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Visual Interactive Virtual Object: Development of Whisk AI Based Animated Video Media to Improve Science Learning Outcomes

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ABSTRACT

The rapid development of digital technology in education requires innovative learning media that can help elementary students understand abstract science concepts more effectively. However, many elementary science learning practices still rely on conventional explanations that limit students' conceptual visualization and interactive engagement. This gap indicates the need for technology-integrated media that combine visual representation and interactive learning experiences. Therefore, this study aimed to develop and examine the validity, practicality, and effectiveness of WHISK AI–based animated video learning media integrating the VIVO (Visual Interactive Virtual Object) concept in elementary science learning. The novelty of this research lies in the integration of artificial intelligence assisted animated video development with interactive virtual object visualization (VIVO), which has not been widely implemented in elementary science learning to support the visualization of abstract concepts through visual interactive scaffolding. This study employed a Research and Development (R&D) approach using the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation. The research subjects were fifth-grade students from SDN 06 KL and SDN 13 LB in West Sumatra during the second semester of the academic year. Data were collected through expert validation sheets, teacher practicality questionnaires, student response questionnaires, observations, and learning outcome tests using a one-group pretest–posttest design. Data analysis techniques included descriptive quantitative analysis using mean scores to determine validity and practicality levels, as well as normalized gain (N-gain) analysis to measure learning effectiveness. The validation results from six experts (language, content, and educational technology experts) showed an average score of 4.32, categorized as highly valid. The practicality test involving six teachers produced an average score of 4.40, indicating that the media are highly practical. Furthermore, the effectiveness test conducted with 80 students demonstrated a moderate improvement in learning outcomes, with an average N-gain score of 0.57, indicating meaningful conceptual improvement after the implementation of the developed media. Based on these findings, the WHISK AI–based animated video learning media integrating the VIVO concept are valid, practical, and effective in improving students' understanding of abstract science concepts. Pedagogically, the integration of AI-generated animation and interactive virtual visualization provides structured visual scaffolding that supports conceptual construction, increases student engagement, and strengthens technology-integrated science learning at the elementary level. Therefore, this media can serve as an innovative alternative to enhance digital-based instructional practices in elementary science education.

Keywords: Science Learning; Elementary School; Animated Video; VIVO; WHISK AI.

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1. INTRODUCTION

Science learning plays a crucial role in developing scientific, critical, and logical thinking skills among prospective elementary school teachers. A solid mastery of fundamental science concepts is essential because elementary school teachers play a pivotal role in establishing the foundation for effective science learning at the basic education level (Ardiansyah & Joyoatmojo, 2025; Maraisane et al., 2021). In teacher education contexts, conceptual understanding becomes even more important since prospective teachers are expected not only to comprehend scientific knowledge but also to transform it into meaningful learning experiences for their future students.

However, one of the major challenges in contemporary science education lies in presenting abstract concepts in an engaging and comprehensible manner, particularly for early-semester pre-service elementary education students (Maryland, 2016; Yuksel & Eker, 2021). Many science topics require advanced visualization and higher-order reasoning skills; therefore, when delivered through conventional methods, students often experience difficulties in achieving deep conceptual understanding. This condition frequently leads to low learning motivation and the emergence of misconceptions (Ningtyas et al., 2024; Osman et al., 2025). Consequently, innovative, interactive, and contextual learning approaches are required to support students in building strong conceptual understanding while enhancing scientific thinking skills as essential competencies for future elementary educators.

From a broader technological perspective, the rapid development of digital learning environments has encouraged the integration of multimedia and artificial intelligence (AI) in instructional design. Technology-based learning media enable complex and abstract scientific phenomena to be visualized more concretely, thereby supporting students' cognitive processing and conceptual construction (Jannah et al., 2024). Furthermore, technology integration has been widely recognized as an important factor in strengthening 21st-century competencies such as critical thinking, creativity, collaboration, and digital literacy (Aslan et al., 2025; Dilekçi & Karatay, 2023; Ramaila & Molwele, 2022).

