

## Educational Game Design for Introduction to Traditional Indonesian Houses Based on *Leap Motion* for Elementary School Students

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### Abstract

*Design of a Leap Motion-Based Educational Game on the Introduction of Indonesian Traditional Houses for Elementary School Students. This research aims to design a Leap Motion-based educational game as an innovative learning media in introducing Indonesian traditional houses to elementary school students. The background is based on the limited interactive learning media used in cultural education, especially on the material of traditional houses which have been taught with conventional approaches. Using Research and Development (R&D) approach with the ADDIE development model, the research focused on the needs analysis stage through interviews and distributing questionnaires to education experts, elementary school teachers, and students. The results of the analysis showed that learning about traditional houses is still static and uninteresting, so it is unable to build a contextualized learning experience. Both teachers and students showed high enthusiasm for the use of gesture-based media that allows visual and kinesthetic interaction. Leap Motion is considered to have high potential in realizing embodied learning that can increase student engagement and understanding. Experts recommended 3D visualization features, gesture-based navigation and cultural narrative in the game. These findings provide a conceptual and empirical foundation for the development of the ArchiLeap: Jelajah Rumah Adat Nusantara that bridges the richness of local culture with an adaptive, fun, and contextualized digital technology approach.*

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## 1. INTRODUCTION

Indonesia's cultural diversity is a very valuable heritage and reflects the nation's identity. This heritage includes various aspects such as art, music, traditional clothing, and traditional architecture that differ in each region. However, the development of globalization and modernization has caused a shift in cultural values, especially among the younger generation. Increasingly, children are less familiar with and understand their regional culture, including traditional houses which are one of the real representations of Indonesia's cultural richness [1]. Therefore, it is very important for every individual to foster a love of the homeland from an early age in order to maintain and preserve this cultural heritage. Character education in accordance with Law No. 22 of 2003 concerning Character Education is very important to be provided from when children are in elementary school [2].

Culture-based learning often relies on lectures and texts, which do not provide interactive experiences for students [3]. Traditional teaching methods with an expository approach must be reduced. Teachers who only transmit knowledge barely stimulate students to actively learn. This does not mean that a particular lecture method is not good or that students do not follow the learning process well. Variations in the learning process encourage students to be more active learners [4]. The current cultural learning system is still limited to conventional media such as textbooks. These conventional media are only able to present information descriptively and two-dimensionally, making them less interactive and engaging for students. This limitation leads to low student interest and understanding of Indonesia's cultural diversity. In fact, understanding local culture such as traditional houses is not only important for preserving cultural heritage, but also for building national identity and increasing appreciation for diversity.

Traditional houses are an important aspect because they reflect the values, philosophy, and social structure of a region. As part of the cultural heritage that plays a role in building national identity, traditional houses must be introduced to students from an early age through effective and engaging methods [5]. The diversity of traditional houses in Indonesia demonstrates the cultural pluralism of each island stretching from Sabang to Merauke. Traditional houses are not just buildings, but rather institutions created for the complexity of life's goals. Traditional houses express the spirit and soul contained within the community. The expression of the spirit and soul of the community causes the form and organization of traditional houses to be influenced by the culture that underlies them [6]. Therefore, learning media are needed that can provide a more in-depth learning experience and motivate students to learn more about their own culture.

In today's digital age, technology offers a variety of opportunities in education, including introducing local culture to elementary school students. One approach that can be used is through educational games based on motion *gesture*. Educational games allow students to not only obtain information but also interact directly with learning materials so that they can increase their involvement in the learning process [7]. Technology *Leap Motion*, which uses hand gesture sensors, can create a more immersive and interactive learning experience compared to traditional learning methods [8]. With this approach, students can learn about traditional houses through simulation and exploration in an engaging digital environment. Using gesture-based media with instructional materials can enrich students' knowledge representation, help them acquire abstract concepts, and improve learning performance and motor skills [7], [9]

According to Adrian & Apriyanti [10] and Arpiansah et al. [11] games are a type of play activity that acts as if it were in a real context and is carried out in accordance with existing regulations. This technological sophistication has a very practical function during learning activities to foster love for the homeland. Games that have educational content are better known as educational games. Educational games are digital games that can provide opportunities to play through a simulated environment and can be an integral part of learning and intellectual development [12], [13].

