



Augmented Reality Dance Teaching Module as a Strategy to Enhance Elementary School Students' Learning Interest

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Abstract: The development of Augmented Reality technology offers new opportunities in education by providing visual, interactive, and exploratory learning experiences, particularly in dance learning that requires strong visual comprehension. This study aims to develop, implement, and evaluate the effectiveness of an AR-based dance-teaching module to increase elementary students' interest in learning. Grounded in a pragmatic paradigm, the research employed a mixed-methods approach using the Design and Development method. Participants included AR experts, dance teachers, and 20 fifth-grade students from Cendekia Leadership School Bandung. Data were collected through interviews, observations, expert validation, tests, and questionnaires, while learning interest was analyzed using the SAFARI indicators: pleasure, interest, attention, and active involvement. Statistical analysis included normality testing, paired-samples t-tests, and N-Gain calculations. Results showed the module was rated "Very Feasible" by experts with a mean score of 90.97%. Field testing indicated significant improvement in student scores from a pre-test mean of 60.15 to a post-test mean of 80.45, with a significant difference ($p < 0.001$) and a high N-Gain of 0.81. Questionnaire findings revealed students' learning interest reached a Very High level (92.19%). Therefore, the AR-based module effectively enhances learning interest through interactive, visually engaging dance instruction for elementary learners.

Keywords: augmented reality; dance teaching module; interactive learning; learning interest

Recommended citation: Firdaus, I., Budiman, A., Masunah, J., Badaruddin, S., Anizaim, A. N., & Narawati, T. (2026). Augmented Reality Dance Teaching Module as a Strategy to Enhance Elementary School Students' Learning Interest. *Journal of Innovation in Educational and Cultural Research*, 7(3), 619-633.

INTRODUCTION

Digital technology has fundamentally transformed the way humans conduct activities, including learning, communication, and interaction (Badaruddin et al., 2023; Lubis, 2024; Rusk et al., 2024). This transformation has become increasingly evident in education amid the COVID-19 pandemic (Chambers-Coe, 2023; Unda-López et al., 2022; Xu et al., 2022). Adapting digital technology to the teaching and learning process during the pandemic has significantly impacted the technical, psychological, and social dimensions of the learning experience for students and teachers (Zhou et al., 2024). Besides that, Yu (2022) found that, despite technology's flexibility, many students experienced a decline in learning motivation due to less-structured learning spaces, limited interaction, and increased individual assignments without direct guidance. This situation suggests that reliance on digital technology in learning needs to be balanced with strategies that can meaningfully revitalize students' motivation and interest in learning (Badaruddin et al., 2025; Guo & Thiagarajan, 2025; Yu & Liu, 2024). For approximately two years of online learning, students have become accustomed to a learning environment that relies heavily on digital media (Berg, 2015; Brown et al., 2024; Giomi, 2024). Consequently, after returning to in-person learning, many students have shown changes in learning behavior, including shorter attention spans, increased procrastination, and greater reliance on technology (Habibi, 2020; Goddess, 2023). These behavioral changes not only impact academic achievement but also decrease students' interest and intrinsic motivation in learning activities. At the elementary school level, this is a critical concern, as this phase is when character development and the formation of long-term learning habits occur.

A similar phenomenon occurs in elementary school dance education. Many students show low interest in dance lessons due to teaching methods that do not effectively utilize digital media (Wikantari & Suranata, 2024; Sari & Nurmiranda, 2024; Firdaus et al., 2025). This suggests that students' interest in learning can increase when the learning process is presented in a visual, interactive format that aligns with the learning styles of the digital generation. This condition underscores the need for digital technology-based learning innovations to increase students' interest in learning (Badaruddin & Firdaus, 2025; Haerani et al., 2020; Husna et al., 2025). Dance learning that still relies on conventional demonstrative methods is often considered monotonous by digital-generation students, so learning innovations are needed to provide a more engaging and contextual learning experience (Badaruddin & Firdaus, 2025). One technology increasingly used in education is Augmented

Reality (AR). AR enables the projection of three-dimensional virtual objects into real space, allowing students to observe costumes, movements, and the aesthetic elements of dance in greater detail and with greater exploration (Frasnyaigu et al., 2023; Husna et al., 2025; Kico & Liarokapis, 2020; Sanni, 2025).

Several studies have shown that AR has great potential in supporting arts learning, including dance. Kico and Liarokapis (2021) found that the use of AR in folk dance instruction can increase student engagement because students can control the viewing angle and movement speed, and observe movement patterns interactively. However, this research focuses more on the media's functionality and does not specifically measure student learning engagement. Meanwhile, Morales et al. (2023) found that the application of AR in education can generally increase student motivation, engagement, and curiosity at various levels. However, the study also highlighted that research on the use of AR in the arts, particularly in dance at the elementary school level, remains very limited.

Furthermore, research conducted by Fitri et al. (2023) demonstrated that the use of AR media in traditional Caping Ngancak dance instruction in elementary schools significantly improved student learning outcomes, with an n-gain of 75.15%. However, the study did not examine learning interest as a psychological variable that indicates the extent to which students are involved and intrinsically motivated in dance learning. Based on a review of three previous studies, it appears that the application of Augmented Reality (AR) in learning has been proven to increase student engagement, motivation, and learning outcomes in various educational contexts (Kico & Liarokapis, 2021; Morales et al., 2023; Fitri, Safiah, & Hidayat, 2023). However, all three indicate important research gaps. Research by Kico and Liarokapis (2021) emphasizes the functional aspects of the media and has not measured learning interest as a psychological variable. Morales et al. (2023) found that AR research in the arts, particularly in dance at the elementary school level, remains very limited. Fitri et al. (2023) focus on improving cognitive learning outcomes without exploring affective dimensions such as students' interests and intrinsic motivation. This condition suggests that studies on the influence of AR on students' learning interests in the context of dance education in elementary schools, especially those that integrate local cultural values, are still scarce. Therefore, this study offers novelty by developing and testing an AR-based dance teaching module that displays visualizations of movement and elements of West Javanese culture (Merak Dance), while empirically measuring its effectiveness in increasing elementary school students' learning interest.

