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Fluistik Zone: Interactive Digital Media for Learning Static Fluid Concepts in Senior High School Physics

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Abstract: *This study aims to develop an interactive digital learning media called Fluistik Zone on static fluid material using the 4D development model (Define, Design, Develop, Disseminate). This media covers the subtopic of introductory static fluids, consisting of density, hydrostatic pressure, Pascal's law, and Archimedes' law. The development procedure begins with a needs analysis through teacher interviews and literature reviews, followed by the initial design of Android application-based media equipped with features such as learning videos, interactive quizzes, and Online Active Learning Guide (OALG). Validation was carried out by material experts and media experts with average validity results of 94% and 99% respectively in the very valid category. The practicality assessment by teachers reached 94% in the very well category and student responses showed an average of 85% in the well category. These findings indicate that Fluistik Zone is valid, practical, and interesting for students in supporting physics learning interactively and contextually. This media is designed following the principles of multimedia learning to increase student engagement and understanding. Therefore, Fluistik Zone has the potential as an effective, interesting, and relevant physics learning media innovation to support 21st century learning. However, testing the effectiveness of the media on learning outcomes has not been carried out experimentally and the trial is still limited to one school. Further research is recommended to test the effect of using Fluistik Zone on student learning outcomes through a quasi-experimental design and expand the development to other physics topics and different levels of education.*

Keywords: *4D models, interactive learning media, multimedia, physics, static fluid*

Fluistik Zone: Media Digital Interaktif untuk Pembelajaran Konsep Fluida Statis di Fisika SMA

Abstrak: Penelitian ini bertujuan untuk mengembangkan media pembelajaran digital interaktif Fluistik Zone pada materi fluida statis dengan menggunakan model pengembangan 4D. Media ini membahas subtopik pengantar fluida statis yang terdiri dari massa jenis, tekanan hidrostatis, hukum Pascal, dan hukum Archimedes. Prosedur pengembangan diawali dengan analisis kebutuhan melalui wawancara guru dan telaah pustaka, dilanjutkan dengan perancangan awal media berbasis aplikasi android yang dilengkapi dengan fitur-fitur seperti video pembelajaran, kuis interaktif, dan *Online Active Learning Guide* (OALG). Validasi dilakukan oleh ahli materi dan ahli media dengan hasil rata-rata validitas masing-masing 94% dan 99% dengan kategori sangat valid. Penilaian praktikalitas oleh guru mencapai 94% dengan kategori sangat baik dan respon siswa menunjukkan rata-rata 85% dengan kategori baik. Temuan tersebut menunjukkan bahwa Fluistik Zone valid, praktis, dan menarik bagi siswa dalam mendukung pembelajaran fisika secara interaktif dan kontekstual. Media ini dirancang dengan mengikuti prinsip-prinsip pembelajaran multimedia untuk meningkatkan keterlibatan dan pemahaman siswa. Oleh karena itu, Fluistik Zone berpotensi sebagai inovasi media pembelajaran fisika yang efektif, menarik, dan relevan untuk mendukung pembelajaran abad 21. Namun, pengujian efektivitas media terhadap hasil belajar belum dilakukan secara eksperimental dan uji coba masih terbatas pada satu sekolah. Disarankan untuk melakukan penelitian lebih lanjut untuk menguji pengaruh penggunaan Fluistik Zone terhadap hasil belajar siswa melalui desain kuasi eksperimen dan memperluas pengembangan ke topik fisika lain dan jenjang pendidikan yang berbeda.

Kata kunci: fisika, fluida statis, media pembelajaran interaktif, model 4D, multimedia

INTRODUCTION

Physics is one of the subjects that requires a deep understanding of concepts and the ability to apply those concepts to various natural phenomena and everyday life. One important topic in physics is static fluids, which discusses the properties and behaviour of fluids at rest. This topic is often considered difficult by students because of its abstract nature and the need for strong visual conceptual understanding to be fully grasped (Irma et al., 2020; Taqwa et al., 2024).

In practice, many teachers still use conventional methods such as lectures and textbooks. These methods are not very interesting for students and often fail to provide a real picture of the physical phenomena being studied, including static fluids (Adrian et al., 2023). As a result, many students experience difficulties in understanding the material and a decline in their interest in learning. Therefore, innovation is needed in the delivery of material through learning media that is interesting, easily accessible, and can bridge students' understanding of abstract physics concepts (Atika et al., 2022).

