

Analysis of Augmented Reality Teaching Material Needs for Science Subjects

Dias Damasyanti, Tri Murwaningsih, Sukarno

Universitas Sebelas Maret
diassyanti@student.uns.ac.id

Article History

accepted 1/2/2026

approved 1/3/2026

published 31/3/2026

Abstract

Science subjects in elementary schools involve abstract concepts that are difficult to understand due to limited visualization in conventional media. This study aims to analyze the need for developing Augmented Reality (AR)-based teaching materials for elementary science. A qualitative descriptive approach with a needs analysis method was used, collecting data through questionnaires and in-depth interviews with teachers, and analyzed descriptively. The results show a high demand for AR-based materials, with teachers showing strong interest in 3D visual media and emphasizing the need for visualization of abstract topics such as the solar system. In conclusion, AR is a promising solution to improve students' understanding of abstract science concepts in elementary education.

Keywords: *Augmented, Reality, Material, Teaching, IPAS*

Abstrak

Mata pelajaran sains di sekolah dasar melibatkan konsep-konsep abstrak yang sulit dipahami karena keterbatasan visualisasi pada media konvensional. Studi ini bertujuan untuk menganalisis kebutuhan pengembangan materi pembelajaran berbasis Augmented Reality (AR) untuk sains di sekolah dasar. Pendekatan deskriptif kualitatif dengan metode analisis kebutuhan digunakan, pengumpulan data dilakukan melalui kuesioner dan wawancara mendalam dengan guru, dan dianalisis secara deskriptif. Hasil penelitian menunjukkan tingginya permintaan akan materi berbasis AR, dengan guru menunjukkan minat yang kuat pada media visual 3D dan menekankan kebutuhan visualisasi topik abstrak seperti tata surya. Kesimpulannya, AR merupakan solusi yang menjanjikan untuk meningkatkan pemahaman siswa terhadap konsep-konsep sains abstrak di pendidikan dasar.

Kata kunci: *Augmented, Reality, Materi, Pengajaran, IPAS*

Social, Humanities, and Education Studies (SHES): Conference Series p-ISSN 2620-9284
<https://jurnal.uns.ac.id/shes> e-ISSN 2620-9292



This work is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License.

INTRODUCTION

The world of education faces significant challenges in the 21st-century learning paradigm, which demands a shift from conventional methods to interactive learning. At the elementary school level, the use of technology is no longer merely complementary, but rather a necessity to bridge the learning styles of Generation Alpha, who are very familiar with digital devices. The government has set content standards to achieve graduate competencies. These content standards are regulated in the "Decree of the Head of the Standardization, Curriculum, and Evaluation Agency of the Ministry of Education, Culture, Research, and Technology Number 033/H/KR/2022 concerning learning outcomes in early childhood education, elementary education, and secondary education within an independent curriculum." (Amirahma & Setyasto, 2024).

Learning Natural and Social Sciences (IPAS) in the Independent Curriculum plays a crucial role in fostering students' curiosity and critical thinking skills (Zahro, F & Fauziah, 2024). Many concepts in IPAS—especially science topics such as the water cycle, the solar system, or the structure of the human body—are abstract and difficult to visualize solely through text or two-dimensional images in conventional textbooks. Students' inability to visualize complex phenomena often leads to misconceptions and low learning motivation. Teachers often struggle to bring real-world objects into the classroom due to budget constraints, time constraints, or the objects being too small or too large. Augmented Reality (AR) is a technological solution that integrates the virtual world into the real environment. AR has the advantage of projecting interactive 3D objects, making initially abstract material more concrete and engaging. Augmented Reality (AR) is a technological solution that integrates virtual worlds into real-time environments (Pombo, L., & Marques, 2019). AR's primary advantage lies in its ability to project interactive 3D objects, enabling students to actively explore (Sirakaya, M., & Sirakaya, 2022).