Augmented Reality (AR) is a technology that combines virtual objects with the real environment in an interactive manner (Wu et al., 2013; Garzón & Acevedo, 2019; Garz, 2021). Augmented Reality was first introduced by Caudell and Mizell (1992) as a technology that allows users to expand their field of view through head-up displays. Furthermore, Azuma (1997) explains that AR is a technology that allows users to see the real world augmented or enriched by virtual objects superimposed on it. However, this definition has been further developed because the application of AR is not limited to sight alone but can also encompass other senses. Based on this, Akçayır and Akçayır (2016) propose a more concise and comprehensive definition: AR is a technology that directly and dynamically adds virtual objects to the real world. The rapid development of personal mobile devices since 2010 has been a key factor in accelerating the adoption and growth of AR applications in various fields, including tourism, medicine, industry, and education (Mekni & Lemieux, 2014; Alfitriani et al., 2021; Erwis et al., 2024). Several studies also show that the application of AR systems across various contexts has a positive impact on effectiveness, efficiency, and user experience (Billinghurst et al., 2015; Martin et al., 2011; Mekni & Lemieux, 2014; Yim et al., 2017). With these positive results, developers and researchers continue to innovate, making AR technology more accessible and optimally integrated into everyday life. With these characteristics, Augmented Reality serves as a learning medium that creates immersive, interactive, and meaningful learning experiences for students.

Direct interaction with virtual objects placed in the real world provides students with the opportunity to explore learning materials in a more concrete and personal way (Kico & Liarokapis, 2020; Lian & Xie, 2024; Narawati et al., 2022). The multisensory engagement offered by AR (through manipulation of 3D objects, observation of visual details, and real-time interactive responses) encourages affective responses, curiosity, increased attention, and student engagement in the learning process. These findings align with the view that enjoyable, challenging, and relevant learning experiences shape learning interest. In this regard, AR technology has great potential to support the components of learning interest described by Safari (2017), including feelings of enjoyment, interest, attention, and active engagement. These four components are affective and behavioral aspects that develop when students engage in a learning process that provides a powerful visual and exploratory experience, such as that offered by AR media. When linked to general motivational theories, such as Expectancy-Value Theory and Self-Determination Theory, students' low interest in learning dance can be attributed to their weak perceptions of the value of learning activities and the unfulfilled basic psychological needs during the learning process. Based on the Expectancy-Value Theory, individuals are motivated to learn when they believe in their own success (expectancy for success) and assess that the learning activities have high value or benefits (task value) (Eccles et al., 1993). In other words, when students do not see relevance or enjoyment in learning activities, their interest will decline.

Meanwhile, Self-Determination Theory explains that a person's intrinsic motivation grows when three

basic psychological needs are met: competence, autonomy, and relatedness (Gagné & Deci, 2005). In the modern era, many students lose their enthusiasm for learning because monotonous learning methods fail to meet their needs. They do not feel cognitively challenged (competence), lack the freedom to learn (autonomy), and do not feel connected to the teacher or the learning environment (connectedness). Digital media and technology have been proven to be able to increase interest in learning because they can attract students' attention through visual and audio displays, encourage active participation, and reduce boredom that often arises due to conventional methods (Mariyah et al., 2021; Andriani et al., 2024; Lubis, 2024; Winarti & Putro, 2024; Firdaus et al., 2025; Nurfadilah et al., 2025; Badaruddin et al., 2025). Furthermore, digital media also provides a more meaningful learning experience because students can interact directly, explore, and receive immediate feedback during the learning process, ultimately increasing their motivation and sense of engagement. The use of digital media has been shown to significantly improve students' literacy skills and learning motivation, increasing by up to 79.28% (Rusdi et al., 2025; Devi et al., 2025).

Based on initial observations at Cendekia Leadership School Bandung, students showed greater enthusiasm when dance material was presented in a digital, interactive format. This finding reinforces the results of previous studies that emphasized the importance of technology-based learning media innovation in increasing student learning engagement. This condition suggests that Augmented Reality (AR)-based dance teaching modules have the potential to be an effective strategy for fostering interest and learning engagement among elementary school students, particularly in understanding the movements and cultural values embodied in the Merak Dance, a traditional West Javanese dance art. Furthermore, this research is highly relevant to the Sustainable Development Goals (SDGs) agenda, specifically Goal 4: Quality Education, which emphasizes improving the quality of education through an inclusive, innovative, and adaptive approach to technological development (UNESCO, 2024). In this case, the development of AR-based dance teaching modules, in addition to providing more interactive, engaging, and context-rich learning experiences, also has the potential to foster students' intrinsic motivation and appreciation for local arts and culture. Furthermore, the application of AR technology in dance learning also supports Goal 9: Industry, Innovation, and Infrastructure, as it integrates digital technologies to strengthen a creativity-based educational infrastructure. Furthermore, this research also contributes to Goal 11: Sustainable Cities and Communities by preserving and introducing West Java's local wisdom through creative, relevant, and sustainable learning media.

Based on a preliminary study conducted at Cendekia Leadership School Bandung through classroom observations and informal teacher interviews, students demonstrated significantly higher levels of enthusiasm, sustained attention, and active engagement when dance materials were presented through digital and interactive media compared to conventional demonstration-based instruction. In contrast, during traditional learning sessions, several students exhibited reduced concentration, passive participation, and limited responsiveness. These empirical findings indicate a mismatch between existing instructional practices and students' learning characteristics in the digital era. Such conditions underscore the urgent need for innovative learning media that align with students' visual, interactive, and exploratory learning preferences. Therefore, the development of an Augmented Reality-based dance teaching module is proposed as a pedagogically relevant solution to enhance elementary students' interest in learning, particularly in understanding dance movements and the cultural values represented in the Merak Dance.

METHODS

This study employed a mixed-methods approach grounded in the pragmatic paradigm. The pragmatic paradigm emphasizes integrating qualitative and quantitative methods to obtain a comprehensive understanding of a research problem and to effectively address research objectives (Creswell & Plano, 2018; Tashakkori & Teddlie, 2010). In this study, quantitative data were obtained through pre-test–post-test measurements, while qualitative data were collected through observations and interviews to capture the implementation process, user responses, and the learning context. The research applied the Design and Development (D&D) model proposed by Richey and Klein (2010), which enables the systematic development and evaluation of educational products. The research consisted of three main stages: design, development, and evaluation.