With the development of information and communication technology, interactive digital-based learning media has become a potential solution. This type of media has proven effective in increasing student motivation and understanding because it is able to present material in a more concrete way through animation, simulation, and dynamic visualisation features (Gulo, 2022). Digital media allows for the presentation of material in an engaging audio-visual format, strengthening students' cognitive processes in linking concepts to dynamic real-world events (Ammar et al., 2023; Ningsih et al., 2020) Furthermore, the integration of audio-visual elements in learning can help accelerate the process of understanding and retaining information (Usmeldi, 2017).

Not only that, interactive learning media also supports independent learning. Through features such as educational videos, e-LKPD, interactive quizzes, and digital materials that can be accessed anytime and anywhere, students have the flexibility to learn at their own pace and according to their learning styles (Chintyawati & Diyana, 2024; Raudhati Putri, 2024). Media that allow for independent exploration provide active learning experiences, which encourage students to engage directly in the learning process, thereby positively impacting their learning outcomes (Sari, 2021). Various interactive physics media have previously been developed on static fluid material such as (Adam et al., 2023; Putra, 2021; Taqwa et al., 2022; Wijaya et al., 2024). However, most of these media still focus on delivering material visually or simulatively without providing space for students to explore independently through structured experiments. In addition, there are not many media that integrate the Online Active Learning Guide (OALG) based on the Investigative Science Learning Environment (ISLE). OALG is a digital-based active learning guide that functions as an interactive e-LKPD, designed to guide students in observing phenomena, formulating questions, making predictions, designing experiments, and analyzing and revising scientific explanations independently.

Based on these needs, the development of innovative learning media is needed that not only presents material visually but also facilitates the scientific thinking process through an inquiry-based approach. One of the efforts made is to develop Fluistik Zone, an integrated interactive learning media specifically designed to support learning static fluid material in the digital era. This media contains complete features such as structured teaching materials, learning videos accompanied by audio explanations, interactive quizzes as formative evaluation tools, and ISLE-based OALG in the form of digital e-LKPD that supports students' independent exploration and practice. This study aims to develop and evaluate the effectiveness of interactive learning media Fluistik Zone based on OALG-

ISLE in improving students' conceptual understanding and involvement in learning static fluid material.

METHOD

This study uses the Research and Development (R&D) method with a 4D development model that includes four stages, namely Define, design, develop and disseminate according to the model developed by Thiagarajan, Semmel, and Semmel (1974). The stages of the 4D model research can be seen in Figure 1.

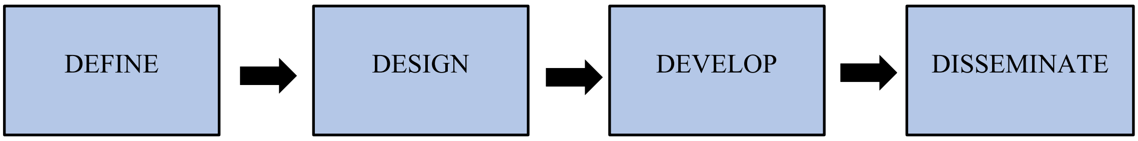

Figure 1. Stages in the 4D model

The research was conducted in one of the high schools in Sampang Regency with research subjects consisting of 19 grade XI students who had studied static fluid material and 1 physics teacher as a respondent to provide input on learning media. In addition, the media validation process was carried out by 1 media experts and 1 material expert. The instruments used in this study consisted of expert validation sheets, both for media and material aspects and teacher and student responses were arranged in the form of a closed questionnaire using a rating scale of 1 to 4. The scores obtained were then averaged and converted into percentages to facilitate interpretation. Interpretation of media and material validation scores is explained in Table 1.

Table 1. Interpretation of Media Expert and Material Expert Validation Scores

Percentage Range (%)	**Criteria**
81-100	Very Valid
61- 80	Valid
41- 60	Quite Valid
21- 40	Less Valid
0-20	Invalid

(Sugiyono, 2008)

After the media was validated, the final stage was carried out by distributing and implementing the media to grade XI students at the school where the research was conducted. To find out user responses, the researcher gave a response questionnaire to teachers and students. The questionnaire scores were analyzed by calculating the average percentage, which was then interpreted according to the categories listed in Table 2.

