Proceeding of International
Conference on Science and Technology
Lembaga Penelitian Pengabdian kepada Masyarakat dan Dakwah Islamiyah, Universitas Islam Kuantan Singingi, Indonesia, September 19th 2024
DOI : https://doi.org/10.36378/internationalconferenceuniks.v2i1
ISSN 2985-8739
Page: 205-209

The Role of Augmented Reality (AR) Technology in Education: Impact on Material Comprehension

Melliofatria
Universitas Islam Kuantan Singingi, Indonesia
Email : melliofatriahendri@gmail.com

Abstract

In an increasingly advanced digital era, Augmented Reality (AR) technology has become one of the most potential innovations in improving the quality of education. AR allows students to experience a more interactive and visual learning experience, thus facilitating the understanding of complex material. This research aims to evaluate the role of AR in improving material comprehension among students. In addition, it will also identify the impact of AR on student engagement, information retention and practical skill development. This research uses the literature study method to collect data and information on the use of AR in education. Data analysis was conducted by comparing the results of previous studies on the use of AR in various disciplines, including science, math, and history. The results show that the use of AR can significantly increase student engagement. AR also helps improve information retention and practical skill development. In addition, AR facilitates contextual learning by presenting information in a real context. Thus, this study shows that AR has an important role in improving the quality of education. AR can be used as an effective tool to improve material comprehension, student engagement and practical skill development. Therefore, the implementation of AR in education can be an effective strategy to improve the overall quality of education.

Keywords: Role, Impact, Augmented Reality (AR), Education, Material Understanding

1. Introduction

In an increasingly advanced digital era, Augmented Reality (AR) technology has become one of the most potential innovations in improving the quality of education. AR allows students to experience a more interactive and visual learning experience, making it easier to understand complex material. By combining virtual elements with the real world, AR opens a new window in the way students learn and interact with learning materials.

Pradana (2020) explains that augmented reality technology is increasingly widespread in today's era. Its use can help various sectors including high school education. Augmented reality technology in the learning process will greatly assist students in understanding existing material. Furthermore, Gusteti et al., (2023) added that the results of their research show that AR enriches the learning experience by increasing student engagement and understanding, especially in visualizing complex concepts such as space geometry and function graphs. AR also improves student motivation and learning outcomes. AR's ability to convert abstract concepts into 3D visualizations makes it easier for students to understand the material from a different perspective. AR also supports students with learning difficulties, by presenting visualizations that facilitate understanding of concepts. However, there are challenges in implementing AR, such as resource requirements, teacher training, and integration into the existing curriculum. Solutions involve intensive training for teachers, improved technological infrastructure, and further research for math-specific AR materials. In conclusion, AR offers great potential in mathematics education, but collaboration between researchers, educators, and practitioners is needed for optimal integration. In addition, according to Nistrina, (2021), Augmented reality in the world of education has not been implemented and applied as a supporting medium for interactive education in schools, because there are no educational institutions that apply it as a mandatory media that functions as a learning tool. The application of Augmented Reality into the world of Education will be a solution for educators to help them provide knowledge to students in addition to video conferencing.

Thus, this research aims to evaluate the role of AR in improving material understanding among students. In addition, this research will also identify issues that may arise in the implementation of AR in education, such as technological limitations and associated costs. The formulation of the problem in this study is how does AR improve material understanding among students?

2. Research Methods

This research will use the literature study method to collect data and information on the use of AR in education. The research will involve analysis of various sources, including academic journals, articles, and related research reports. AR has been shown to increase student engagement and material comprehension, especially in the visualization of

complex concepts such as space geometry and function graphs. Technology and cost limitations are some of the issues that may arise in the implementation of AR in Education. Thus, this research is expected to make a significant contribution in understanding the role of AR in improving the quality of education and identifying strategies to overcome the problems associated with AR implementation.