From a regulatory perspective, the improvement of technology-based learning quality at the elementary education level has been emphasized in various national policies. Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 22 of 2016 on Process Standards for Primary and Secondary Education stipulates that learning processes should be conducted in an interactive, inspirational, and enjoyable manner, while also motivating students to actively participate, including through the use of instructional media and learning technologies that are appropriate to students' characteristics. This policy direction aligns with global educational frameworks emphasizing digital transformation in teaching and learning processes (Huang et al., 2024; Joseph et al., 2024). Several studies also highlight that effective technology integration in classrooms requires not only infrastructure but also pedagogically meaningful instructional media design (Kale et al., 2020; Thelma et al., 2024). In addition, digital learning environments supported by artificial intelligence have been reported to enhance adaptive learning experiences and support personalized instruction (Akavova et al., 2023; Sajja et al., 2024).

Furthermore, the implementation of the Merdeka Curriculum, as regulated in the Regulation of the Minister of Education, Culture, Research, and Technology Number 56 of 2022, underscores the importance of student-centered and contextual learning, as well as the strengthening of 21st-century competencies such as critical thinking, creativity, and digital literacy from the elementary

school level. In this context, the utilization of technology-based and artificial intelligence-supported instructional media is considered relevant for enhancing the quality of science learning in a meaningful, adaptive, and future-oriented manner. In the context of teacher education, the success of prospective teachers is strongly influenced by their ability to design and utilize technology-based learning media effectively (Albion & Gibson, 2000; Pamelasari et al., 2024; Zhang, 2022).

Classroom observations conducted during science learning activities at SDN 06 KL and SDN 13 LB in West Sumatra during the second semester of the academic year revealed that many students still experienced difficulties in understanding basic science concepts, such as force, energy, and human body organs. One contributing factor was the use of learning media that tended to be static and limited to presentation slides and text-based materials with minimal interactivity. As a result, the learning process became monotonous and less engaging for students. Several students expressed the need for learning media that are more engaging, simple, and easy to understand while enabling active participation in learning. This finding is consistent with previous studies indicating that learners strongly prefer instructional media that present content in clear and visually supported formats Raklaemthong et al. (2025); Pem & Sukavatee (2024) which play an important role in concretizing abstract concepts.

Based on these conditions, several key challenges in science learning can be identified: (1) the limited availability of instructional media capable of visualizing abstract science concepts interactively, (2) the insufficient utilization of artificial intelligence technology in developing elementary science learning media, and (3) the lack of practical and effective animated video media aligned with students' characteristics. Although previous studies have demonstrated that animated videos can enhance students' motivation and conceptual understanding (Tugtekin & Dursun, 2022; Cakiroglu & Yilmaz, 2017; Rosdiana & Ulya, 2021), most studies still focus on conventional multimedia animation without integrating AI-based interactive visualization.

The use of AI technology in learning media development has recently gained attention due to its ability to generate adaptive, efficient, and high-quality visual content (Bootchuy et al., 2025). Interactive visual based learning media also support students' knowledge construction by enabling them to actively interpret representations and transform abstract concepts into meaningful learning experiences (Tippett, 2016). Supporting this perspective, several studies emphasize that AI integration in instructional design facilitates personalized learning and increases learner engagement through adaptive environments (Peng & Li, 2025). While animated multimedia may help manage students' cognitive load when learning abstract concepts (Fitria, 2024; Schnotz & Rasch, 2005), its effectiveness strongly depends on visual quality and alignment with learners' characteristics (Hashimi et al., 2019; Guo et al., 2025; Nurhasanah, 2025).

Despite the growing use of animated multimedia and artificial intelligence in educational contexts, limited studies have specifically integrated AI-based animation with interactive virtual object visualization to support elementary students' understanding of abstract science concepts. Previous research has generally examined animation or AI separately, without combining interactive virtual visualization and AI-generated animation within a systematic instructional media development framework. Therefore, this study addresses this gap by developing WHISK AI based animated video learning media integrated with the VIVO (Visual Interactive Virtual Object) concept.

The novelty of this study lies in the integration of AI-assisted animated video production with interactive virtual object visualization (VIVO) to create dynamic, interactive, and learner-centered

science learning media. This innovation is expected to provide more effective conceptual visualization while supporting meaningful and personalized learning experiences.

Therefore, the objective of this study is to develop and examine the validity, practicality, and effectiveness of WHISK AI–based animated video learning media integrating the VIVO (Visual Interactive Virtual Object) concept in elementary science learning. This study also evaluates the media's ability to visualize abstract science concepts interactively and accurately while assessing its practicality for classroom implementation and its effectiveness in improving students' conceptual understanding.

