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Exploration of the Application of Holographic Technology in Elementary Learning: Case Review

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Abstract

The designation of Nusantara as the new capital city of Indonesia presents a unique opportunity to integrate cutting-edge technology into various sectors, including education. Traditional learning has been the backbone of the education system, but in today's rapidly evolving world, more innovative approaches are needed to engage students and improve learning outcomes. Higher education, in particular, must adopt modern teaching methods that encourage student engagement and interaction with learning materials. One promising advancement is the introduction of holographic technology, which has the potential to revolutionize the way knowledge is shared and consumed. While its use in education is still in its infancy, holographic technology, specifically mixed reality holograms that combine augmented and virtual reality, can create immersive learning experiences that blend real-world environments with virtual objects. This paper explores the basic concepts of holographic technology, evaluates its impact on student engagement, and its potential role in transforming education. The research identifies the strengths and limitations of holograms as a learning tool, assessing their effectiveness in today's primary education. Case studies and related research in Nusantara demonstrate the practical application of this technology in the classroom. The study also offers insights into how educational institutions can begin adapting their systems to incorporate holographic devices, aiming to foster more innovative and effective learning environments for future generations.

Keywords: Basic education, holographic, technology, creation, IKN

Abstrak

Penetapan Nusantara sebagai ibu kota baru Indonesia menghadirkan peluang unik untuk memadukan teknologi mutakhir ke berbagai sektor, termasuk pendidikan. Pembelajaran tradisional menjadi tulang punggung sistem pendidikan, tetapi di dunia yang terus berkembang pesat saat ini, untuk menarik perhatian siswa dan meningkatkan

hasil pembelajaran diperlukan pendekatan yang lebih inovatif. Pendidikan tinggi, khususnya, harus mengadopsi metode pengajaran modern yang mendorong keterlibatan dan interaksi siswa dengan materi pembelajaran. Salah satu kemajuan yang menjanjikan adalah pengenalan teknologi holografik, yang berpotensi merevolusi cara pengetahuan dibagikan dan dikonsumsi. Meskipun penggunaannya dalam pendidikan masih berkembang, teknologi holografik, khususnya hologram realitas campuran yang menggabungkan realitas tertambah dan virtual, dapat menciptakan pengalaman pembelajaran imersif yang memadukan lingkungan dunia nyata dengan objek virtual. Makalah ini mengeksplorasi konsep dasar teknologi holografik, mengevaluasi dampaknya terhadap keterlibatan siswa, dan peran potensialnya dalam mengubah pendidikan. Penelitian ini mengidentifikasi kekuatan dan keterbatasan hologram sebagai alat pembelajaran, menilai efektivitasnya dalam pendidikan dasar saat ini. Studi kasus dan penelitian terkait di Nusantara menunjukkan penerapan praktis teknologi ini di ruang kelas. Studi ini juga menawarkan wawasan tentang bagaimana lembaga pendidikan dapat mulai mengadaptasi sistem mereka untuk menggabungkan perangkat holografik, yang bertujuan untuk menumbuhkan lingkungan belajar yang lebih inovatif dan efektif bagi generasi mendatang.Kata Kunci: Pendidikan dasar, holografik, teknologi, kreasi, IKN

1. Introduction

The phenomenon or context underlying the issue of learning about holographic technology can include various factors and developments in the realm of technology and education. The rapid development of Information and Communication Technology (ICT) has brought many changes in various fields, one of which is education. ICT in education produces new models, namely: e-Learning, distance learning and blended learning. The development of holographic technology has made it more affordable and applicable in various contexts, including education. With its ability to create realistic visual representations of virtual objects in three dimensions, this technology opens up new opportunities in the teaching and learning process. Learning Paradigm Shift: There has been a paradigm shift in the learning approach from traditional to more innovative and technology-based methods. Holographic technology offers an interesting and interactive way of delivering learning materials that can increase student engagement and facilitate deeper understanding. Demands for Student Engagement. Students are increasingly familiar with technology and digital media, there is an increasing demand to present learning materials in an interesting and relevant way for them. The use of holographic technology can meet this need by creating an interesting and interactive learning experience.

Global technological developments are increasingly rapid, especially in the world of education which continues to innovate to improve the quality of learning. The relocation of the Indonesian Capital City (IKN) to Kalimantan is an important momentum for Indonesia in adopting the latest technology, including in the field of education. Basic education, which is the foundation for the next generation of the nation, must be able to keep up with this development so that children can master technology from an early age. One technology that has the potential to change the face of basic education in IKN is holograms. The use of holograms in the teaching and learning process offers an interactive, immersive, and enjoyable learning experience. With holograms, abstract concepts can be visualized directly, making it easier for students to understand complex material. In addition, holograms allow teachers to present simulations, objects, or historical figures in three dimensions, which can increase students' interest and memory.