The design stage involved analyzing the needs of teachers and students, identifying the characteristics of dance learning in elementary schools, and formulating learning objectives for integrating Augmented Reality (AR) into the dance teaching module. The development stage included producing 2D illustrations, transforming them into 3D models, integrating AR objects into the teaching module, and conducting expert validation to assess visual, technical, and pedagogical feasibility. The evaluation stage consisted of formative and summative evaluations. Formative evaluation was conducted through expert validation and limited trials, while summative evaluation used a one-group pre-test–post-test design to measure the effectiveness of the AR-based module in increasing students' learning interest.

This study involved several participants in the development, validation, and evaluation of the Augmented Reality (AR)-based dance teaching module. An AR expert with expertise in animation, immersive multimedia,

and visual design evaluated the media's visual quality and technical feasibility, while a dance teacher provided pedagogical feedback on the suitability of the material and its implementation. The population consisted of all fifth-grade students at Cendekia Leadership School in Bandung. The sample included 20 students selected through purposive sampling, considering their prior experience in dance learning and familiarity with Android-based devices required for AR activities. The relatively small sample reflects a limited trial stage within Design and Development (D&D) research, where early product testing is commonly conducted with a small group to assess usability and preliminary effectiveness before wider implementation (Gall et al., 2003; Richey & Klein, 2010). Students served as the primary users of the AR module and as the main data source for measuring learning interest before and after the intervention.

Data were collected through expert validation questionnaires, student learning interest questionnaires, classroom observations, tests, and short interviews with dance teachers. The learning interest questionnaire was developed based on four indicators: feelings of pleasure, interest, attention, and active involvement. Quantitative data were analyzed to determine the effectiveness of the AR-based dance teaching module in increasing students' learning interest. Likert-scale data from expert validation and student questionnaires were calculated using Arikunto's (2013) formula to obtain feasibility and learning interest percentages. Prior to hypothesis testing, a normality test was conducted to ensure that the pre-test and post-test data met the assumptions for parametric analysis. Subsequently, a paired-samples t-test in SPSS version 29 with a significance level of $p < 0.05$ was used to examine differences before and after the intervention. To further assess the magnitude of improvement, an N-Gain analysis was conducted, categorizing the results into high ($g > 0.7$), moderate ($0.3-0.7$), and low ($g < 0.3$) improvement levels.

RESULT AND DISCUSSION

Changes in student learning behavior, along with the increasing intensity of digital technology use, indicate a growing need for interactive and attention-grabbing learning media, particularly in dance education. Current learning patterns indicate that students are increasingly accustomed to visual and technology-based learning environments, making it more challenging for demonstrative or conventional learning approaches to maintain their focus, motivation, and engagement. This condition highlights the importance of learning media that align with the characteristics of the digital generation and offer a more engaging, interactive, and meaningful learning experience. This finding is reinforced by initial observations at class 5 Cendekia Leadership School, which showed that students displayed greater enthusiasm when learning materials were presented on digital devices than when delivered verbally or presented as static visuals. The results of initial observations at Cendekia Leadership School also support this finding, showing that students were more enthusiastic when materials were introduced through digital devices than through verbal delivery or static visuals.

Cendekia Leadership School (CLS) is a national school with a Leadership curriculum that implements a holistic, inclusive, and student-centered learning approach. CLS's characteristics, which emphasize the balance of cognitive, affective, and psychomotor aspects through the 4H approach (Head, Heart, Hands, and Health), require learning strategies that can facilitate active, meaningful, and contextual learning experiences. Observations in grade 5 showed that students had a greater interest in moving and interactive visual displays, especially when allowed to explore them directly. This finding suggests that students' learning interest increases when using learning media, aligning with the characteristics of the digital generation. This condition also strengthens the Expectancy-Value Theory, which states that learning motivation grows when students feel capable of following the learning (expectancy) and view learning activities as something valuable and enjoyable (task value). In this case, dance learning at CLS offers limited visualization and minimal space for active involvement, which may reduce the meaningfulness of student learning. Therefore, the Augmented Reality (AR)-based dance teaching module is designed as a relevant pedagogical solution to bridge the learning needs in CLS with the limitations of conventional media, while supporting active engagement, independent exploration, and meaningful learning experiences.

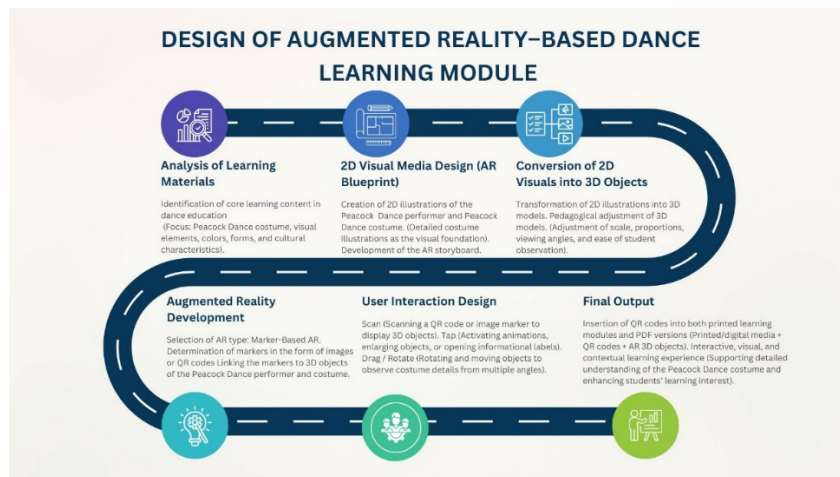


Figure 1. Design of Augmented Reality-Based Dance Learning Module

Figure 1 shows the design of an AR-based dance teaching module. The module was developed with a focus on the Merak Dance costume, incorporating its visual elements, colors, shapes, and characteristics. All materials were prepared as 2D illustrations as a basis for developing AR media. These illustrations were then used as a blueprint for creating AR objects through conversion to 3D models, with pedagogical adjustments to ensure the objects can be easily observed from various perspectives. The technology used is marker-based AR, which is activated by scanning images or QR codes within the dance teaching module. User interaction is designed through scan, tap, and drag/rotate activities, allowing students to actively and immersively explore objects. AR integration is achieved by inserting QR codes into printed and digital teaching modules, enabling flexible use and providing a visual, interactive, and contextual learning experience for understanding Merak Dance costumes. The development of an Augmented Reality (AR)-based dance teaching module resulted in a series of visual components, digital objects, and interactive features that support more immersive dance learning. The development process included 2D illustration design, conversion to a 3D model, and creation of a QR code that triggers the AR object.