2. METHODS

This study employed a Research and Development (R&D) approach using the ADDIE model, as it is considered systematic, structured, and appropriate for the development of educational technology based learning media (Branch, 2009). Chronologically, the research began with the Analysis stage, which involved identifying learning needs, obstacles encountered in elementary science subjects, and the characteristics of the research participants, namely fifth-grade students at SDN 06 KL and SDN 13 LB, West Sumatra, during the second semester of the academic year. The needs analysis was conducted through preliminary observations, brief interviews, and the identification of learning gaps, as commonly recommended in educational media development research.

2.1 Research Subjects

The research subjects consisted of:

a. Six expert validators, including two language experts, two material experts, and two technology/context experts.
b. Six elementary school teachers involved in the practicality test (three teachers from SDN 06 KL and three teachers from SDN 13 LB).
c. Eighty fifth-grade students, consisting of 40 students from SDN 06 KL and 40 students from SDN 13 LB, who participated in the effectiveness test.

These subjects were selected purposively to represent users and evaluators of the developed WHISK AI–based animated learning media. This study was conducted in accordance with research ethics principles. Permission was obtained from the participating schools prior to data collection. Students and teachers were informed about the purpose of the study, and all data were used solely for research purposes. Participants' identities were kept confidential, and the implementation of the learning media did not interfere with the regular instructional process.

2.2 ADDIE Development Procedures

a. Analysis Stage

   At this stage, a needs analysis was conducted to identify students' difficulties in understanding abstract science concepts, the availability of existing learning media, and the characteristics of fifth-grade elementary students. Data were collected through classroom observations and teacher interviews to obtain comprehensive and contextual information. The results of the analysis indicated a strong need for interactive visualization-based learning media to support students' conceptual understanding more effectively.

b. Design Stage

The design stage involved several systematic activities, including preparing learning objectives based on science competency standards, designing the storyboard and animation flow, determining the VIVO (Visual Interactive Virtual Object) concept, and developing assessment instruments such as validation sheets, practicality questionnaires, and learning outcome tests. All instruments were constructed using a five-point Likert scale ranging from 1 (very poor) to 5 (very good) to ensure measurable and consistent evaluation results.

c. Development Stage

At this stage, the WHISK AI–based animated video media were produced in accordance with the previously developed storyboard design. After the production process was completed, the media were validated by experts based on three main aspects: language feasibility, content/material feasibility, and technology/context feasibility. Each validation instrument consisted of 15–20 items, depending on the specific aspect being evaluated, to ensure a comprehensive assessment of the developed media.

d. Instrument Validity and Reliability

Content validity was ensured through expert judgment to confirm the relevance and appropriateness of each instrument item. Instrument reliability was tested using Cronbach's Alpha, with reliability coefficients exceeding 0.80, indicating that the instruments were highly reliable for research use. Revisions were subsequently made based on expert suggestions prior to implementation to improve the overall quality and accuracy of the instruments.

e. Implementation Stage

The implementation stage consisted of two steps:

1) Practicality Test

The practicality test was conducted using a teacher response questionnaire consisting of 20 items that measured several aspects, including ease of use, clarity of display, suitability with learning objectives, and flexibility of use. Prior to completing the questionnaire, teachers implemented the media directly in classroom learning to ensure that their responses were based on actual experience in using the WHISK AI–based animated video media.

2) Effectiveness Test

Media effectiveness was tested using a one-group pretest posttest design. In this procedure, students were administered a pretest before using the media and a posttest after participating in learning activities with the WHISK AI–based animated video media. The test instrument consisted of 25 multiple-choice items developed based on science competency indicators to measure students' learning outcomes accurately.

f. Evaluation Stage

Evaluation was carried out comprehensively through the analysis of expert validation results, practicality analysis based on teacher responses, and effectiveness analysis using the gain score to measure the improvement in students' learning outcomes after the implementation of the WHISK AI–based animated video media.

g. Data Analysis Techniques

1) Validation and Practicality Analysis

Scores from validation and practicality questionnaires were analyzed using the mean formula:

$$\bar{X} = \frac{\sum X}{N} \quad (1)$$

The results were categorized using the following criteria

Table 1. Criteria for Categorizing Mean Scores of Validity and Practicality

Mean Score	Category
4.21–5.00	Highly Valid/Practical
3.41–4.20	Valid/Practical
2.61–3.40	Fair
1.81–2.60	Less Valid
1.00–1.80	Invalid

2) Effectiveness Analysis (Gain Score)

The effectiveness of the media was calculated using the normalized gain (N-Gain) formula:

$$g = \frac{Posttest - Pretes}{max - prestest} \quad (2)$$

The gain criteria were, as shown in Table 2.