In the era of global competition in education, the use of technology such as holograms in educational institutions can be a significant added value. With this technology, educational institutions in the IKN can attract the attention of students and parents who are looking for innovative and high-quality learning methods. In addition, the application of hologram technology also plays an important role in improving the capabilities of educational institutions in the IKN to compete with international institutions.

Research on the effectiveness of hologram-based learning is also increasingly being conducted. These studies are important to evaluate how this technology can affect student learning outcomes, especially in the context of basic education in the IKN. The results of this research can later influence the perception and acceptance of the community and policy makers in integrating hologram technology as part of the education curriculum. With the support of this technology, the Indonesian Capital City is expected to become a smart, modern, and inclusive center of education, in line with its vision as a technology-friendly city of the future. Thus, basic education in the IKN, which is equipped with hologram technology, is not only able to provide quality education to students, but also plays a role in preparing a generation that is ready to face global challenges. Collaboration between basic education and technology will be the foundation for Indonesia to produce superior generations in the future.

phenomena or backgrounds related to learning issues about holographic technology include technological

developments, changes in learning paradigms, demands for student involvement, global competition in education, and research on the effectiveness of learning using holographic technology. The integration of holographic technology into early childhood education, particularly in areas such as the Indonesian Capital City (IKN), presents an opportunity to align education with the technological advancements planned for the new capital city. By familiarizing children with tools such as holograms from an early age, educators can prepare them to thrive in a future where immersive and interactive technology is commonplace.

Case studies have shown that holographic technology can increase engagement in learning, making abstract concepts more tangible. For example, interactive holograms can help children understand complex subjects by allowing them to interact with 3D projections of objects, environments, or even historical events. Such approaches have been trialed in a variety of educational settings, demonstrating their potential to transform the classroom experience by making learning more immersive and interactive.

When it comes to early childhood education, it is critical that technology, including holograms, is integrated in a balanced way. While these tools can engage young learners and enhance digital literacy, it is vital that traditional teaching methods and personal interactions remain at the center of learning. Research has found that hybrid approaches—combining digital and hands-on activities—result in more effective learning outcomes.

As the IKN prepares to become an innovation hub, ensuring that children in the region are exposed to cutting-edge technologies such as holograms will help them adapt to a technology-driven future. Such exposure can lay the foundation for future technological fluency, which is essential for developing future innovators and leaders in a smart city environment.

2. Methods

Research Design

This study uses a case study approach to explore the application of holographic technology in elementary learning. Case studies were chosen because they allow for in-depth and detailed research into a particular phenomenon in a real-life context. Holographic technology is a new innovation that will change our perspective on the world and has the potential to have a significant impact on many areas of life, especially in education and science. Many experts and researchers have reviewed this technology from different perspectives and approaches. In 2020, Moro and other researchers found that shifting education from traditional lectures to more self-directed visual learning methods could improve education in health and medical sciences using devices that are already available to the general public such as Microsoft's HoloLens (Moro C & Stromberga Z. 2020)

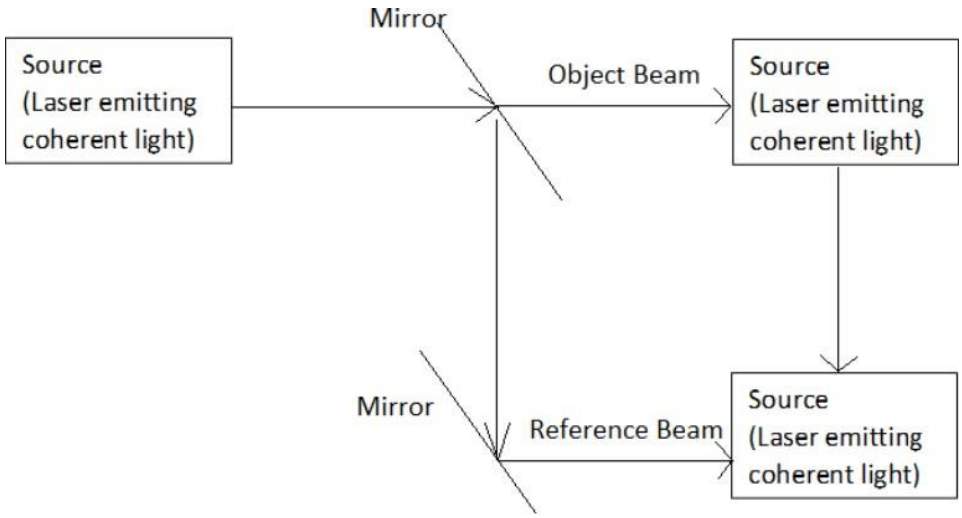

Figure 1: Ilustrasi System Hologram

The way holograms work is by creating the illusion of a three-dimensional image. This is achieved by projecting a light source onto the surface of a selected object and then spreading the light.