Table 2. Interpretation of Teacher and Student Response Questionnaire Scores

Percentage Range (%)	**Criteria**
86 – 100	Very Well/Strongly agree
76 – 85	Well/Agree
60 – 75	Enough
55-59 ≤ 54	Not Enough/Disagree Less Once/Totally Disagree

(Daryanes et al., 2023)

RESULTS AND DISCUSSION

Research and Development of Interactive Media on static fluid material using a 4D model produces a product called "FLUISTIK ZONE" which contains sub-topics of static fluid material including introduction to static fluid, density, hydrostatic pressure, Pascal's law and Archimedes' law. Media Development Procedures include

Define

The define stage is to identify learning needs and problems related to static fluid material. Data collection was carried out through interviews with physics subject teachers and literature reviews from journals and other relevant sources. Based on interviews, it is known that students have difficulty understanding the concept of static fluid. In addition, teachers stated that the learning media used in schools are still limited to textbooks and simple visual displays, so they have not been able to facilitate active student involvement in learning. The literature review also shows that interactive media-based learning can improve students' understanding of concepts and learning interests (Jabaliah et al., 2021; Putri & Mufit, 2023; Suwindra, 2012). Therefore, researchers identified the need to develop contextual and enjoyable interactive physics learning media, especially for the topic of static fluid. The product developed is named Fluistik Zone, which is an interactive learning media designed to help students understand the basic concepts of static fluids in a more visual and applicable way.

Design

The design stage is carried out based on the results of the needs analysis at the definition stage. At this stage, the initial design of the Fluistik Zone learning media is prepared, which is designed to support students' understanding of static fluid concepts interactively and contextually. The design process begins with mapping learning outcomes based on the Independent Curriculum for the SMA level. At this stage, the media is designed with several menus including learning outcomes, learning objectives, materials presented at the beginning with trigger questions, videos, quizzes and online active learning guides (OHLG) that help students in doing practicums. The following is a visual display of the media developed.

Figure 2. Main Menu Display

The main menu in the fluistik zone media consists of several important components that are systematically arranged to support the learning process. The menu includes Instructions, Learning Achievements, Learning Objectives, Materials, OALG (Online Active Learning Guides), Videos, Quizzes, References, and Profiles. Each menu has a specific function that complements each other to facilitate students in understanding the material thoroughly through an Interactive approach.

Figure 3. Learning Achievement Menu Display

Figure 4. Learning Objectives Menu Display

This menu displays the competencies that students are expected to achieve after participating in learning that is adjusted to the Decree of the Head of BSKAP Number 032/H/KR/2024 concerning Learning Achievements in the Curriculum. This menu contains specific goal statements that students want to achieve in each learning session or meeting derived from Learning Achievements.

Figure 5. Material Menu Display

This menu presents the main learning content on static fluids, including basic concepts that focus on the sub-topics of density, hydrostatic pressure, Pascal's law and Archimedes' law, equipped with trigger questions before students enter the material. The trigger questions are adjusted to the context that students often encounter in everyday life. These questions serve to activate students' prior knowledge, encourage them to think critically, and create an atmosphere that supports active learning (Fasna et al., 2024; Hafizah, 2020).

Figure 6. OHLG Menu Display

This menu is an e-LKPD that students can use directly in class or independent activities at home by loading online practicums using the ISLE (Investigative Science Learning Environment) approach adapted from (Etkina et al., 2019). This menu is equipped with a report format for students that is linked to Google Docs to make it easier for teachers to check individual participation/involvement in completing the report.

Figure 7. Video Menu Display

This menu provides learning videos that can visualize static fluid material to improve student understanding and facilitate diverse student learning styles. It is also said (Ramadhan et al., 2021) that it helps students understand complex concepts in a more concrete way and students respond positively to the use of videos as learning media, especially those provided through platforms such as YouTube, with an average percentage score reaching 82% (Humaidi et al., 2022).