3. Results and Discussions

Results

A. Augmented Reality (AR)

Augmented Reality (AR) is a technology that combines digital elements with the real world to provide a more interactive and visual experience (Kesim & Ozarslan, 2012). Augmented Reality (AR) is a technology used to add digital information into an existing physical environment. It allows users to see virtual objects or information added into their real experience, usually through devices such as smartphones, AR glasses, or VR headsets. As such, AR is not only a technology that adds digital information into a physical environment, but it also has a significant impact in improving students' engagement, information retention, and practical skills in various fields of education.

B. The Role of Augmented Reality in Education

Augmented Reality (AR) is a technology that combines real-world elements with digital elements in real-time. In the context of education, AR offers a more interactive, visual, and immersive learning experience. Here are some of the main roles of AR in education:

1. Interactivity and Student Engagement:

   AR technology provides an interactive learning experience, allowing students to engage directly with teaching materials. By incorporating interesting visual elements, students are more focused and engaged in learning. The role of AR in interactivity and student engagement is to provide an interactive learning experience. AR technology provides a learning experience that allows students to interact with educational content directly. For example, through AR applications, students can see 3D models of objects studied, such as cell structures in biology or historical buildings in history. This direct interaction increases students' interest and motivation to learn (Juwita et al., 2021).

   AR technology increases emotional engagement. The experience offered by AR can make students feel more emotionally involved with the teaching material. When students can see and interact with relevant content in an engaging way, they are more likely to connect with the material, which results in a more maximized learning experience (Saidin et al., 2015).

   AR technology provides practical learning and simulation. AR allows students to simulate and practice learning. For example, in science lessons, students can use AR to conduct virtual experiments that may be difficult or impossible to do in the real world. This enhances their understanding of the principles learned through real-life experiences (Alfitriani et al., 2021).

   AR technology also enables collaboration between students. Many AR applications are designed to be used in groups, which encourages collaboration between students. They can work together on projects using AR, share discoveries, and produce a better collective understanding. This collaboration also helps in developing social and communication skills (Gusteti et al., 2023).

   AR technology provides real-time feedback. AR facilitates immediate feedback for students as they interact with the content. For example, if students complete a task through an AR app, they can receive corrections or additional explanations instantly, which accelerates the learning process (Elmqaddem, 2019).

2. Visualization of Complex Concepts:

   AR helps students understand abstract concepts through clear and detailed visualizations. For example, in science subjects, students can see and interact with 3D models of solar systems, cells, or electric lights, which will strengthen their understanding. AR transforms abstract concepts into 3D visualizations (Alfitriani et al., 2021). AR allows students to see abstract concepts in an interactive 3D form, making complex concepts easier to understand. For example, in science, AR can be used to visualize human anatomical structures or complex physiological processes. AR increases understanding and engagement. With 3D visualization and animation, AR increases student engagement and facilitates better understanding. Students can interact with the subject matter in depth, which means they are more involved in the learning process.

   AR Helps Understand Math Concepts. In mathematics, AR can play an important role in visualizing complex concepts. Geogebra AR integration, for example, allows students to better visualize space geometry and function graphs (Gusteti et al., 2023).

AR brings simulation and visualization. AR allows students to explore simulations and visualizations that make complicated concepts easy to understand. With virtual chemistry lab simulations or hospital surgeries, AR provides deep and unparalleled understanding (Subhashini et al., 2020).

AR increases learning motivation. The use of AR in learning provides an unforgettable experience for students. With its ability to integrate digital information into the real world, AR creates a more engaging and interactive learning environment, which impacts students' learning motivation (Ploetzner et al., 2020).

With AR, learning can be transferred from the classroom to relevant environments. For example, history lessons can be reinforced with AR experiences that take students to historical locations virtually (Avila-Garzon et al., 2021).

AR can be used for group projects, where students can work together in designing and completing tasks, developing collaborative and communication skills (Eh Phon et al., 2014). AR allows students to get immediate feedback while interacting with the material, helping them to understand mistakes and correct understanding immediately.