Table 2. Gain Score Classification Criteria

Gain Score	Category
$g \geq 0.70$	High
$0.30 \leq g < 0.70$	Moderate
$g < 0.30$	Low

This gain analysis was used to determine the improvement in students' conceptual understanding after using the learning media. To strengthen the effectiveness claim, a paired sample t-test was also conducted to examine the statistical significance of differences between pretest and posttest scores.

3. RESULT AND DISCUSSION

The learning media developed in this study adopts the VIVO (Visual Interactive Virtual Object) concept, which represents a novel approach to science learning based on WHISK AI technology. The VIVO concept was designed to address challenges in visualizing abstract science concepts by utilizing interactive and dynamic virtual objects. This media aims to provide a deeper learning experience by enabling fifth-grade elementary school students to directly interact with scientific concepts through animated visualizations that illustrate processes and phenomena in an engaging and interactive manner.

The development of this media was grounded in an analysis of learning needs and student characteristics, with the primary objective of making science content more comprehensible, engaging, and relevant to students' real-world contexts. Each learning topic was systematically organized, beginning with the presentation of learning objectives, followed by concept

explanations reinforced through examples and summaries. These concepts were visualized using animations and virtual objects that could be manipulated by students. Through the VIVO approach, the media does not merely present information but also creates an active learning experience that actively involves students in directly constructing their understanding of scientific concepts.

The WHISK AI based animated video media is equipped with visually appealing and interactive elements, incorporating colors, animations, and audio narration that align with the characteristics of elementary school students. Each concept is presented in the form of moving virtual objects that respond to students' interactions, allowing them to explore and understand science material more deeply. In addition, the media was designed to be easily used by teachers in face-to-face classroom instruction as well as a supplementary tool for independent learning, thereby offering flexibility for implementation across various learning contexts. The initial interface of the WHISK AI based animated video learning media is presented in Figure 1, while examples of material presentation and visualization of science concepts are shown in Figures 2 and Figure 3.

Figure 1. Cover Page

Figure 2. Material Presentation Flow

Figure 3. Visualization of the Human Body Organ System Concept

3.1 Availability of the Learning Media

The animated video learning media is available online through the researcher's YouTube channel, allowing it to be utilized as an easily accessible and sustainably usable learning resource.

3.2 Expert Validation Results

To determine the feasibility of the developed media, an expert validation process was conducted to assess the appropriateness of language, content/material, and contextual technological aspects of the WHISK AI based animated video learning media. The validation results served as the basis for determining the feasibility of the media prior to its implementation in elementary science learning. The validation process involved six expert validators, consisting of two language experts, two content/material experts, and two context/technology experts. The purpose of this validation was to evaluate the media's feasibility in terms of linguistic quality,

alignment of content with the curriculum, and the technical and contextual aspects of media use in elementary science learning. The assessment was conducted using Likert-scale validation sheets ranging from 1 to 5, enabling the experts to provide systematic and objective evaluations of the quality of the developed media, as shown in Table 3.

Table 3. Expert Validation Results of the WHISK AI Based Animated Video Media

Validation Aspect	Number of Validators	Mean Score	Category
Language	2	4.26	Highly Valid
Content/Material	2	4.34	Highly Valid
Context/Technology	2	4.37	Highly Valid
Overall Mean	6	4.32	Highly Valid

Based on the data presented in Table 3, it can be concluded that all validation aspects achieved mean scores within the *highly valid* category, with an overall mean score of 4.32. These results indicate that the WHISK AI based animated video learning media meets the feasibility criteria in terms of language quality, content accuracy, and technical as well as contextual aspects. Therefore, the media is suitable for use and can be further evaluated in practicality and effectiveness testing stages.