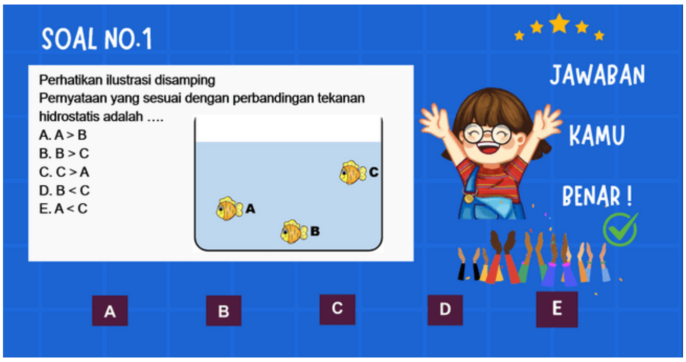

Figure 8. Quiz Menu View

This menu contains interactive practice questions or quizzes to test students' understanding after studying the material in the form of multiple choices consisting of 5 questions. The quiz is equipped with feedback assessment according to the concept understanding indicators. Assessment with feedback plays an important role in the learning process. The goal is not only to assess student learning outcomes but also to encourage the development of student understanding (Misnawati et al., 2023; Pare & Wainsaf, 2023; Safithri & Muchlis, 2022). Supporting this view, the use of valid media has been shown to facilitate structured learning activities and provide opportunities for feedback that enhance students' engagement and understanding during the learning process (Irmawati et al., 2023). In the design process, the researcher determined that the media would be developed in the form of an android application (.apk) by considering the ease of access and the level of device affordability among students. The initial product design was designed in the form of a prototype draft, which includes the homepage display, navigation menu, material page structure, simulation features, and interactive quizzes. Instructional design principles were applied to ensure aspects of text readability, intuitive navigation, and aesthetic visual appearance that were attractive and in accordance with the characteristics of students.

Development

In the development, the initial product was prepared based on the design that had been made, then validated by two expert lecturers, namely material experts and media experts, as well as by one high school physics teacher to assess the practical aspects of media use. The results of the media expert validation along with the indicators assessed can be seen in Figure 9.

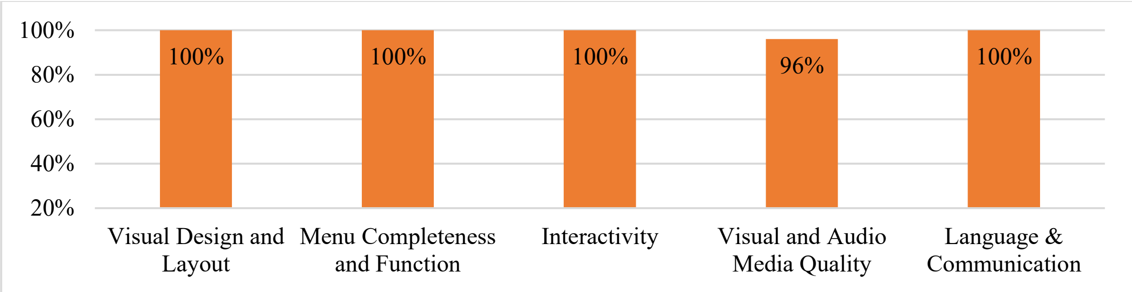

Figure 9. Media Expert Validation Results

Based on the results in Fugure 8, the Fluistik Zone media obtained an average score of 99% with a very valid category. All indicators received a maximum score of 100%, except for the visual and audio media quality indicators which received a score of 96%. This shows that in general this media is considered very valid in terms of visual design, completeness of features, interactivity, clarity of language, and audio-visual quality.
The media validator commented that: “The media is suitable for field trials with the statement that all link buttons function properly, the media display is attractive and appropriate. And the audio-visual displayed is interrelated with the text displayed”. The results of this validation indicate that Fluistik Zone has met the criteria as an interactive learning media that is suitable for use in learning the concept of static fluids. This finding also forms the basis for making final improvements before conducting limited trials with teachers and students.

Material validation was carried out by a physics material expert lecturer to assess the suitability of the contents of the Fluistik Zone media with learning achievements and the accuracy and meaningfulness of the static fluid material presented. The results of the assessment by the material expert are presented in Figure 10.