Figure 2. 2D model illustration of Peacock Dancer and Costume

The development of an Augmented Reality (AR)-based dance teaching module began with the creation of a 2D model illustrating the peacock dance, including dancers, costumes, and supporting attributes. All 2D illustrations were carefully designed to ensure the suitability of the various clothing elements with the peacock dance. The 2D illustrations were validated previously during the development of the Sundanese dance teaching module by material and design experts to ensure that each component, proportion, color, and visual appropriateness met dance learning standards. Media development continued with the conversion of the visual assets into 3D. At this stage, the illustration of the Peacock dancer and all of her costume components were transformed into three-dimensional models. This conversion aimed to create digital objects that could be displayed interactively through AR, allowing students to observe the costume details from various perspectives, no longer limited to a flat, two-dimensional view.

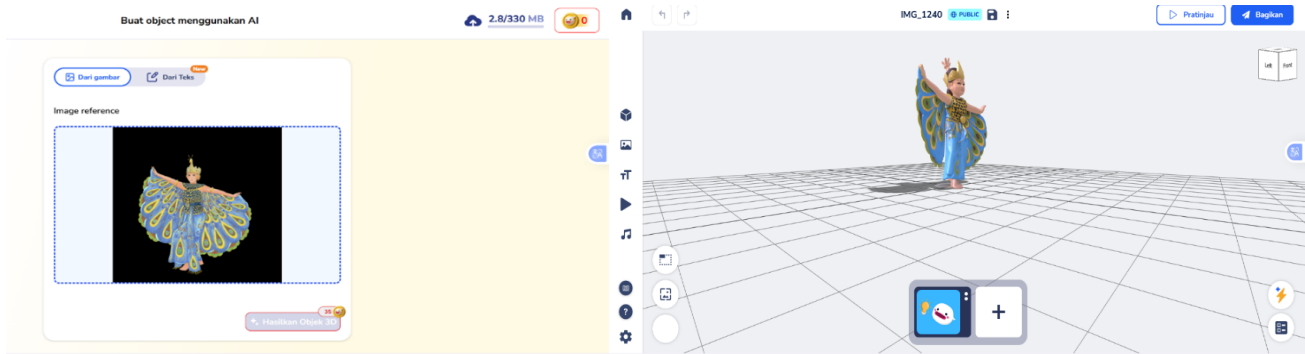


Figure 3. Convert 2D visuals into 3D models

Figure 3 shows the process of transforming a two-dimensional (2D) illustration of a Merak Dance dancer into a three-dimensional (3D) object using artificial intelligence (AI)-based technology. At this stage, the 2D illustration serves as a reference image, providing the basis for creating a 3D model and ensuring that the visual character, body proportions, clothing details, and distinctive attributes of the Merak Dance are maintained in accordance with the original representation. The conversion process enables the translation of flat visual information into a volumetric form, producing a 3D object with depth, spatial dimensions, and a more realistic visual structure. Converting the 2D illustration into a 3D model yields a complete Merak dancer model with clothing attributes, ready to be embedded in AR.

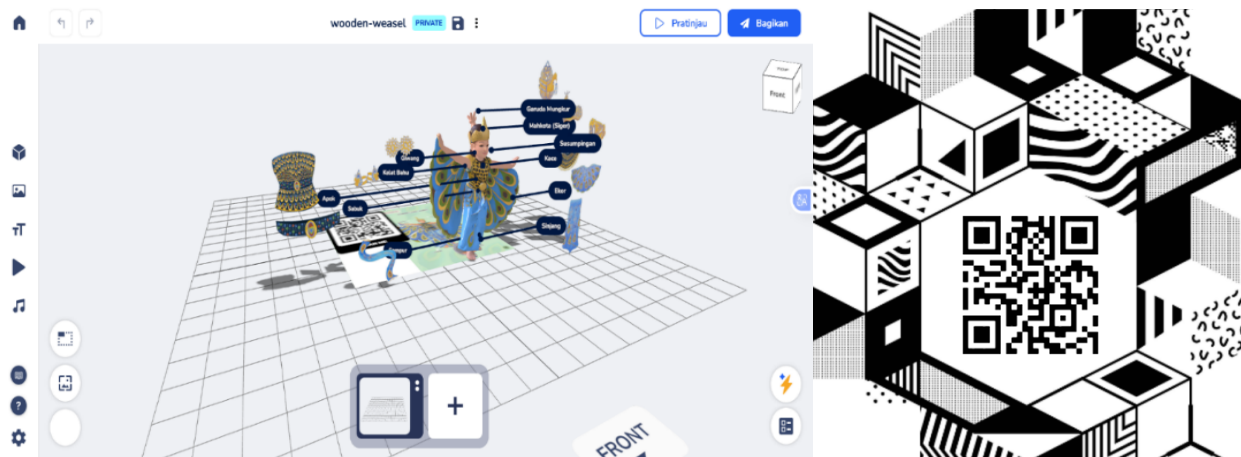


Figure 4. Arranging the Augmented Reality & QR Code as an Augmented Reality Marker to Access the 3D Model of the Peacock Dance

The resulting 3D objects were integrated into a marker-based Augmented Reality (AR) system to create a comprehensive, interactive learning experience. At this stage, all 2D illustrations previously converted to 3D models were arranged in a single digital workspace (scene) using an AR platform, creating a structured, user-friendly visual composition. The Merak dancer model was placed as the main object at the center of the virtual space, serving as the focus of student observation, while the clothing and supporting attributes were arranged proportionally around it. The AR system was activated via a QR code at the bottom of the object, which triggered the appearance of the 3D model. When the QR code was scanned with a mobile device, the Merak dancer object and its informative labels appeared in real time in the physical space, allowing students to manipulate the object via rotation, zoom, and drag. This integration made the learning process not only visual but also kinesthetic and interactive, thus strengthening the immersive, contextual learning experience and aligning with the characteristics of dance learning in elementary schools.