C. Impact on Material Understanding

The impact of using AR in education according to Garzón, (2021); Cabero Almenara & Barroso Osuna, (2016) and O'Shea, (2011) are:

1. Increased Information Retention:
   Students who use AR tend to remember information better compared to traditional methods. Research shows that interactive visual experiences improve memory retention.
2. Empathetic Learning:
   AR can create experiences that evoke emotions and empathy, such as in simulations that show living conditions in certain places, so that students' understanding of certain issues can be deeper.
3. Encouraging Independent Learning:
   With the accessibility of AR through mobile devices, students can do their own exploration, which supports learning outside the classroom. Augmented Reality (AR) has a significant impact on the understanding of material in education.
4. Improved Understanding of Material:
   AR allows students to visualize abstract concepts in an interactive 3D form, thus making complex concepts easier to understand. This can be seen in research that shows that the use of AR in science learning increases the achievement of learning materials up to 98% compared to 89% in students who do not use AR.
5. Increases Student Engagement:
   AR increases students' engagement in learning as they can interact directly with the material. Research shows that the use of AR in teaching can increase student engagement and participation in the classroom.
6. Improves Information Retention:
   Visual and interactive experiences through AR help students to better understand and remember information. This has been shown to improve students' information retention.
7. Development of Spatial Visualization Skills:
   AR improves students' spatial visualization skills by allowing them to visualize objects and concepts in 3D. This is especially beneficial in subjects such as geometry, architecture, and design.
8. Practical Skill Development:
   In disciplines such as medicine, VR technology (but also relevant to AR) allows the development of practical skills without any real risk. Students can practice medical procedures with high realism.

Discussion

The role and impact of AR in education are:

1. Increased Student Engagement
   Empirical Evidence: Research shows that the use of AR in education significantly increases student engagement. For example, in a study conducted by Nabila Alfitriani, Wisheila Ayunisa Maula, and Angga Hadiapurwa, the use of AR in learning to recognize the shape of the earth increases student engagement because they can interact with the material more interactively.
   Benefits: AR allows students to actively participate in the learning process, not just as spectators. This increases learning motivation and makes the learning process more enjoyable.
2. Improved Information Retention
   Empirical Evidence: The use of AR has been shown to improve students' information retention. For example, studies conducted by several researchers show that visual and interactive experiences through AR help students to better understand and remember information.
   Benefits: AR facilitates better understanding because 3D visualizations and animations make complex concepts easier to grasp. This enhances students' ability to recall information more effectively.
3. Practical Skill Development
   Empirical Evidence: In disciplines such as medicine, VR technology (but also relevant to

AR) enables the development of practical skills without any real risk. For example, aspiring doctors can practice medical procedures with high realism using AR.
Benefits: AR allows students to develop practical skills in a safe and controlled environment, so they are prepared to face real situations with more confidence.

4. Contextualized Learning
Empirical Evidence: AR enables learning in a real context. For example, students can learn about history while being at the historical location itself through AR applications that present related information.
Benefits: AR helps students to understand concepts in a more contextualized manner, so that they can relate theory to real practice.

5. Providing Wider Access to Education
Empirical Evidence: AR and VR technologies open up access to education for those who are in remote locations or do not have easy access to traditional educational resources. For example, students in remote areas can access high-quality education through AR.
Benefits: AR bridges the education gap and empowers students to empower themselves, thus improving educational equality worldwide.

4. Conclusion

Augmented reality (AR) technology has an important role in enhancing engagement, information retention, practical skill development, and contextual learning. By facilitating immersive and interactive learning experiences, AR helps students to understand complex concepts better and increase their learning motivation. Therefore, the implementation of AR in education can be an effective strategy to improve the overall quality of education.