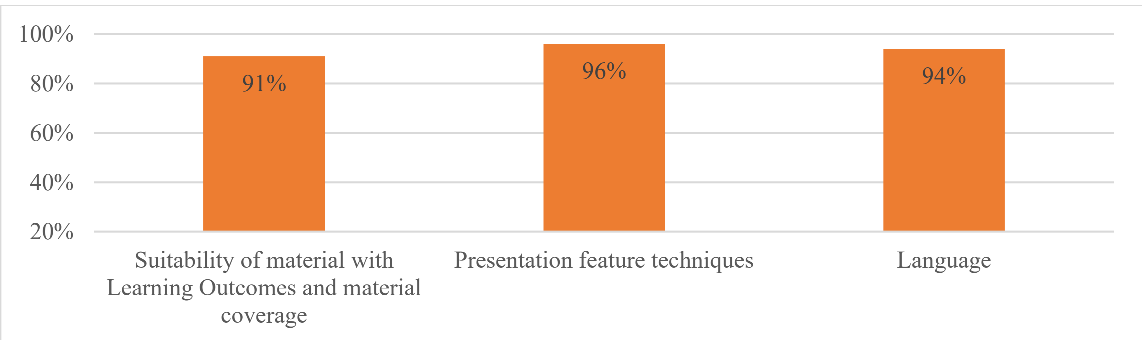

Figure 10. Material Expert Validation Results

Based on Figure 10, it can be seen that the average percentage of material eligibility reached 94% with a very valid category. All indicators scored above 90%, indicating that the static fluid material in the Fluistik Zone media has met the learning content standards in accordance with the Merdeka Curriculum.

The material validator commented that:

"The material is in accordance with the learning outcomes, the language is communicative, and the flow of delivery is clear. However, the initial part needs revision on the trigger questions to make it more inspiring and the visual illustrations are made clearer so that students can more easily imagine the intended context."

This note is the basis for making improvements to the introductory part of the material, especially to improve the visual clarity and effectiveness of the trigger questions in stimulating student thinking. This validation strengthens that in terms of material, Fluistik Zone has met the eligibility criteria and is ready to be tested in the context of actual learning. After going through the validation stage by experts, the Fluistik Zone media is then assessed by high school physics teachers to measure the level of practicality of its use in learning. This assessment includes ease of use, suitability of the media to the learning process in the classroom, integration of the media in learning activities, and the effectiveness of the available features in supporting the delivery of static fluid material. The recapitulation data of teacher assessments of the practicality of the media are presented in Figure 11.

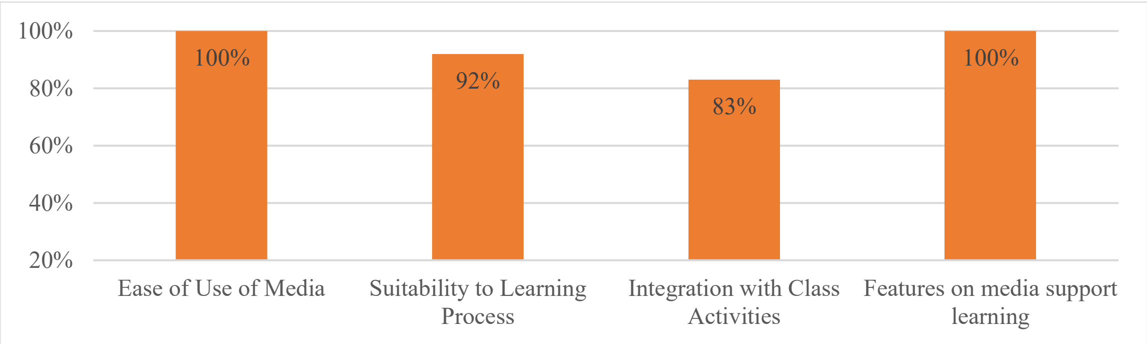

Figure 11. Results of Teacher Responses to Media

Based on Figure 11, the average percentage of media practicality assessment by teachers reached 94%, with a very well category. All indicators were assessed as very good, especially in the aspect of ease of use and media features that received the maximum score. The teacher commented: "This media makes it easier for me to deliver static fluid material in a more interesting and systematic way. All features work well and intuitively so that no modifications are needed in terms of practicality". There was no input related to revisions to the practicality aspect, so this media was considered suitable for use in learning without further changes. This finding strengthens the potential of Fluistik Zone as an alternative innovative media in physics learning at the high school level.

After the Fluistik Zone media was implemented in the learning process, measurements were taken of student responses to determine the extent to which this media was accepted, understood, and felt its benefits in helping the learning process. The assessment focused on several main aspects, such as the appearance and attractiveness of the media, ease of use, understanding of the material, and the usefulness of interactive features in the form of OALG and quizzes. The results of the recapitulation of student assessments of the Fluistik Zone learning media are presented in Figure 12.