The module uses a QR code as a visual trigger to display objects. The QR code serves as a marker that triggers the appearance of Augmented Reality (AR) objects in the AR-based dance teaching module. When scanned, this QR code will display a 3D model of the Peacock dancer, along with the costume components and supporting attributes previously arranged. This marker is a key element in the scanning-based AR system because it ensures that digital objects appear accurately and stably in real space, based on the marker's position as recognized by the device. The QR code design is placed on a geometric visual background to ensure high readability on mobile devices. The visual pattern surrounding the QR code serves as an optical boundary, helping the camera recognize the marker more quickly and providing context that this marker is part of the AR system used in the learning module. The resulting 3D model allows students to conduct more in-depth visual exploration through the rotate, zoom, and drag features in the AR application. The introductory material for the Peacock

Dance costume, previously presented as 2D images, is transformed into a lively, engaging digital object accessible by scanning the QR code in the teaching module. The use of QR codes as markers allows students to access 3D objects independently by scanning the module pages, making the learning process more interactive, flexible, and in accordance with the characteristics of the digital generation.

The next step in developing this module was to ensure that the resulting media had visual, technical, and instructional qualities suitable for use in learning. To this end, the developed module was assessed by an expert with competencies in animation, immersive multimedia, art and design, and visual design, ensuring that the assessment reflected professional standards in AR-based media development. Based on indicators formulated from theoretical reviews and previous research, the Augmented Reality-based dance teaching module was then assessed using a media validation instrument covering eight main aspects: visual appearance, accuracy of cultural representation, ease of use, AR performance, interactivity, instructional suitability, technical feasibility, and safety and content suitability for elementary school-aged students. The assessment was conducted by an expert with backgrounds in animation, immersive multimedia, art and design, and visual design, ensuring that the evaluation results reflected professional standards for developing educational digital media. Each assessment aspect consisted of several observation items that described the quality of the AR media from a technical and pedagogical perspective. Scores were given using a 1–5 Likert scale and then converted to percentages to determine the eligibility category. The assessment results, presented by aspect, are shown in the following table to provide a comprehensive overview of the AR module's feasibility level.

Table 1. Recapitulation of Media Expert Validation Results Regarding Augmented Reality-Based Dance Teaching Modules

Assessment Indicators	Number of Observation Items	Ideal Score	Actual Score	Percentage (%)	Eligibility Category
Visual Quality	4	20	19	95	Very Worthy
Cultural & Content Accuracy	4	20	16	80	Worthy
Usability	4	20	20	100	Very Worthy
Performance & Stability	4	20	17	85	Very Worthy
Interactivity Level	4	20	19	95	Very Worthy
Instructional Alignment	4	20	19	95	Very Worthy
Technical Feasibility	4	20	16	80	Worthy
Safety & Age Appropriateness	4	20	20	100	Very Worthy
Total	32	160	146	91.25	Very Worthy

Based on the media expert evaluation, the feasibility percentage obtained from the validation results of AR media experts provides a quantitative overview of the quality of the Augmented Reality-based dance teaching module that has been developed. The 91.25% feasibility value indicates that this module meets the visual, technical, pedagogical, and instructional suitability standards set by the learning media feasibility criteria. To clarify the distribution of feasibility across each assessment aspect, the results are presented graphically. The graphical presentation aims to provide a more comprehensive visualization of the contribution of each aspect (visual appearance, accuracy of cultural representation, ease of use, AR performance, interactivity, instructional suitability, technical feasibility, and age suitability) to the total assessment.

The overall AR expert validation results indicate that the Augmented Reality-based dance teaching module falls into the "Very Feasible" category, with a total feasibility percentage of 90.97%. This indicates that the visual, technical, interactive, and instructional design of the teaching module with augmented reality integration has met the quality standards of learning media and can be implemented in dance learning in elementary schools. In terms of visual appearance, it achieved 95%, indicating that the 3D model has good visual quality, is not blurry, and is easy to observe. This assessment is based on the clarity of the 3D model, the suitability of the colors and motifs of the Merak Dance costume, the balanced proportions of objects, and the readability of the labels on the clothing components, thus strengthening the principle of the feasibility of learning media that the media must be clear, aesthetic, and informative to support effective learning (Heinich et al., 1996). Meanwhile, the accuracy aspect of cultural representation obtained a percentage of 80% with the category of Decent with observation points including the suitability of the 3D model with the original Peacock Dance illustration, the accuracy of the position and function of clothing attributes, the accuracy of cultural ornaments/motifs, as well as the correctness of anatomy and poses; the validator assessed that the model already resembled the character of the Peacock Dance although there were still minor improvements in the details of anatomy and movement positions, in line with the importance of accurate object representation in AR for cultural learning (Akçayır & Akçayır, 2017).

The usability aspect reached 100% based on the ease of scanning the QR code, the clarity of the

interface, smooth interaction (tap, rotate, drag), and navigation, as viewed. Delgado (2020) states that a simple, intuitive user experience is key to the success of AR implementation in education. In addition, the AR performance aspect (performance & stability) obtained 85% because AR objects appeared quickly and stably when scanned, with indicators of appearance speed, tracking stability, proportion of model size to real space, and minimal lag, in line with the finding that technical performance stability influences the effectiveness of AR-based learning (Kico & Liarokapis, 2020). In terms of interactivity, with 95% in the very feasible category, 360° observation capabilities, access to information labels, student engagement during interactions, and interaction support for conceptual understanding align with the finding that AR consistently increases students' interest and curiosity. Morales et al. (2023) found that AR consistently increases students' interest and curiosity.