Learning about traditional houses is also a strategy for cultivating cultural literacy to strengthen personal and group identity and values that contribute to cultural diversity. Literacy is an important basic skill for students, parents, and society in general, needed in the 21st century. Cultural learning also stimulates children's creativity. The most effective way to develop creativity is through education. This is because education is an important means to produce quality human resources. Literacy in the world of education seems to be obscured. The lack of cultural literacy in schools is only based on results, not a process. Research [14] proves that literacy can be an alternative solution to improve children's

cognitive intelligence, both through writing, reading simple words, and solving problems related to memory and thinking activities.

Technology-based educational game development of *motion gestures* for elementary school students, this research is an innovation that can support learning about Indonesian culture, particularly regarding traditional houses. Previous studies have only shown technology *augmented reality* (AR) used in introducing culture. For example, research on AR applications of *marker less* for education on traditional Indonesian houses showed high compatibility with modern devices and received positive feedback from users [15]. Research conducted [16] discussed the limited learning media needed to introduce traditional houses to students and also the minimal use of technology such as smartphones is not yet optimal so an application was created *Augmented Reality Traditional Sumatran House* with the method of *Multimedia Life Cycle* [17]. In addition, AR-based applications to introduce traditional Indonesian clothing have succeeded in providing an interactive experience, although they are still limited to the use of markers as media [18]. Other studies have also developed AR applications for traditional Balinese architecture and the Tongkonan Toraja traditional house, each of which has succeeded in improving user experience and cultural knowledge [19], [20]. There is a lack of exploration of interactive technologies to increase student engagement in learning culture through innovative methods, especially related to educational game-based technology of *motion gesture*.

Theoretically, this research bases its approach on the theory of *Constructivism* by Jean Piaget who stated that the most effective learning occurs when students actively construct their own knowledge through direct experience and interaction with the environment [21]. By using *motion gestures*, this game also allows students to learn through physical and cognitive activities that align with theory *Embodied Learning* [22] which shows that learning involves physical engagement to support conceptual understanding. This educational game is designed to provide an interactive and reflective learning experience so that students can understand cultural concepts through active exploration.

Positive innovation in the field of education is the use of games as a teaching method. Various models and types of game are used as a learning medium, all with the aim of increasing student motivation, understanding, and learning outcomes [23]. This is reinforced by [24], educational games are one of the innovative learning media solutions available. Educational games can be created as an interesting, fun learning medium, have a storyline, and are expected to improve students' mathematical understanding abilities.

This research aims to design an educational game based on *Leap Motion* as a learning medium that can enhance students' understanding of traditional houses in Indonesia. Furthermore, this research also explores aspects of the need to increase student motivation in learning culture through more interactive and enjoyable experiences. With the development of this educational game, it is hoped that students will be more active in cultural learning, thereby increasing their appreciation and understanding of Indonesia's cultural diversity and strengthening their national identity.

## 2. RESEARCH METHOD

Approach *Research and Development* (R&D) was used in the development of this educational game. According to Sugiyono [25], research and development is a research method that aims to produce a product and evaluate its effectiveness. In this development process, the ADDIE learning design model was used, which is a systematic approach in developing learning media. Romiszowski [26] stated that a systematic approach in learning design has been widely applied in the development of computer-based, audiovisual, and text-based materials to increase the effectiveness of the learning process.

The steps in developing this interactive media refer to the ADDIE model, which consists of five main stages: (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation. This model was chosen because of its systematic and theory-based approach to learning design. These stages are summarized into three main components: planning, development, and evaluation, to facilitate implementation in this educational game.

The research is designed to last two years. In the first year (2025), the main focus will be the planning and development phase, while evaluation will be conducted the following year. The planning phase includes two main processes: needs analysis and design. The focus of this research is on the needs analysis phase. The needs analysis was conducted to identify problems and needs in the development of interactive learning media. This process included interviews with teachers and experts to understand students' needs in learning about traditional houses. The analysis also included identifying learning materials, instructional objectives, and the characteristics of elementary school students as the primary users of this media.

Data collection was conducted through questionnaires and interviews with teachers and experts in early childhood education and educational technology. Data obtained from the needs analysis will be used in further planning stages. Furthermore, a literature review was conducted to identify relevant theories for developing this educational game. This review assisted in designing the appropriate development stages to ensure the resulting media meets the educational needs of early childhood education.

### 3. RESEARCH RESULTS AND DISCUSSION (12 Pt)

The main findings in this study focus on the analysis of needs in the development of educational games "*Archi Leap: "Exploring Traditional Houses of the Archipelago"* based on *Leap Motion*. The process of analyzing educational game development needs involved three main groups: education and learning technology experts, elementary school teachers, and students as users. The analysis was conducted using a multidisciplinary approach of *Grounded theory*. This involves a coding stage. This stage is the initial part of the ADDIE model-based media development planning process, which aims to design interactive cultural learning media that aligns with the characteristics of elementary school students.

