

Technology on Learning Behavior and Attitudes of Preschool Students in Science activities. The study aimed to develop AR-based activities for children aged 3 to 6.

The findings revealed that the AR-based learning system significantly enhanced active learning behaviors and positively influenced students' attitudes toward Science. In a study conducted by Yao, Wang, and Liu (2024), they developed two AR applications aimed at enhancing English and Math skills. These applications integrated cartoon picture cards, 3D models, and animated videos, creating an enriched learning experience through marker-based AR techniques.

The results indicated that the AR applications provided an enjoyable and engaging learning environment, thus fostering children's participation. In another study by Vargavan and Yunus (2021), they used Augmented Reality (AR) to Enhance Preschool Children's English Word Reading Skills. The findings indicated that AR technology significantly improved preschoolers' reading skills, with boys outperforming girls in the post-test. Overall, the study concluded that AR technology effectively engages both teachers and children, contributing to the enhancement of English word reading skills among preschoolers. Preschool educators expressed a positive attitude toward the use of AR applications, with the study concluding that these tools effectively supported the development of English and Math skills among preschool children.

In a recent study, Letchumanan and Karim (2024) explored the potential of AR technology to increase engagement and understanding in Science education among preschool children. The study applied a mixed-method approach and involved 12 six-year-old preschool children and a science teacher from a preschool in Port Dickson, Negeri Sembilan. The findings indicated a significant increase in children's knowledge and interest in Science after the introduction of AR-based materials. The study recommended providing training for preschool teachers in the use of AR technology for the preparation of instructional materials to support Science education in early childhood settings.

AR technology allows the integration of digital images or objects into real-world environments, creating immersive, dynamic, and interactive learning experiences. This distinctive capability of AR technology is particularly advantageous for educational purposes, as it promotes student engagement with digital content rooted in real-world contexts. Incorporating 3D virtual elements in AR technology has been shown to significantly enhance student achievement.

Early Childhood teachers' understanding and perceptions towards receptiveness to Augmented Reality (AR) technology are unknown. Rapti, Sapounidis, and Tselegkaridis (2024) conducted a study to examine the use and potential of virtual reality in preschool education. The results indicated that although educators faced several challenges in using AR, they recognized that technology rapidly transforms education by creating immersive learning environments.

Cascales, Pérez-López, and Contero (2013) examined the influence of parental attitudes on Augmented Reality (AR). The research sought to understand how parents shape the integration of AR into early childhood learning environments by analyzing interviews with parents. The study concluded that AR technology offers various benefits, such as enhancing motivation, facilitating knowledge, and fostering creativity.

The technology of Augmented Reality has been widely applied in various industries, particularly the education sector. Technology is paying more attention to the usage of applications in the field of education to make the learning process more straightforward, more exciting, and more participatory by fusing the virtual and real worlds.

According to Maeve (2024), AR enhances student motivation, knowledge, and creativity by adapting to the latest technological innovations (Hu et al., 2021). Integrating AR into coloring activities can promote creativity in early childhood education (Mohd Fadzil & Mohd Noor, 2023). A good understanding of AR technology is positively perceived as a means to enhance institutional efficiency (Wong et al., 2024). More studies need to be implemented among early childhood teachers.

III. STUDY OBJECTIVES

- i. To assess the understanding of AR technology among Early Childhood Teachers
- ii. To gain insights into the perceptions of Early Childhood Education Teachers concerning the ability of AR technology to enhance learning
- iii. To explore how Early Childhood Teachers' understanding of AR technology enhances learning

IV. FINDINGS

After the completed questionnaires were collected, a descriptive analysis procedure was conducted. The survey involved 200 Early Childhood Teachers. Most participants were between the ages of 25 and 35.

5.1 Respondents' Understanding Concerning AR Technology

This section of the questionnaire consists of eight items, which were utilized to gauge the understanding levels of respondents concerning AR technology. Table 1 illustrates the calculated mean values and standard deviation scores for the questionnaire items.

Items	Representation	Mean Values	Standard Deviations
1	AR technology will become a vital component within Malaysian Early Childhood Education initiatives.	4.07	.847
2	AR technology consolidates the real and virtual world components to enhance user experiences by offering massive amounts of rich information and interactions.	4.28	.976
3	AR technology can be utilized to greatly improve the teaching of complicated subjects and concepts based on interactive curricula and highly engaging immersive experiences.	4.31	.798
4	AR technology is able to combine and display 2D or 3D virtual elements in real-world user settings.	4.28	.841
5	AR technology enhances real-world contexts by superimposing digital information into physical objects or settings.	4.22	.858
6	AR technologies allow students to explore and mold 3D models, and better visualize concepts that are abstract.	4.33	.780
7	AR technology is an extremely viable tool for learning that is student-centered and can cater to individualistic learning styles.	4.22	.817
8	AR technology has a great potential to motivate students, keep them engaged and more easily attain learning objectives.	4.22	.901

10	AR technology is an extremely viable teaching tool for all forms of learning that are problem-based.	4.23	.885
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5.2 Links Between Respondents' Understanding of AR and Their Perceptions of It Enhancing Learning

In order to determine any links between the respondents' understanding of AR technology and their perceptions of it being able to enhance learning, the Pearson correlation coefficient (r) was utilized. The test indicated that the links for these variables were positive and significant ($r = .93, p < .001$). The outcome indicates that the respondents had a solid understanding of AR technology and perceived it as capable of enhancing learning.