The instructional suitability aspect is also high at 95%, because AR is considered to be aligned with the objectives of dance learning and helps explain concepts that are difficult to understand through static media, for example, the structure of the Peacock Dance costume, in accordance with the principles of instructional design that require media to facilitate exploration and in-depth understanding. In terms of technical feasibility, the AR-based dance teaching module received a score of 80%, placing it in the feasible category. Based on the findings of this study, the module was compatible with students' Android devices, could run without a strong internet connection, and showed adequate optimization of 3D file size and QR code readability at various print sizes. However, the results also indicate that improvements are still needed, particularly in optimizing 3D file size and enhancing QR code readability at smaller print scales.

These findings support previous research emphasizing that AR-based learning media should consider the limitations of user devices, including processing capacity, file size, and marker readability (Akçayır & Akçayır, 2017). Therefore, the results of this study reinforce the argument that technical optimization is an important factor in ensuring the effectiveness and accessibility of AR applications in educational settings. Finally, the safety and age-appropriateness aspects achieved 100% because the visual content was deemed safe, did not contain inappropriate elements, reinforced positive cultural values, and was comfortable for elementary school students to use, in line with the emphasis on the importance of safe, positive, and age-appropriate educational content. Wang and An (2021), which underscores the importance of safe, positive, and age-appropriate content.

Learning using Augmented Reality-based dance teaching modules was implemented on a limited basis in one elementary school in Bandung City, namely Cendekia Leadership School, by adapting the Discovery Learning model and technology-based exploration demonstration methods. The Discovery Learning model was chosen because it enables students to gain conceptual understanding through observation, investigation, and independent discovery, aligning with the interactive and exploratory characteristics of AR media. Through this model, students are guided to find information about the Merak Dance costume by observing 3D objects, identifying clothing components, and drawing conclusions from their exploration.

In addition, the demonstration method was used in the initial stage to introduce how AR technology works, including scanning QR codes, using the rotate, zoom, and drag features, and reading information labels on 3D models. Demonstrations were provided to help students understand the technical procedures before conducting independent exploration. After understanding how to use the media, the exploration method was applied to encourage students to interact directly with the 3D model. AR-based exploration provided students with opportunities to observe the details of the Merak Dance costume from various perspectives, a difficult task in static media. This approach is particularly relevant for the development of elementary school students, who tend to learn through visual experiences, manipulatives, and hands-on activities.

The use of the Discovery Learning model and the exploratory demonstration method is considered appropriate for the objectives of AR implementation in dance learning, as both support increased learning engagement, encourage curiosity, strengthen understanding through sensorimotor experiences, and provide students with space to construct knowledge through interaction with technology. The following procedures are carried out during the implementation stage of AR-based teaching module products:

- a) In the first meeting, the teacher began by opening the lesson with an apperception activity about the Peacock Dance, explaining the objectives and flow of AR-based learning, and administering a pre-test to measure students' initial interest and understanding. The teacher also introduced the structure of the AR-based teaching modules and demonstrated how to access AR features. During this session, students responded to apperception questions, completed the pre-test, observed the explanation and demonstration, and shared their initial impressions of AR use. The objective of this meeting was to identify students' baseline knowledge and introduce the concept of AR-supported learning.
- b) The second meeting focused on demonstrating the Peacock Dance costume through AR visualization. The teacher reviewed prior material, demonstrated QR code scanning using the AR application, and explained each costume component (such as the siger, kelat bahu, sinjang, selendang, and tail) along with their functions and symbolic meanings. Students observed the 3D costume model, paid attention to the explanations, and reflected on which costume part impressed them most. This stage aimed to provide a foundational understanding of costume structure and meaning through visual interaction.
- c) In the third meeting, students engaged in independent AR exploration. The teacher reviewed AR usage

procedures, organized students into small groups, and facilitated exploration activities such as rotating, zooming, and dragging the 3D model while providing technical guidance. Students independently scanned QR codes, explored the models from various angles, discussed observations, recorded results in worksheets, and presented their findings. This session aimed to increase active participation, independent inquiry, and deeper comprehension.

- d) The fourth meeting served as the evaluation and reflection stage. The teacher administered a post-test, re-displayed AR models for reinforcement, facilitated reflection, and distributed learning interest questionnaires. Students completed the post-test, shared their learning experiences, and filled out questionnaires measuring enjoyment, interest, attention, and active involvement. This final stage aimed to assess improvements in students' understanding and learning interest, and to evaluate the effectiveness of the AR-based teaching modules.

To test the effectiveness of the Augmented dance learning module, a series of quantitative analyses was conducted, including pre-test and post-test measurements, a recapitulation of learning interest scores based on indicators (pleasure, interest, attention, and active involvement), and statistical tests, including normality tests, Paired Sample t-Tests, and N-Gain tests. This analysis aims to provide a comprehensive overview of changes in students' learning interests after participating in AR-based learning, ensuring that the improvements are not only descriptively visible but also statistically significant.

Table 2. Student Pre-test & Post-test Total Score Results

No	Pre-test			Post-test		
	Interval	Frequency	Percentage (%)	Interval	Frequency	Percentage (%)
1.	53–55	3	15	76–78	5	25
2.	56–58	4	20	79–81	6	30
3.	59–61	5	25	82–84	5	25
4.	62–64	4	20	85–88	4	20
5.	65–68	4	20			
Total		20	100	Total	20	100

The distribution of pre-test scores in Table 2 indicates that students' initial abilities were relatively even, with a moderate level of performance. The majority of students were concentrated in the 56–64 range, with the highest frequency in the 59–61 range (25%). A small proportion of students fell into the low (53–55) and high (65–68) ranges. This distribution pattern forms a nearly normal curve, indicating that students' initial abilities were homogeneous before the intervention. Thus, Augmented Reality-based learning can be implemented effectively without being hindered by significant differences in students' initial abilities.

In contrast to the pre-test scores, the post-test results showed a shift in student learning outcomes to a higher category after the implementation of the Augmented Reality-based dance teaching module. All students achieved scores above the Minimum Competency (KKM) of 75, with the largest concentration of scores in the 79–84 range, reflecting a uniform and significant improvement in learning outcomes. Some students even achieved high scores in the 85–88 range, indicating optimal engagement and readiness to learn. The post-test distribution pattern, which formed a relatively normal curve and was centered in the middle to upper categories, confirmed that AR-based learning was effective in improving student learning outcomes and interest through visual, interactive, and contextual learning experiences.