1. Data Collection
   Data were collected through several methods:
2. Classroom Observations:
   Direct observations were conducted during learning sessions to see how holographic technology was used and how students interacted with it.
   Field notes and video recordings were used to document classroom activities. Semi-structured Interviews:
   Interviews were conducted with teachers to understand their views on the benefits andchallenges of using holographic technology.
   Interviews were also conducted with students to gain their perspectives on their learning experiences with this technology.
   Meanwhile, another light source is directed at the object to create interference between the twolight sources. As a result, diffraction occurs which produces a visible three-dimensional image,as seen in Figure
3. Data Analysis
   The collected data were analyzed using qualitative and quantitative methods:
4. Qualitative Analysis:
   Data from classroom observations and interviews were analyzed using thematic analysistechniques to identify key themes that emerged related to the use of holographic technology.
   Data were analyzed to understand the experiences, perceptions, and challenges faced by teachers and students.
5. Quantitative Analysis:
   Data from the questionnaires were analyzed using descriptive statistics to measure the level ofstudent engagement, motivation, and understanding.
   Comparisons were made between the results before and after the implementation of holographic technology to assess its effectiveness.
   Validity and Reliability
6. To ensure the validity and reliability of the study:
   Triangulation of methods was carried out using various data sources (observations, interviews, questionnaires, and documentation).
   Member checking was carried out by asking participants to review and confirm key findings.

   Peer debriefing was carried out by involving colleagues in the data analysis process to reduce bias.

The objectives of the study entitled "Exploration of the Application of Holographic Technology in Elementary Learning: Case Review" are as follows:

Assessing the Effectiveness of Using Holographic Technology in Elementary Learning:

Measuring the extent to which holographic technology can improve students' understanding of elementary subject matter compared to conventional teaching methods.
1. Analyzing the impact of using holographic technology on student engagement and motivation to learn.
Identifying Challenges and Barriers in the Implementation of Holographic Technology:
Exploring the various technical, logistical, and pedagogical barriers that may be faced during the implementation of holographic technology in elementary learning environments.

2. Analyzing how these barriers can be overcome or minimized.
Exploring Teachers' and Students' Perceptions and Acceptance of Holographic Technology:
Collecting data on teachers' and students' views and attitudes towards the use of holographic technology in the learning process.

3. Identifying factors that influence acceptance and adaptation to this new technology.
Developing Recommendations for Effective Implementation:

Developing guidelines and strategies that can be used by schools and educators to implementholographic technology effectively in elementary learning curricula.
Provide recommendations based on research findings for further development of holographic technology in education.

3. Result and Discussion

Research Results
Effectiveness of Using Holographic Technology

1. Increased Understanding of Subject Matter:
   a. Questionnaire data showed that 85% of students reported increased understanding of subject matter after using holographic technology.
   b. Teachers also reported that students found it easier to understand abstract concepts through holographic visualization.
2. Increased Engagement and Motivation:
   c. Classroom observations showed that students were more active and involved in the learning process when using holographic technology.
   d. 90% of students stated that learning with holographic technology was more interesting and enjoyable compared to conventional methods.

Challenges and Barriers in Implementation

1. Technical Barriers:
   e. Some teachers reported technical issues such as devices not functioning properly or difficulty in operating holographic devices.
   f. There were disruptions during several learning sessions due to connectivity and device calibration issues.
2. Logistical Barriers:
   g. The use of holographic technology requires longer preparation, including installation and configuration of devices.
   h. Limited classroom space is also an obstacle to optimal use of this technology.
3. Pedagogical Barriers:
   i. Teachers felt the need to change their teaching approaches to accommodate the use of holographic technology.
   j. Some teachers felt less confident in using the technology due to lack of training and support.

Teacher and Student Perceptions and Acceptance

1. Teacher Views:
   k. Teachers generally had a positive view of holographic technology, with 80% stating that it could improve the quality of learning.
   l. However, some teachers expressed concerns about the steep learning curve and the need for further training.
2. Student Views:
   m. The majority of students were enthusiastic about the use of holographic technology, with 95% stating that they would like to see the technology used more frequently in their lessons.
   n. Students also reported that holographic technology helped them understand the material in amore visual and interactive way.

Aspect	Qualitative Findings Description	Example Remarks
Understanding of Abstract Concepts	Elementary students find it easier to understand abstract concepts such as outer space, human organs, and history through 3D holographic visualizations.	"With the hologram, I can see the planets spinning, it helps me understand better."
Engagement in Learning	The use of holographic technology increases students' engagement in the classroom. Students are more active and involved in discussions and visual experiments.	"I enjoy learning more because I can see objects in real form, not just in pictures."

