear, communicative, and appropriate for the students' level of understanding. Positive responses to all of these indicators show that VR media is very well received by students and is able to support the creation of more interactive and meaningful learning. These results are consistent with the study by Rohmayani and Sugianto (2024), In addition, research conducted by Risdianto et al. (2021) shows that the integration of virtual technology in physics learning has a significant impact on increasing learning motivation, active engagement, and student participation during the learning process. In his research, the use of virtual-based media allows students to gain a more contextual and exploratory learning experience, so that students do not only receive information passively, but are also involved in the process of observation and interaction with the phenomena being studied. which claims that students respond favorably to the use of VR media in the classroom because it can boost interest, engagement, and comfort. Furthermore, VR-based learning offers an immersive learning experience that improves student involvement and the caliber of the learning process, according to research by Radianti et al. (2020).

Implications

The study's findings suggest that using the PBL model supported by VR media, PhET simulations, and ClassPoint can be an effective learning alternative, especially for fluid material. VR media acts as a solution to the limitations of physics laboratory facilities by providing an immersive and contextual learning experience, while PhET and ClassPoint support concept exploration, interaction, and learning evaluation. The implementation of this learning method has been shown to dramatically improve student engagement and cognitive learning outcomes, so teachers can use it as a guide to create engaging and creative physics lessons.

Research Contributions

This study contributes to the creation of Kuula-based virtual reality learning materials that are integrated with ClassPoint and utilize the PBL paradigm in fluid content, especially Archimedes' Principle. Students can learn abstract fluid concepts more effectively by using this generated media as an alternate learning aid. Additionally, the study's findings demonstrate that using VR media can enhance high school students' cognitive learning outcomes.

Limitations

This study has several limitations to keep the discussion focused. The VR learning media used in this study is a 360° VR video based on the Kuula platform. Although there are various other platforms that can be used to develop VR media, this study is limited to the use of Kuula so that the features and characteristics of the VR media developed by that platform can be explored. The VR media developed is still exploratory in nature and is used as an initial insight for students to gain a basic understanding of the physics laboratory environment and Archimedes' Principle practical activities. Therefore, the VR media in this study has not been designed as fully interactive VR that allows students to perform practical simulations directly.

Suggestions

Further research is recommended to develop VR learning media using more interactive platforms or technologies, so that students not only engage in visual exploration, but can also conduct practical simulations directly to gain a more in-depth learning experience.

CONCLUSION

It may be inferred from the findings of this study on the creation of VR learning materials that Kuula platform-based VR learning media assisted by ClassPoint with the PBL model effectively improves the cognitive learning objectives of high school students in the eleventh grade on fluid material, particularly Archimedes' Principle. The developed media was declared very feasible based on expert validation with an average percentage of 90.16% and received a very good response from students with a mean of 91.37%. The improvement in learning outcomes is demonstrated by an N-Gain value of 0.83 (high category) across all cognitive indicators (understanding, applying, analyzing, evaluating). Thus, this media can be an innovative alternative solution for schools with limited laboratory facilities, while supporting more interactive, immersive, and meaningful physics learning.

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AI DISCLOSURE STATEMENT

The author used artificial intelligence (AI), namely DeepSeek AI, in the process of writing this article to help improve the language, refine the sentence structure, and clarify the academic writing. All scientific content, the author is solely responsible for the data analysis, results interpretation, and conclusions. The author has thoroughly reviewed and edited this publication and is fully responsible for its content and authenticity.

AUTHOR CONTRIBUTION STATEMENT

The authors' contributions to this study are as follows: RAR was responsible for conceptualization, data collection, media development, data analysis, and initial manuscript writing. ER provided supervision, methodological validation, and manuscript review and editing. BG provided input on the design and analysis of the research results.

CONFLICTS OF INTEREST

The authors declare that this research was conducted without any conflicts of interest, whether financial, institutional, or personal, that could influence the research process, data analysis and interpretation, manuscript preparation, or the decision to publish the research results.

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