V. DISCUSSION

The findings of this study reveal that respondents possess a solid understanding of AR technology and perceive it to enhance learning. Respondents' knowledge of AR indicates their receptiveness toward utilizing this technology for their teaching activities (Wong et al., 2024). However, given the rapid pace of technological advancement, it is crucial for Early Childhood Teachers to constantly update their skills. The positive perception of AR as a practical teaching tool and as a means to enhance children's performance is promising. With a deeper understanding of AR technologies, Early Childhood Teachers will likely embrace their use in educational activities. One way of ensuring this is by adopting the latest technological innovations (Hu et al., 2021).

CONCLUSION

The rapid growth of the digital economy, coupled with technological innovations, highlights the importance of integrating digital teaching modules and advanced learning strategies to align with the evolving global economic landscape. AR technologies hold immense potential to revolutionize learning outcomes in Early Childhood Education. They offer immersive, interactive, and personalized learning experiences that bridge the gap between real-world applications and abstract concepts. The Ministry of Education in Malaysia would greatly benefit from adopting these technologies, fostering the development of well-rounded students who can think critically, understand concepts deeply, and collaborate effectively.

REFERENCES

- [1] Abdul Rauf, F., & Tan, W. H. (2020). Potensi realiti terimbuah dalam aktiviti mewarna: Satu kajian di sebuah prasekolah. *Southeast Asia Early Childhood Journal (SAECJ)*, *9*(2), 1-10.
- [2] Cascales, A., Pérez-López, D., & Contero, M. (2013). Study on Parent's Acceptance of the Augmented Reality Use for Preschool Education. *Procedia Computer Science*, *25*, 420-427. <https://doi.org/10.1016/j.procs.2013.11.053>.
- [3] Chin, Y. F., Leung, W. C., Rahman, M. F. A., & Zhang, L. (2024, April). Impact of artificial intelligence in the financial industry: Disruption or annihilation. In 2024 International Conference on Science Technology Engineering and Management (ICSTEM) (pp. 1-5). IEEE.
- [4] Hu, X., Goh, Y. M., & Lin, A. (2021). Educational impact of an Augmented Reality (AR) application for teaching structural systems to non-engineering students. *Advanced Engineering Informatics*, *50*, 101436.
- [5] Letchumanan, Y., & Karim, N. A. A. (2024). Meningkatkan Pengetahuan dan Minat dalam Pendidikan Sains dalam kalangan Murid Prasekolah dengan Membina dan Menggunakan Teknologi Augmented Reality. *e-Jurnal Penyelidikan Dan Inovasi*, *11*(1), 150-176. <https://doi.org/10.53840/ejpi.v11i1.181>
- [6] Malaysia Communications and Multimedia Commission, Internet Users Survey 2018: Statistical Brief 23, 2018. Retrieved from *Our_lives_online_-_Executive_Summary.pdf (unicef.org)*.
- [7] Maeve, J. (2024). Penerimaan Guru Pelatih Terhadap Penggunaan Realiti Berperantara (AR) dalam Pendidikan Prasekolah. *Mempertingkatkan Pendidikan Pada Abad ke-21*, *12*(1), 46-53. <https://doi.org/10.51200/jpp.v12i1.5006>

- [8] Mohd Fadzil, M. Z., & Mohd Noor, N. A. (2023). Mengintegrasikan Augmented Reality dalam Pembelajaran Bentuk 2D dan 3D. *Journal of Engineering, Technology, and Applied Science (JETAS)*, **5**, 12-22. 10.36079/lamintang.jetas-0501.500
- [9] Payne, K.P., Lee, R., & Ompok, CC. (2024). An Improve Augmented Reality Approach for STEM in Early Childhood Via Image Processing. *The Seybold Report*. DOI: 10.5281/zenodo.11071289
- [10] Rapti, S., Sapounidis, T., & Tselegkaridis, S. (2024). Investigating Educators' and Students' Perspectives on Virtual Reality Enhanced Teaching in Preschool. *Early Childhood Educ J*. <https://doi.org/10.1007/s10643-024-01659-z>
- [11] Yao, W., Wang, L., & Liu, D. (2024). Augmented reality-based language and math learning applications for preschool children education. *Univ Access Inf Soc*. <https://doi.org/10.1007/s10209-024-01101-6>
- [12] Vargavan, S., & Yunus, F. (2021). Penggunaan Augmented Reality (AR) untuk meningkatkan kemahiran membaca perkataan Bahasa Inggeris kanak-kanak prasekolah. *International Journal Of Education And Pedagogy*, **3**(1), 156-172.
- [13] Wong, N. Z. Y., Chin, Y. F., Sharif, S., & Ompok, C. S. C. (2024). Data-Driven Decision Making in TVET: The Impact of Augmented Reality Technology on Institutional Efficiency. *J. Electrical Systems*, **20**-10s, 4898-4903.
- [14] Zhufeng, Y., & Sitthiworachart, J. (2024). Effect of augmented reality technology on learning behavior and attitudes of preschool students in science activities. *Educ Inf Technol*, **29**, 4763–4784. <https://doi.org/10.1007/s10639-023-12012-z>