Reference

Alfitriani, N., Maula, W. A., & Hadiapurwa, A. (2021). Penggunaan Media Augmented Reality dalam Pembelajaran Mengenal Bentuk Rupa Bumi. Jurnal Penelitian Pendidikan, 38(1), 30–38. https://doi.org/10.15294/jpp.v38i1.30698

Avila-Garzon, C., Bacca-Acosta, J., Kinshuk, , Duarte, J., & Betancourt, J. (2021). Augmented Reality in Education: An Overview of Twenty-Five Years of Research. Contemporary Educational Technology, 13(3), ep302. https://doi.org/10.30935/cedtech/10865

Cabero Almenara, J., & Barroso Osuna, J. (2016). Posibilidades educativas de la Realidad Aumentada. Journal of New Approaches in Educational Research, 6(1), 44–50. https://doi.org/10.7821/naer.2016.1.140

Eh Phon, D. N., Ali, M. B., & Halim, N. D. A. (2014). Collaborative augmented reality in education: A review. Proceedings - 2014 International Conference on Teaching and Learning in Computing and Engineering, LATICE 2014, 78–83. https://doi.org/10.1109/LaTiCE.2014.23

Elmqaddem, N. (2019). Augmented Reality and Virtual Reality in education. Myth or reality? International Journal of Emerging Technologies in Learning, 14(3), 234–242. https://doi.org/10.3991/ijet.v14i03.9289

Garzón, J. (2021). An overview of twenty-five years of augmented reality in education. Multimodal Technologies and Interaction, 5(7). https://doi.org/10.3390/mti5070037

Gusteti, M. U., Rahmalina, W., Azmi, K., Mulyati, A., Wulandari, S., Hayati, R., Syariffan, S., & Nurazizah, N. (2023). Penggunaan Augmented Reality dalam Pembelajaran Matematika: Sebuah Analisis Berdasarkan Studi Literatur. Edukatif : Jurnal Ilmu Pendidikan, 5(6), 2735–2747. https://doi.org/10.31004/edukatif.v5i6.5963

Juwita, J., Saputri, E. Z., & Kusmawati, I. (2021). Teknologi Augmented Reality (Ar) Sebagai Solusi Media Pembelajaran Sains Di Masa Adaptasi Kebiasaan Baru. Bioeduca : Journal of Biology Education, 3(2), 124–134. https://doi.org/10.21580/bioeduca.v3i2.6636

Kesim, M., & Ozarslan, Y. (2012). Augmented Reality in Education: Current Technologies and the Potential for Education. Procedia - Social and Behavioral Sciences, 47(222), 297–302. https://doi.org/10.1016/j.sbspro.2012.06.654

Nistrina, K. (2021). Penerapan Augmented Reality dalam Media Pembelajaran. Jurnal Sistem Informasi, J-SIKA, 03(01), 1–6.

O'Shea, P. M. (2011). Augmented Reality in Education. International Journal of Gaming and Computer-Mediated Simulations, 3(1), 91–93. https://doi.org/10.4018/jgcms.2011010108

Ploetzner, R., Berney, S., & Bétrancourt, M. (2020). A review of learning demands in instructional animations: The educational effectiveness of animations unfolds if the features of change need to be learned. Journal of Computer Assisted Learning, 36(6), 838–860. https://doi.org/10.1111/jcal.12476

Pradana, R. W. (2020). Penggunaan Augmented Reality Pada Sekolah Menengah Atas Di Indonesia. Jurnal Teknologi Pendidikan : Jurnal Penelitian Dan Pengembangan Pembelajaran, 5(1), 97. https://doi.org/10.33394/jtp.v5i1.2857

Saidin, N. F., Halim, N. D. A., & Yahaya, N. (2015). A review of research on augmented reality in education: Advantages and applications. International Education Studies, 8(13), 1–8. https://doi.org/10.5539/ies.v8n13p1

Subhashini, P., Siddiqua, R., Keerthana, A., & Pavani, P. (2020). Augmented Reality in Education. Journal of Information Technology and Digital World, 02(04), 221–227. https://doi.org/10.36548/jitdw.2020.4.006Alfitriani, N.,

Maula, W. A., & Hadiapurwa, A. (2021). Penggunaan Media Augmented Reality dalam Pembelajaran Mengenal Bentuk Rupa Bumi. Jurnal Penelitian Pendidikan, 38(1), 30–38. https://doi.org/10.15294/jpp.v38i1.30698