3.3 Practicality Results of the Learning Media

The practicality test of the WHISK AI based animated video learning media was conducted to obtain insights into its ease of use and perceived usefulness in supporting elementary science learning. This evaluation was essential to ensure that the developed media is not only conceptually sound but also practically applicable for teachers in daily classroom instruction. The practicality test involved six teachers, consisting of three teachers from SDN 06 KL and three teachers from SDN 13 LB, who were directly involved in teaching fifth-grade science classes. The assessed aspects included ease of operation, clarity of visual presentation, alignment of content with learning objectives, and the flexibility of the media for use in various learning conditions. The evaluation was conducted using a practicality questionnaire, allowing teachers to provide responses based on their direct experiences while using the media during instruction, as shown in Table 4.

Table 4. Practicality Test Results by Teachers

School	Number of Teachers	Mean Score	Category
SDN 06 KL	3	4.39	Highly Practical
SDN 13 LB	3	4.41	Highly Practical
Overall Mean	6	4.40	Highly Practical

Based on the data presented in Table 4, the WHISK AI based animated video learning media received highly positive responses from teachers at both schools. The media was perceived as easy to use and did not cause technical difficulties during the learning process. Its visually appealing design and systematic presentation flow were considered effective in assisting teachers in delivering science content more clearly and in a well-structured manner. Moreover, teachers reported that the media could be flexibly used either as a primary instructional tool or as supplementary material to reinforce students' understanding. The high level of practicality was also reflected in the media's ability to increase students' attention and engagement during learning activities, thereby fostering a more active and conducive learning environment. These

findings indicate that the WHISK AI based animated video learning media demonstrates a high level of practicality and is suitable for implementation in elementary science learning.

3.4 Effectiveness Results of the Learning Media

The effectiveness test of the WHISK AI based animated video learning media was conducted to examine its impact on improving students' science learning outcomes at the elementary school level. This evaluation aimed to ensure that the developed media is not only valid and practical but also capable of making a meaningful contribution to students' conceptual understanding and learning achievement. The effectiveness test involved 80 fifth-grade students, consisting of 40 students from SDN 06 KL and 40 students from SDN 13 LB. Media effectiveness was analyzed through the administration of a pretest and a posttest developed based on science competency achievement indicators. The comparison between pretest and posttest scores was used to examine changes in students' understanding after participating in learning activities using the WHISK AI–based animated video media, as shown in Table 5.

Table 5. Results of the Media Effectiveness Test (Pretest–Posttest)

School	Number of Students	Mean Pretest	Mean Posttest	Gain Score	Category
SDN 06 KL	40	61.25	82.40	0.55	Effective
SDN 13 LB	40	60.80	83.10	0.58	Effective
Overall Mean	80	61.03	82.75	0.57	Effective

Based on the data presented in Table 5, there was a clear improvement in students' learning outcomes after using the WHISK AI based animated video learning media in both schools. The mean posttest scores showed a significant increase compared to the pretest scores, indicating that the media effectively supported students in achieving a better understanding of science content. Gain score analysis revealed that the improvement in learning outcomes fell within the moderate-to-high category, suggesting that the developed media is effective in enhancing students' conceptual understanding of science. These findings demonstrate that the visualization of science content through WHISK AI based animated video media facilitates students' comprehension of abstract concepts and supports more meaningful, student-centered learning processes.

In addition to the effectiveness findings described above, several research limitations were identified during the implementation process. Despite the positive findings, this study has several limitations that should be considered when interpreting the results. First, the implementation of the WHISK AI–based animated video media was conducted only in two elementary schools with a limited number of participants, which may affect the generalizability of the findings to broader educational contexts. Second, the effectiveness test focused primarily on students' cognitive learning outcomes through pretest and posttest scores, while affective and psychomotor aspects were not comprehensively measured. Third, the duration of the implementation was relatively short, so the long-term impact of the media on students' conceptual retention and learning motivation has not yet been fully identified. Therefore, future studies are recommended to involve larger samples, longer implementation periods, and more comprehensive assessment dimensions to further validate the effectiveness of AI-based interactive learning media.