#### 3.1. Expert Needs Analysis

A needs analysis from experts was conducted to explore conceptual and pedagogical perspectives related to learning about local culture, particularly traditional houses, at the elementary school level. A questionnaire was completed by 17 experts, and interviews were conducted with seven of those who completed the questionnaire. The experts involved came from the fields of elementary education, learning technology, and culture. This process was conducted to formulate key problems and innovative solutions that could be integrated into the development of interactive learning media. An interview approach and an open-ended questionnaire were used to extract key ideas in the development of a game-based educational game. *leap Motion*.

#### *Learning Conditions*

In the current learning environment, most experts agree that teaching about traditional houses in elementary schools remains conventional and is not supported by adequate learning media. Learning is generally delivered through verbal presentations and static visuals such as pictures in textbooks or posters. This results in the learning process being less contextual and engaging enough for students at the concrete operational stage of development.

*"Learning is carried out using visual methods by showing pictures or videos to children, or by giving children assignments to browse the internet about traditional houses in Indonesia."(Interview Member 15)*

As explained by Hsiao and Chen [7], learning approaches that do not involve interactive elements and direct experiences will tend to fail to reach the cognitive and affective needs of early childhood students. At this age, children learn better through visual exploration and motor activities that are connected to the concepts being learned. Similar research by [27] also found that elementary school students were more actively engaged and showed better understanding when they were given multisensory and interactive media, compared to only using static or expository media.

### ***Cultural Challenges and Learning***

Although local cultural content is included in the elementary school curriculum, its implementation still faces various obstacles. Experts in this study identified three main obstacles contributing to the ineffectiveness of traditional house instruction. These challenges were examined based on media and the use of learning technology.

One of the most glaring challenges is the limited availability of interactive visual media. Traditional house learning is generally delivered through static, two-dimensional images, whether through textbooks, posters, or projectors. These types of media prevent students from exploring the architectural forms of traditional houses more fully, including the roof shape, interior spaces, and cultural ornamentation. As a result, students struggle to construct a complete mental representation of the traditional houses they are studying.

According to Mayer [28], conceptual understanding will increase when information is presented multimodally, namely through text, images, animation, and interaction. Learning media that only present information in a passive visual manner tends to hinder the process of constructing meaning, especially for elementary school-aged students who have visual and kinesthetic learning characteristics. This finding is in line with a study by Hsiao & Chen [7] which shows that early childhood children need media that they can actively explore to understand abstract concepts.

Limited infrastructure and supporting devices are also a significant issue identified by experts. Teachers in many schools, especially in rural areas, do not yet have access to technology-based visual aids such as devices of *augmented reality*, 3D simulations, or digital platforms based on local culture. This causes the cultural learning process to be purely informative without providing space for students to experience, observe, and explore. Research [29] confirms that technology-based learning media based on culture can significantly increase student engagement and understanding of cultural heritage. However, limited availability of devices and training in their use makes technology integration less than optimal in the context of elementary schools in Indonesia.

Another obstacle is the lack of integration of information and communication technology (ICT) into the learning process. This is not only related to the lack of devices, but also to the low digital literacy of teachers and the lack of technology-based pedagogical training. Teachers are not yet accustomed to designing interactive learning that utilizes digital devices, and many of them still position technology as a secondary tool, not an integral part of the teaching strategy [30]. Another study [31] stated that the biggest obstacles to ICT adoption in elementary schools are teachers' unpreparedness in terms of technical knowledge, limited time to learn new technologies, and the absence of systemic support from educational institutions. In addition, the tendency to return to the lecture method remains strong because it is considered faster and more familiar, even though it is less effective in achieving meaningful learning.

These findings reinforce the urgency of developing learning media that is not only based on advanced technology but also designed with consideration for the limited capacity of users (teachers) and the availability of facilities in schools. In this context of *Leap Motion* is seen as a solution that has the potential to bridge the need for interactivity and ease of use in one body movement-based learning system.

### ***Leap Motion's Potential as an Innovative Technology***

Potential of *Leap Motion* lies in its ability to strengthen the approach of *embodied learning*, namely a learning approach that emphasizes physical involvement as part of the cognitive process. According to Wilson [22], *embodied cognition* is a concept that states that the mind works not only abstractly in the brain, but is also greatly influenced by body movement and sensory-motor interactions with the environment. In other words, learning is more effective when students not only listen or see but also physically "feel" the concepts through relevant activities.