Avila-Garzon, C., Bacca-Acosta, J., Kinshuk, , Duarte, J., & Betancourt, J. (2021). Augmented Reality in Education: An Overview of Twenty-Five Years of Research. Contemporary Educational Technology, 13(3), ep302. https://doi.org/10.30935/cedtech/10865

Cabero Almenara, J., & Barroso Osuna, J. (2016). Posibilidades educativas de la Realidad Aumentada. Journal of New Approaches in Educational Research, 6(1), 44–50. https://doi.org/10.7821/naer.2016.1.140

Eh Phon, D. N., Ali, M. B., & Halim, N. D. A. (2014). Collaborative augmented reality in education: A review. Proceedings - 2014 International Conference on Teaching and Learning in Computing and Engineering, LATICE 2014, 78–83. https://doi.org/10.1109/LaTiCE.2014.23

Elmqaddem, N. (2019). Augmented Reality and Virtual Reality in education. Myth or reality? International Journal of Emerging Technologies in Learning, 14(3), 234–242. https://doi.org/10.3991/ijet.v14i03.9289

Garzón, J. (2021). An overview of twenty-five years of augmented reality in education. Multimodal Technologies and Interaction, 5(7). https://doi.org/10.3390/mti5070037

Gusteti, M. U., Rahmalina, W., Azmi, K., Mulyati, A., Wulandari, S., Hayati, R., Syariffan, S., & Nurazizah, N. (2023). Penggunaan Augmented Reality dalam Pembelajaran Matematika: Sebuah Analisis Berdasarkan Studi Literatur. Edukatif : Jurnal Ilmu Pendidikan, 5(6),