The average pre-test score of 60.15 indicates that students' initial interest and understanding are in the moderate category, with relatively homogeneous but suboptimal learning readiness. This condition indicates the need for learning interventions that can strengthen students' interest and understanding of the Merak Dance costume material. After implementing the Augmented Reality-based learning module, the average post-test score increased significantly to 80.45, a 20.30-point increase, with all students exceeding the Minimum Completion Criteria of 75. The distribution of scores was concentrated in the middle to upper categories. This increase reflects a shift in student performance from the moderate to the high category, not only quantitatively but also indicating an improvement in the quality of learning engagement. 3D object visualization and AR interactivity play a significant role in fostering a more concrete, exploratory learning experience, thereby strengthening students' attention, curiosity, and active participation. Given the significant difference in the means between the pre-test and post-test, further statistical analysis is necessary to ensure the increase has a strong inferential basis. Therefore, a normality test was conducted to verify whether the data met the assumption of normality, and a paired-samples t-test was used to assess the statistical significance of the difference in scores. These two tests serve as the basis for objectively and comprehensively determining the effectiveness of Augmented Reality-based dance teaching modules.

A normality test was performed as a prerequisite for using parametric tests, with the Shapiro–Wilk test chosen for its high sensitivity to distributional deviations, given the relatively small sample size ($n = 20$). The

test results showed that the pre-test (0.740) and post-test (0.298) significance values were above the 0.05 threshold, indicating that both data sets were normally distributed, as presented in Table 4. This finding was reinforced by the Kolmogorov-Smirnov test results, which also showed that the data distribution did not deviate from normality. With these assumptions met, the analysis continued using a paired-samples t-test to assess, inferentially, the significance of differences in pre-test and post-test scores, thereby evaluating the effectiveness of the Augmented Reality-based learning module statistically and objectively.

Table 3. SPSS v.29 Output Normality Test and t-Test

Tests of Normality									
Kolmogorov-Smirnov^a					Shapiro-Wilk				
	Statistic	df	Sig.		Statistic	df	Sig.		
Pre-test	.085	20	.200*		.969	20	.740		
Post-test	.113	20	.200*		.945	20	.298		
*. This is a lower bound of the true significance									
a. Lilliefors Significance Correction									
P Paired Samples Test									
Paired Differences							Significance		
95% Confidence Interval									
	Mean	Std. Deviation	Std. Error Mean	of the Difference		t	df	One-Sided p	Two-Sided p
Pair 1 Pre-test - Post-test	-20.300	1.922	.430	Lower	Upper	-47.230	19	<.001	<.001

The results of the normality test indicated that the pre-test and post-test data were normally distributed, as all p-values were greater than 0.05. Therefore, the data met the assumptions required for parametric testing. The paired-samples t-test showed a significant difference in students' learning interest scores before and after the implementation of the Augmented Reality-based dance teaching module ($p < 0.001$). The negative mean difference indicates that post-test scores were higher than pre-test scores, demonstrating an increase in students' learning interest after using the AR-based module. These findings suggest that integrating Augmented Reality into dance learning increased students' engagement and interest during the learning process. To further examine the magnitude of this improvement, an N-Gain analysis was conducted to measure learning effectiveness as the relative increase from pre-test to post-test scores.

Table 4. SPSS v.29 N-Gain Score Output

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Ngain_Score	20	.51	1.00	.8112	.14741
Ngain_Persen	20	51.35	100.00	81.1163	14.74063
Valid N (listwise)	20				

The N-Gain analysis yielded an average score of 0.81, placing it in the great improvement category ($g > 0.7$). This result indicates that implementing the Augmented Reality-based dance teaching module produced a substantial increase in students' learning interest. The findings suggest that AR-based learning effectively enhances students' engagement through interactive 3D visualization and exploratory learning experiences. However, while the quantitative results demonstrate a significant improvement in learning interest, they do not fully capture students' emotional responses and learning experiences during the implementation. Therefore, additional qualitative analysis is required to provide a more comprehensive understanding of the AR-based learning process. To obtain a more comprehensive picture, additional measurements were conducted using a learning interest questionnaire at the final learning session. This questionnaire was developed using the SAFARI indicators, which comprise four main aspects: enjoyment, student interest, attention during the learning process, and active student engagement. Each indicator was measured using several statements that reflected how students perceived, experienced, and responded to the use of AR technology in dance learning.

Table 5. Recapitulation of Student Learning Interests After Using Augmented Reality-Based Teaching Modules

Indicator	Number of Observation Items	Ideal Score	Actual Score	Percentage (%)	Learning Interest Category
Happy Feeling	4	16	15	93.75	Very high
Student Interest	4	16	14	87.50	Very high
Attention in the Learning Process	4	16	14	87.50	Very high
Active Student Involvement	4	16	16	100	Very high
Total	16	64	59	92.19	Very high

The questionnaire recapitulation results in Table 5 show that all learning interest indicators are in the Very High category, with a total percentage of 92.19%. The feeling of pleasure aspect received the strongest response, which was reflected in the students' enthusiasm when interacting with the 3D visualization of the Peacock Dance costume, indicating that the AR-based learning experience was able to trigger a positive emotional response and increase the learning appeal (Akçayır & Akçayır, 2017; Morales et al., 2023). The interest and attention indicators also showed very high scores (87.50%), confirming that AR effectively attracted interest and maintained student focus through concrete and visual learning experiences. Meanwhile, active engagement reached a maximum percentage of 100%, indicating that AR's interactive features encouraged students to engage in independent exploration, discussion, and active participation during learning, in line with the finding that immersive media plays a significant role in increasing engagement. Study (Ibáñez et al., 2020; Avila-Garzon et al., 2021).