3.5 Discussion

The results of the needs analysis indicate that students continue to experience difficulties in understanding basic science concepts, particularly introductory science topics that are abstract in nature. This finding is consistent with Rubenstein et al. (2023) who emphasized that elementary education students tend to face obstacles in comprehending science concepts when learning relies solely on traditional lecture-based methods. However, the findings of this study reveal a more complex condition, as students not only encounter conceptual difficulties but also express concerns regarding the limited availability of visual learning media that align with their context and characteristics. This result strengthens the argument of Chang & Tseng (2011), who asserted that visual media play a crucial role in enhancing conceptual understanding through dual-channel verbal and visual stimulation. Therefore, the need for AI-based animated video learning media has become increasingly relevant in elementary science education.

During the design stage, the learning media was developed using WHISK AI technology, which is capable of generating animations automatically from text input. This approach represents a significant departure from the study by Junjun & Pillai (2024), which developed animations manually using Adobe Animate and required longer production time and greater resource investment. The integration of artificial intelligence in this study enabled a more efficient media development process without compromising the quality of content visualization. This finding aligns with Yeh (2016), who emphasized that learning becomes more effective when media are designed according to multimedia principles, particularly the integration of synchronized narration and visuals. Accordingly, the alignment between instructional design principles and the technology employed in this study contributed to the overall quality of the developed learning media.

The validation results provided by content experts demonstrated a very high level of validity, indicating that the media content aligns well with science concept standards and the applicable curriculum. This finding is consistent with the study by Haastrecht et al. (2024), which reported that the validity of learning media is closely related to the clarity of conceptual representation and the soundness of the instructional structure used to convey learning content. Interestingly, this study found that the use of AI-generated narration enhanced pronunciation consistency and reduced the potential for linguistic errors. This aspect differentiates the present study from previous research involving manually produced animated media. Furthermore, the high level of media expert validity supports the findings of Özcan & Kiliç (2017), who asserted that simple, clear, and informative animations are more effective than overly complex animations that may impose excessive cognitive load on learners.

The practicality of the learning media received highly positive responses, as reflected in its classification as highly practical. This finding is in line with studies by Afrilyasanti & Zen (2023); Nussli & Oh (2025), which suggest that digital-based learning media tend to be more accessible and preferred by Generation Z learners who are accustomed to using digital devices. However, this study demonstrated a relatively higher level of practicality, as the AI-based animated video media could be accessed in various formats and resolutions, making it compatible with a wide range of student devices. This result reinforces the argument of Ramdhani et al. (2025) that digital-native learners require learning media that are responsive, adaptive, and flexible in keeping pace with technological advancements.

The effectiveness of the learning media was evident in the improvement of students' learning outcomes following the use of WHISK AI based animated video media. This finding aligns with cognitive learning theory as proposed by Roozafzai & Zaeri (2025), which posits that animations

can strengthen conceptual understanding by concretely visualizing abstract material. When compared to the study by Siregar (2024), which demonstrated that conventional video media can improve learning outcomes, the present study showed more optimal improvement due to the more coherent, consistent, and systematic visualizations provided by AI-based animations. This suggests that artificial intelligence technology can offer more stable and structured learning experiences compared to manually produced media.

The improvement in students' learning outcomes can be interpreted through cognitive multimedia learning principles, where the integration of visual animation, narration, and interactive virtual objects helps reduce cognitive load while strengthening dual-channel processing. The VIVO concept enables students to construct mental representations of abstract science concepts more effectively because visual interaction supports conceptual encoding and retention. This indicates that the effectiveness of the developed media is not merely influenced by visual attractiveness but by the alignment between instructional design structure and interactive visualization features.

The gain score analysis revealed that the improvement in students' learning outcomes fell within the moderate-to-high category. This finding supports the study by Faruk et al. (2022), which reported that animation-based media contribute significantly to the retention of science concepts. However, the present study introduces a new dimension by demonstrating that AI integration enables the use of natural-sounding narration and automated graphics with greater consistency. According to Ramendra & Dewantara (2025), such combinations can enhance students' concentration while reducing cognitive load during learning. Thus, the use of AI in media development not only improves production efficiency but also provides substantial pedagogical value.

Several factors contributed to the effectiveness of the developed media. First, the use of AI-generated animation allowed consistent visualization of abstract science processes. Second, the integration of interactive virtual objects enabled active student engagement rather than passive viewing. Third, the alignment between content structure and competency indicators ensured that the learning process remained concept-oriented. These factors collectively strengthened conceptual understanding and learning motivation.