2735–2747. https://doi.org/10.31004/edukatif.v5i6.5963
Juwita, J., Saputri, E. Z., & Kusmawati, I. (2021). Teknologi Augmented Reality (Ar) Sebagai Solusi Media Pembelajaran Sains Di Masa Adaptasi Kebiasaan Baru. Bioeduca : Journal of Biology Education, 3(2), 124–134. https://doi.org/10.21580/bioeduca.v3i2.6636
Kesim, M., & Ozarslan, Y. (2012). Augmented Reality in Education: Current Technologies and the Potential for Education. Procedia - Social and Behavioral Sciences, 47(222), 297–302. https://doi.org/10.1016/j.sbspro.2012.06.654
Nistrina, K. (2021). Penerapan Augmented Reality dalam Media Pembelajaran. Jurnal Sistem Informasi, J-SIKA, 03(01), 1–6.
O'Shea, P. M. (2011). Augmented Reality in Education. International Journal of Gaming and Computer-Mediated Simulations, 3(1), 91–93. https://doi.org/10.4018/jgcms.2011010108
Ploetzner, R., Berney, S., & Bétrancourt, M. (2020). A review of learning demands in instructional animations: The educational effectiveness of animations unfolds if the features of change need to be learned. Journal of Computer Assisted Learning, 36(6), 838–860. https://doi.org/10.1111/jcal.12476
Pradana, R. W. (2020). Penggunaan Augmented Reality Pada Sekolah Menengah Atas Di Indonesia. Jurnal Teknologi Pendidikan : Jurnal Penelitian Dan Pengembangan Pembelajaran, 5(1), 97. https://doi.org/10.33394/jtp.v5i1.2857
Saidin, N. F., Halim, N. D. A., & Yahaya, N. (2015). A review of research on augmented reality in education: Advantages and applications. International Education Studies, 8(13), 1–8. https://doi.org/10.5539/ies.v8n13p1
Subhashini, P., Siddiqua, R., Keerthana, A., & Pavani, P. (2020). Augmented Reality in Education. Journal of Information Technology and Digital World, 02(04), 221–227. https://doi.org/10.36548/jitdw.2020.4.006Alfitriani, N.,
Maula, W. A., & Hadiapurwa, A. (2021). Penggunaan Media Augmented Reality dalam Pembelajaran Mengenal Bentuk Rupa Bumi. Jurnal Penelitian Pendidikan, 38(1), 30–38. https://doi.org/10.15294/jpp.v38i1.30698
Avila-Garzon, C., Bacca-Acosta, J., Kinshuk, , Duarte, J., & Betancourt, J. (2021). Augmented Reality in Education: An Overview of Twenty-Five Years of Research. Contemporary Educational Technology, 13(3), ep302. https://doi.org/10.30935/cedtech/10865
Cabero Almenara, J., & Barroso Osuna, J. (2016). Posibilidades educativas de la Realidad Aumentada. Journal of New Approaches in Educational Research, 6(1), 44–50. https://doi.org/10.7821/naer.2016.1.140
Eh Phon, D. N., Ali, M. B., & Halim, N. D. A. (2014). Collaborative augmented reality in education: A review. Proceedings - 2014 International Conference on Teaching and Learning in Computing and Engineering, LATICE 2014, 78–83. https://doi.org/10.1109/LaTiCE.2014.23
Elmqaddem, N. (2019). Augmented Reality and Virtual Reality in education. Myth or reality? International Journal of Emerging Technologies in Learning, 14(3), 234–242. https://doi.org/10.3991/ijet.v14i03.9289
Garzón, J. (2021). An overview of twenty-five years of augmented reality in education. Multimodal Technologies and Interaction, 5(7). https://doi.org/10.3390/mti5070037
Gusteti, M. U., Rahmalina, W., Azmi, K., Mulyati, A., Wulandari, S., Hayati, R., Syariffan, S., & Nurazizah, N. (2023). Penggunaan Augmented Reality dalam Pembelajaran Matematika: Sebuah Analisis Berdasarkan Studi Literatur. Edukatif : Jurnal Ilmu Pendidikan, 5(6), 2735–2747. https://doi.org/10.31004/edukatif.v5i6.5963
Juwita, J., Saputri, E. Z., & Kusmawati, I. (2021). Teknologi Augmented Reality (Ar) Sebagai Solusi Media Pembelajaran Sains Di Masa Adaptasi Kebiasaan Baru. Bioeduca : Journal of Biology Education, 3(2), 124–134. https://doi.org/10.21580/bioeduca.v3i2.6636
Kesim, M., & Ozarslan, Y. (2012). Augmented Reality in Education: Current Technologies and the Potential for Education. Procedia - Social and Behavioral Sciences, 47(222), 297–302. https://doi.org/10.1016/j.sbspro.2012.06.654
Nistrina, K. (2021). Penerapan Augmented Reality dalam Media Pembelajaran. Jurnal Sistem Informasi, J-SIKA, 03(01), 1–6.
O'Shea, P. M. (2011). Augmented Reality in Education. International Journal of Gaming and Computer-Mediated Simulations, 3(1), 91–93. https://doi.org/10.4018/jgcms.2011010108
Ploetzner, R., Berney, S., & Bétrancourt, M. (2020). A review of learning demands in instructional animations: The educational effectiveness of animations unfolds if the features of change need to be learned. Journal of Computer Assisted Learning, 36(6), 838–860. https://doi.org/10.1111/jcal.12476
Pradana, R. W. (2020). Penggunaan Augmented Reality Pada Sekolah Menengah Atas Di Indonesia. Jurnal Teknologi Pendidikan : Jurnal Penelitian Dan Pengembangan Pembelajaran, 5(1), 97. https://doi.org/10.33394/jtp.v5i1.2857
Saidin, N. F., Halim, N. D. A., & Yahaya, N. (2015). A review of research on augmented reality in education: Advantages and applications. International Education Studies, 8(13), 1–8. https://doi.org/10.5539/ies.v8n13p1
Subhashini, P., Siddiqua, R., Keerthana, A., & Pavani, P. (2020). Augmented Reality in Education. Journal of Information Technology and Digital World, 02(04), 221–227. https://doi.org/10.36548/jitdw.2020.4.006