In the context of traditional houses, students can "enter" the cultural environment without having to physically be there, making the learning experience immersive and meaningful. The following statement from an expert in the questionnaire confirms these findings:

*"This motion gesture technology is interesting and can provide a contextual and engaging learning experience for children."*(Expert Questionnaire 16)

This statement shows that *Leap Motion* is seen as a learning medium that has high potential in answering the stagnation of conventional learning methods, especially on local cultural topics such as traditional houses which have been difficult to visualize directly.

Several other studies also provide support for the use of technology of *gesture-based learning*. Chen et al. [32] found that technology based on *gestures* can strengthen students' cognitive abilities and attention during the learning process, especially for spatial and visual materials. In the case of traditional houses, which require an understanding of the building form, spatial structure, and social function of traditional architecture *Leap Motion* offers new ways for students to learn through interactive experiences.

Moreover, this technology is considered a relevant alternative in 21st century education because it integrates the principles of technological *pedagogical content knowledge* (TPACK). *Leap Motion* able to support cultural learning content, while introducing new technological skills and pedagogical approaches in one system. As a relatively inexpensive, flexible, and easy-to-use technology of *Leap Motion* is suitable for application in elementary school contexts, especially if designed with a child-friendly interface.

### ***Recommended Media Development Features***

Experts provide a number of recommendations for features that are considered important to be integrated in the development of traditional house-based learning media of *Leap Motion*. These features are designed to enhance learning effectiveness by integrating visual, kinesthetic, and cultural aspects. One of the key suggested features is a three-dimensional (3D) visualization of traditional houses, which allows students to observe the building's structure in its entirety, both from the exterior and interior. This visualization is expected to help students form a complete and concrete spatial representation of the various types of traditional houses in Indonesia.

Additionally, experts emphasize the importance of gesture-based navigation, such as pointing, rotating, or zooming in on specific parts of a traditional house. These

features are designed to suit the user's abilities of *Leap Motion* in detecting *gesture* users, providing an interactive and intuitive learning experience for elementary school students. This interactivity not only enhances student engagement in the learning process but also supports the strengthening of understanding through hands-on exploration.

To strengthen the educational aspect, it is recommended to include contextual and historical narratives explaining the philosophy, cultural values, and social function of each traditional house. This way, students will not only learn about traditional houses as architectural forms but also understand the local values they embody. Experts also recommend integrating cultural locality, including explanations of the origins of traditional houses, their structural uniqueness, and their relationship to the social system and local customs.

The recommended features are in line with the principles/constructivist *learning environments* which emphasizes the importance of personalized learning experiences, independent exploration, and active participation in the knowledge construction process [33]. Within this framework, learning media not only functions as a tool for transferring information, but also as a vehicle for constructing meaning individually and socially. Therefore, media developed with input from these experts is expected to be able to become a link between traditional cultural heritage and a digital learning approach that is adaptive to the needs of the current generation of learners.

### 3.2. Elementary School Teacher Needs Analysis

The results of a questionnaire involving elementary school teachers indicated that they generally had experience teaching traditional houses in social studies. All teachers stated they had presented the material to students. However, the methods used were still dominated by conventional approaches. Seventy-three percent of teachers reported using lectures, either exclusively or in combination with images and videos. This reflects that, despite efforts to introduce local culture, teaching strategies remain limited to one-way communication and two-dimensional visual media.

In terms of student acceptance of the material on traditional houses, all Teachers assessed that students were actually interested in learning about traditional houses. However, the challenges faced by teachers in the teaching process were quite significant. As many as 80% of teachers stated that students often had difficulty connecting traditional houses to their life contexts, and the learning media used were not yet able to convey the diversity of Indonesian culture in an immersive and in-depth manner. This finding is in line with the study by Hsiao and Chen [7] who stated that learning will be more effective if it involves physical activity and active exploration, especially for elementary school-aged students.

When asked about the use of digital media, teachers welcomed the innovative approach of educational games. All teachers agreed that educational games could be used as a learning tool to introduce traditional houses. Furthermore, all respondents agreed that such media should be equipped with instructional videos, practice questions, and other interactive features. Teachers' expectations for educational games reflect the need for media that not only convey information but also create enjoyable and meaningful learning experiences.

Even though the majority of teachers (91%) are not yet familiar with technology *Leap Motion* Previously, they showed high enthusiasm for the potential use of this technology. All respondents agreed that learning about traditional houses could be done using devices. *Leap Motion* on the grounds that this technology can provide visualizations and interactions not available in conventional methods. Teachers also

believe that students will be more interested in movement-based learning methods, as evidenced by data showing that all teachers assessed that students would be interested in learning about traditional houses through movement-based educational games of *Leap Motion*.