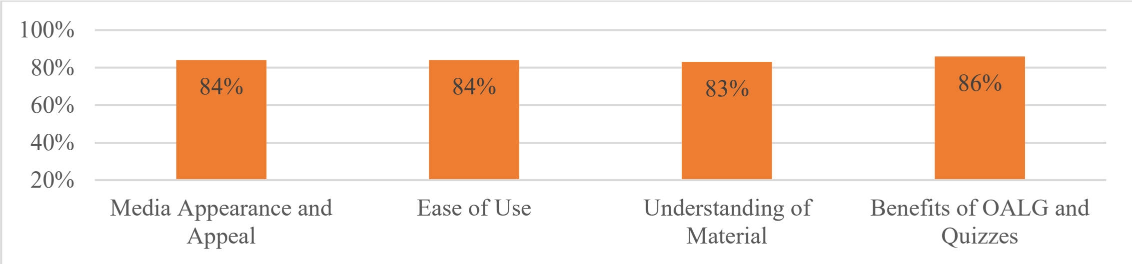

Figure 12. Results of Student Responses to Media

The results in Figure 12 show that students' responses are generally in the well category with an average of 85%. The highest value is shown in the OALG feature and quiz usefulness indicators, which indicate that interactive and evaluative elements in the media are able to increase students' involvement and understanding of the concept of static fluids. In addition, the visual appearance, easy navigation, and clarity of the material are also appreciated by students. These findings support that the Fluistik Zone media is not only valid and practical from the developer and teacher perspective, but is also liked and well received by students, thus potentially increasing the effectiveness of physics learning in the classroom.

This finding is in line with Mayer's Multimedia Learning Theory which emphasizes that learning will be more effective when students are actively involved in the process of selecting, organizing, and integrating information through verbal and visual channels. According to Mayer (2002), students learn better when learning materials include images and words (Multimedia Principle), when words are delivered through audio rather than written text to avoid overloading the visual channel (Modality Principle), and when learning experiences are delivered in a personal and engaging manner (Personalization Principle). Therefore, the positive responses of students indicate that the Fluistik Zone media successfully implemented these principles, thereby enhancing students' cognitive processing and affective involvement in learning the concept of static fluids.

Disseminate

The dissemination stage is the final stage that focuses on the distribution of the product development results to a wider audience. However, in this study, this stage could not be implemented due to time constraints and limited research scope. Based on the validation results, the Fluistik Zone media was declared valid by experts, received very well responses from teachers and well responses students in supporting the physics learning process, especially in static fluid material. Media designed with an attractive appearance and interactive features have been proven to be able to increase students' motivation and interest in learning, so that they are more encouraged to understand science concepts in depth and enjoyably. This finding is in line with Nyemas (2020) technology-based learning media, such as Android-based applications, have been shown to have a positive impact on student understanding. In addition, Media improves understanding of physics concepts, problem-solving skills, and academic performance (Khasawneh, 2024) Support for the effectiveness of digital media was also conveyed by Girwidz & Kohnle (2021) who explained that various modalities, representations, and interactivity to support learning theories such as retaining knowledge, mental models, and cognitive flexibility.

CONCLUSION AND SUGGESTIONS

The results of the study indicate that Fluistik Zone has great potential as an interactive digital learning media to support the understanding of physics concepts, especially in static fluid material. This media has been validated quantitatively by material and media experts, with the results showing a very high level of validity in terms of visual appearance, completeness of features, and suitability of content to learning outcomes. In addition, the practicality test shows that this media is easy to use by teachers and attracts students' interest because it supports independent, interactive, and contextual learning. This study has several limitations. First, although validation was carried out quantitatively by experts, testing the effectiveness of the media on student learning outcomes has not been carried out through an experimental design. Second, media trials are still limited to a small scale in one school, so they do not represent the diversity of learning contexts. Third, this media has not gone through a wide dissemination stage, so the level of adoption in other schools and the challenges of its implementation have not been identified comprehensively. Further research is recommended to conduct experimental testing using a pretest-posttest design with a control group to determine the impact of using Fluistik Zone on improving students' learning outcomes and scientific skills. In addition, further development can also include expansion to other physics topics as well as trials at different levels of education as well as media dissemination to more schools and data collection from various student backgrounds also needs to be carried out.

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