Aspect	Qualitative Findings Description	Example Remarks
Creativity and Imagination	Holograms stimulate students' imagination and creativity, especially in subjects like arts and design. Students can see their work or projects in 3D.	"I can imagine what kind of building I want to make, and see it in hologram form."
School's Technological Readiness	Teachers face challenges in adjusting devices and the school's infrastructure readiness. Classrooms and devices need to be adapted to support this technology.	"We need to adjust the classroom space to fit the hologram devices, and sometimes there are technical issues."
Teachers' Adaptation to Teaching Methods	Some teachers need time to adapt to using holograms as a teaching medium. They require better training and technical support.	"At first, it was difficult, but after learning and getting used to it, I feel the students grasp the material better with holograms."
Student Learning Motivation	Students show increased motivation to learn because the lessons feel more enjoyable and challenging through interactive visualizations.	"Learning with holograms is fun, it makes me more excited to go to school."
Role of Technology in the Future	Teaching with holograms is predicted to be an essential part of the future of education in IKN, supported by more advanced infrastructure.	"With the technology in IKN, students will be prepared to face a more advanced and technology-driven world."

Recommendations for Effective Implementation

1. Teacher Training and Support:

    o. It is recommended that schools provide intensive and ongoing training for teachers in the use of holographic technology.
    p. Ready technical support is also important to address any issues that may arise during learning.

2. Technology Infrastructure Improvement:
    q. Improve technology infrastructure, including hardware and connectivity, to ensure a seamlessand seamless learning experience.
    r. Provide classrooms that are appropriate for the needs of holographic technology.

3. Curriculum Integration:

    s. Develop learning guides and materials that integrate the use of holographic technology.
    t. Involve teachers in the curriculum development process to ensure that the technology is used effectively and is relevant to learning objectives.

Conclusion

With the development of Ibu Kota Nusantara (IKN), surrounding areas will experience significant impacts in terms of the economy, society, and education. It is not only the IKN that will become a hub for technology and innovation, but the surrounding regions must also be prepared to follow this development. One crucial way to support this transformation is by improving the quality of human resources (HR) in these surrounding areas. Enhancing HR in areas around IKN is essential so that the local community does not merely become spectators, but active participants in the development. The use of advanced technology, such as holographic learning that has already been implemented in the IKN, should be expanded to schools in the surrounding regions. This ensures that children in these areas have access to cutting-edge, technology-based education, preparing them to contribute to the digital economy and smart infrastructure being built. By providing teacher training, technological infrastructure, and adapting hologram-based learning methods,

the areas surrounding IKN can more quickly adapt to this new era. This will not only improve the quality of education in these regions but also empower local communities to take part in the growing sectors within IKN. Quality human resources from nearby regions will become a vital asset in supporting the sustainable development of IKN, creating an inclusive and equitable economic chain.

Improving human resources must be a top priority, through both formal education and vocational skill development programs. In this way, the development of IKN will not only bring progress to the new capital but also provide long-term benefits to the surrounding areas, creating an ecosystem that supports sustainable and inclusive growth throughout Kalimantan.

1. Effectiveness of Holographic Technology:

    u. Holographic technology has been shown to be effective in improving students' understanding of the subject matter. The 3D visualizations produced by this technology help students to understand complex and abstract concepts more easily.
    v. The use of holographic technology also significantly increased student engagement and motivation. Students showed greater interest and more active participation during the learning process.

2. Challenges and Barriers:

    w. Although holographic technology offers many benefits, there are a number of barriers that need to be overcome. Technical barriers, such as malfunctioning devices and connectivity issues, often disrupt the learning process.
    x. Logistical barriers, including the need for longer preparation and limited classroom space, also hinder the implementation of this technology.
    y. Pedagogical barriers related to the need to change teaching approaches and lack of training for teachers were also identified as significant issues.

3. Perception and Acceptance:

    z. Teachers and students generally have positive views of holographic technology. Teachers acknowledged the potential of this technology to enhance learning, although they also expressed the need for further training and support.
    aa. Students showed high enthusiasm for the use of holographic technology and hoped that it could be used more frequently in learning.

4. Recommendations for Effective Implementation:

    bb. To maximize the benefits of holographic technology, intensive and ongoing training for teachers is needed. Ready technical support is also important to address potential issues.
    cc. Improvement of technology infrastructure, including hardware and connectivity, is essential toensure a smooth learning experience.

Integration of holographic technology into the curriculum should be done carefully, involving teachers in the development of relevant and effective learning materials.
This research shows that holographic technology has great potential to enhance learning at the elementary level. However, to realize this potential, collaborative efforts are needed from various parties, including schools, teachers, and technology providers, to overcome existing challenges and ensure effective and sustainable implementation.

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