Students' responses to the use of the learning media indicated that animated videos increased learning motivation due to their engaging and non-monotonous presentation. This finding reinforces the intrinsic motivation theory proposed by Friska et al. (2022), which suggests that visually appealing learning media can enhance students' interest and engagement. In contrast to the findings of Herder & Rau (2022) who reported that instructional videos may lead to boredom when narration is not aligned with visual elements, this study demonstrates that AI-based automatic narration results in a more coherent and comprehensible instructional flow. Consequently, the use of WHISK AI offers a competitive advantage over conventional learning media.

Overall, the findings of this study demonstrate that AI-based animated video learning media meet the three primary quality criteria of educational media: validity, practicality, and effectiveness. This study not only reinforces previous research highlighting the importance of digital media in science learning but also extends the literature by demonstrating that AI integration can accelerate media development processes while simultaneously enhancing learning quality. This conclusion aligns with Oxley (2025), who argued that artificial intelligence has the potential to become a key catalyst for educational innovation in the future. Therefore, this study contributes to the scientific literature by proposing an AI-integrated model for developing

animated science learning media at the elementary school level, an area that remains relatively underexplored in previous research.

Despite the positive findings, this study has several limitations. First, the effectiveness test used a one-group pretest posttest design without a control group, which limits the comparison of learning improvements across different instructional approaches. Second, the implementation was conducted only in two elementary schools within a limited regional context, which may affect the generalizability of the findings. Third, the measurement of effectiveness focused primarily on cognitive learning outcomes, while affective and long-term retention aspects were not extensively examined. Future research is recommended to involve experimental designs and broader samples to strengthen the empirical evidence. This study contributes to the literature by proposing an AI-assisted animated media development framework integrated with the VIVO visualization concept for elementary science learning. The findings extend previous research by demonstrating that artificial intelligence can be systematically embedded into instructional media design to improve conceptual visualization and learning engagement simultaneously.

From a pedagogical perspective, the findings indicate that the integration of AI-based animated visualization and interactive virtual objects can serve as an effective instructional alternative for elementary science learning, particularly in explaining abstract concepts. Teachers are encouraged to utilize interactive multimedia that aligns with students' cognitive characteristics to enhance engagement and conceptual understanding. Furthermore, the VIVO approach provides opportunities for developing more adaptive, visual, and student-centered digital learning environments in accordance with current technology-integrated education practices.

4. CONCLUSION

Based on the research findings, the WHISK AI–based animated video learning media integrating the VIVO (Visual Interactive Virtual Object) concept are empirically proven to be valid, practical, and effective for elementary science learning. The expert validation results show a mean score of 4.32 (highly valid), the practicality test by teachers indicates a mean score of 4.40 (highly practical), and the effectiveness test demonstrates a normalized gain score of 0.57 (moderate-to-effective), confirming improvements in students' conceptual understanding after the implementation of the developed media. The main scientific contribution of this study lies in the integration of artificial intelligence generated animated visualization with the VIVO interactive virtual object approach to support the visualization of abstract science concepts in elementary education. This integration extends previous instructional media research by demonstrating that AI-assisted animation can systematically enhance conceptual visualization and student engagement. Pedagogically, the findings imply that AI-based interactive animated media can serve as an alternative instructional strategy to support student-centered and concept-oriented science learning, particularly for abstract material that requires visual representation. However, this study has several limitations, including the use of a one-group pretest posttest design without a control group and the implementation limited to two elementary schools. Future research is recommended to apply experimental designs with broader samples and to examine long-term learning retention as well as affective learning outcomes to strengthen the empirical evidence of AI-based learning media effectiveness.

Based on the findings of this study, it is recommended that teachers utilize artificial intelligence based animated video learning media as part of their instructional strategies in science education to enhance students' conceptual understanding and learning motivation. For

future researchers, it is suggested to develop similar media for broader science topics or at different educational levels, as well as to examine its impact on students' critical thinking skills, creativity, and other 21st-century competencies. Additionally, further studies may integrate more advanced interactive features or AI-based adaptive learning systems to enhance learning personalization and optimize the effectiveness of instructional media.

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