These findings confirm that teachers are conceptually ready and open to adopting a technological approach to local cultural learning. Despite limited experience with advanced technology, teachers still expressed interest in integrating this approach into their learning activities, provided that the media is easy to use, relevant to the curriculum, and supports the achievement of learning competencies.

Overall, the results of this questionnaire provide strong justification for proceeding to the media development stage. Teachers, as direct users, have provided positive signals regarding the adoption of video-based educational games of *motion gesture* and they also provide an overview of the features needed in the media. By designing media that suits teacher needs and student characteristics of *Leap Motion* can be an innovative solution that bridges the richness of local culture with a modern and interactive digital learning approach.

### 3.3. Elementary School Student Needs Analysis

As the end user of traditional house-based learning media of *Leap Motion*. Thirty elementary school students were involved in a needs analysis to explore their experiences, perceptions, and preferences regarding current learning methods. A questionnaire was used as the instrument. Data analysis was conducted quantitatively and descriptively by calculating the percentage of respondents' choices. The results demonstrated high student enthusiasm for the use of interactive media and movement-based learning.

The majority of students stated they were familiar with traditional houses (80%) and had studied them in school (93%). This indicates that the material on traditional houses is quite familiar to students and has been integrated into the basic education curriculum. However, only 33% of students found learning about traditional houses interesting. The majority reported that learning activities were still limited to reading books, looking at pictures on the blackboard, or listening to teacher explanations. These findings confirm that passive learning methods tend not to foster student interest in local cultural materials.

A study by Hsiao and Chen [7] showed that learning that relies solely on static visuals and an expository approach is less effective in facilitating the learning styles of elementary school-aged children who tend to be visual and kinesthetic. Children at this age need learning experiences that involve the senses, body movement, and direct interaction to be able to understand concepts fully and meaningfully.

As many as 73% of students reported having played educational games, and 90% expressed interest in learning about traditional houses through educational games. This demonstrates that educational games are familiar to elementary school students, and they already have positive expectations for game-based learning experiences. This approach aligns with the concept of game-based *learning which* emphasizes the integration between the pleasure of playing and the achievement of learning goals [34].

According to Gee [35], well-designed educational games are able to create a motivating learning environment, allow free exploration, and provide immediate feedback, which is very much needed by beginning learners. In this context, students show openness and readiness to learn local culture through game-based media as long as the media is designed in an interesting way and is appropriate to their developmental level.

Although only 17% of students reported having tried motion-based games, the majority expressed high enthusiasm for the approach. Ninety-seven percent of students expressed interest in trying educational games about traditional houses, which can be played with hand or body movements. In fact, 87% of students believed that learning through movement was more enjoyable than simply reading a book or listening to a teacher's explanation.

This preference indicates that technology *Leap Motion* A technology that relies on body-based interactions has great potential for acceptance by elementary school students. This technology allows students to virtually "touch," "rotate," or "explore" traditional houses, creating a more immersive and contextual learning experience. This concept aligns with the traditional learning approach of *embodied learning* which states that sensorimotor experiences can strengthen cognitive understanding, especially in spatial and conceptual learning [22]. Study [36] also confirms that gesture-based learning can increase engagement, attention, and retention of material in elementary school-aged children. Therefore, students' interest in gesture-based media of *motion gestures* like *leap motion* not only shows the potential for adoption, but also provides design direction that suits their learning characteristics.

#### 4. CONCLUSION

The results of a needs analysis conducted by experts, elementary school teachers, and elementary school students indicate that traditional house instruction has not been optimal in fostering active and contextual learning experiences. The dominance of lecture methods and static media has diminished student interest in cultural lessons, which actually have significant potential to be instilled as part of character building and national identity. *Leap Motion* emerged as a promising solution because it provides a movement-based, exploratory, and visual learning experience. Both experts and teachers assessed that this approach could address the challenges of conventional learning, while students showed high interest in educational games that can be played with hand movements. The responses of all three groups indicated a need and readiness for transformation in traditional house learning strategies. Thus, the development of educational games "*Archi Leap: Exploring Traditional Houses of the Archipelago*" based on *Leap Motion* can be a strategic step in modernizing cultural learning in elementary schools. This media is expected to not only increase student engagement and understanding but also play a role in strengthening appreciation for Indonesia's rich cultural heritage through an adaptive and enjoyable technological approach.

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