The increase in students' learning interest after using the Augmented Reality (AR)-based dance teaching module is clearly evident in the quantitative results presented in Table 3, which show a significant difference between pre-test and post-test scores. The average score increased from 60.15 in the pre-test to 80.45 in the post-test, indicating a substantial improvement in students' learning interest after the implementation of AR-based learning. This improvement is also supported by the paired sample t-test results in Table 3, which show a statistically significant difference between the two measurements ($p < 0.001$). Furthermore, the N-Gain analysis indicates a value in the high effectiveness category, confirming that the AR-based learning module significantly increased students' learning interest. These quantitative findings are supported by the learning interest questionnaire, which showed very high scores across the four indicators of the SAFARI model: feelings of pleasure, interest, attention, and active involvement. The high scores on these indicators indicate that AR-based learning not only improved students' cognitive engagement but also influenced the affective dimensions that underlie learning interest.

From the perspective of Expectancy Value Theory (Eccles et al., 1993), the increase shown in the pre-test–post-test results can be interpreted through two main components: expectancy for success and task value. The AR media allows students to observe dance objects clearly and in detail through interactive 3D visualization, which may increase their confidence in understanding the material. This improved perception of competence can strengthen students' expectations of success. In addition, the visual attractiveness of the 3D Peacock Dance costume models increases the perceived value of the learning task, making the activity more meaningful and engaging for students. A similar interpretation can be explained using Self-Determination Theory (Gagné & Deci, 2005). The improvement reflected in the statistical results and questionnaire scores suggests that the learning process supported the fulfillment of students' basic psychological needs, namely competence, autonomy, and relatedness. Competence emerged when students understood the details of the Merak Dance costume through direct interaction with the 3D model. Autonomy was supported through the exploration process, where students independently used the rotate, zoom, and drag features of the AR media. Meanwhile, relatedness developed through discussions with peers and interactions with the teacher during the exploration activities.

These interpretations are consistent with the high scores on the SAFARI indicators, in which students reported feeling happy and enthusiastic when observing the 3D objects, showed strong interest in exploring the costume details, maintained attention during the AR exploration, and actively interacted with the learning media. The interaction between these elements demonstrates that the increase in learning interest shown in the statistical results is closely related to the visual interactivity and exploratory learning experience provided by AR. Overall, the findings presented in Table 3 and the N-Gain analysis indicate that the AR-based dance teaching module effectively enhances students' learning interest through a combination of visual engagement, interactive exploration, and motivational support. These results are consistent with previous studies indicating that AR technology can enhance student motivation, attention, and engagement in learning environments (Akçayır & Akçayır, 2017; Morales et al., 2023). Thus, the AR-based dance teaching module has been proven to significantly increase students' learning interest through a combination of visual, affective, and motivational approaches that align with the characteristics of digital-generation learners.

The findings of this study provide important implications for the development of dance instruction in elementary schools. The use of Augmented Reality (AR)-based learning modules has been shown to increase

student interest in learning through visual, interactive, and exploratory learning experiences. This aligns with previous research findings that suggest AR can increase student motivation, engagement, and interest in learning by providing a more concrete and immersive learning experience than conventional media (Akçayır & Akçayır, 2017; Morales et al., 2023). The integration of immersive technology into arts learning can facilitate the visual presentation of material, providing students with space to build understanding through direct interaction with digital objects, especially for material that is difficult to visualize, such as the structure of clothing and the aesthetic elements of dance. In a pedagogical context, AR can be utilized by teachers as a medium that enriches conventional demonstrations and supports student-centered learning.

The successful implementation of AR in this study underscores the need to transform learning approaches that are more adaptive to the characteristics of the digital generation, which tends to be responsive to visual stimuli, multisensory experiences, and exploratory activities (Garzón et al., 2020). Thus, AR has the potential to be an effective strategy not only for increasing learning interest but also for strengthening cultural appreciation and building more meaningful, contextual learning experiences. However, implementing AR also requires digital infrastructure readiness and teacher competence in operating the technology. Previous research confirms that the success of AR in education is significantly influenced by ease of use, device readiness, and educators' ability to integrate technology into pedagogical learning rather than merely technical use (Delgado, 2020). Therefore, educational institutions need to consider teacher training, provide adequate devices, and integrate AR into the curriculum to ensure its sustainable use and optimal impact.

Although this study yields positive results, several limitations should be considered. The limited number of participants in the study, conducted at a single elementary school, limits the generalizability of the findings. Furthermore, the relatively short learning duration does not allow for evaluation of the long-term impact of AR use on students' learning interests. From a technological perspective, AR performance is heavily influenced by device quality, system stability, and the complexity of interactive features, as noted in research on the technical limitations of AR implementation in educational settings (Akçayır & Akçayır, 2017; Kico & Liarokapis, 2020). Given these limitations, further research is recommended to involve a wider range of participants with diverse school backgrounds and infrastructure, and to employ a more robust experimental design, such as a quasi-experimental design with a control group, to enable a more objective comparison of AR's effectiveness. Furthermore, the future development of AR modules should expand interactivity features, such as dance movement simulations and choreography animations, to enrich the learning experience and strengthen the link between cognitive, affective, and psychomotor aspects in dance learning.

CONCLUSION

The integration of Augmented Reality (AR) in a dance teaching module has proven to be a pedagogical intervention that increases elementary school students' interest in learning through a more immersive, visual, and participatory learning experience. The module's 90.97% feasibility, based on expert validation, confirms that its technical, visual, cultural representation, and instructional suitability meet the standards for effective learning media. The increase in learning interest scores from pre-test to post-test, from an average of 60.15 to 80.45, supported by statistical significance in the paired t-test ($p < 0.001$) and a high N-Gain value (0.81), confirms the strong and consistent development of learning interest after the use of AR. In addition, the results of the SAFARI model-based questionnaire showed that all indicators of feelings of pleasure, interest, attention, and active involvement were in the Very High category, indicating that AR can meet students' affective and cognitive needs while making dance learning more engaging and relevant to the characteristics of the digital generation. Critically, these findings confirm that AR does not merely add visual elements to learning but also serves as a medium that strengthens intrinsic motivation, increases focus, and encourages independent exploration through interactions with 3D objects rooted in local culture. Thus, the AR-based dance teaching module deserves to be declared effective as an innovative learning strategy in the context of dance education in elementary schools and has broad potential for application to other cultural materials that require a visual and exploratory approach.

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