This research can add valid and in-depth initial data on the real needs of teachers, students, and elementary school conditions as a foundation for the development of Augmented Reality-based teaching material products. This is crucial for determining content features and displays that are appropriate to the characteristics of science materials, ensuring that the resulting AR materials are both effective and target-oriented (Cano et al., 2020). In analyzing the needs for AR teaching materials, the process should be conducted comprehensively, taking into account both student characteristics and available school resources (Bacca et al., 2018). However, the reality in schools often reveals a significant gap in technology infrastructure and teacher capabilities, which frequently hinders the ideal implementation of the results of the analysis in actual pedagogical settings (Garzón, 2021).

Based on preliminary studies with observations and interviews in the field, several challenges in learning science with conventional media are the lack of concrete visualization in abstract science material, the media used is still limited to textbooks or simple teaching aids that are less interactive, students tend to get bored because the material is presented only through lectures and teachers have difficulty in explaining abstract concepts due to the limited availability of adequate visual support media.

Research on the analysis of the needs of Augmented Reality-based teaching materials has been carried out several times, one of which was by Zulfah Tahta Alfina, (2024) entitled "Analysis of the Needs for Science Learning Media Based on QR-TET Plant Cards Integrated with Augmented Reality" (Alfina, Z. T. & Rusilowati, A., Subali, B & Lestari, 2024). The results of this study explain that field data supports the need to develop Augmented Reality teaching materials to address students' difficulties in understanding abstract science concepts. Other research on the analysis of the needs for developing Augmented Reality-based learning multimedia has also been conducted by (Cahdriyana, R. A & Nurnugroho, 2023). The results of this study explain the need for the development of Augmented Reality-based learning multimedia on the solar

system material to develop one of the skills in the 4.0 era, namely computational thinking skills. Research on the application of the Activity System-Based Process Model in Augmented Reality-Based Learning for Natural Science Subjects in Elementary Schools by (Huang, C. Y., Chou, Y. Y., Chen, C. H. & Tsai, 2022). The results of the analysis show that the group of students who learned using the Augmented Reality system had better learning outcomes and learning attitudes compared to the group who used traditional learning.

Based on the relevant research, it can be seen that there is no research on the analysis of the needs of Augmented Reality-based teaching materials in the subject of science and social studies that integrate complex cross-field content between science and social. This research also relates to the obstacles faced by teachers in preparing and using AR teaching materials. This research focuses on the analysis of the needs of integrated science and social science content and the obstacles faced in preparing the use of Augmented Reality teaching materials for sixth-grade students in elementary schools in Laweyan District, Surakarta.

METHOD

This study uses a qualitative descriptive approach to investigate teachers' needs for Augmented Reality (AR)-based science teaching materials. This approach is based on Moleong's (2017) view that qualitative research aims to understand phenomena about what research subjects experience holistically by describing them in words and language in a specific, natural context (Moleong, 2017). This allows researchers to gain an in-depth understanding of real classroom conditions and the instructional dynamics that occur in the field. In line with this, this research procedure is carried out through a preliminary study stage to identify potential and problems, as explained by Sugiyono (2020) that the initial step in development research is to conduct a needs analysis to find problems that require innovative solutions (Sugiyono, 2020).

Research subjects were selected using a purposive sampling technique to ensure that the data obtained was relevant to the research objectives (Creswell, J. W., & Poth, 2018). The subjects included 20 sixth-grade teachers as questionnaire respondents and six teachers specifically selected as informants for in-depth interviews. The integration of these two groups of subjects was intended to provide a comprehensive picture, both general and specific, of the need for innovative learning media in elementary schools.

Data collection techniques used a combination of questionnaires and semi-structured interviews to identify teacher needs, expected benefits, and potential challenges in implementing AR-based materials. This aligns with Arikunto's (2013) opinion, which states that using questionnaires is highly effective for gathering information from a large number of respondents to obtain objective data on needs in the field (Arikunto, 2013). Furthermore, documentation techniques were used to review the availability of digital support facilities in schools as technical considerations for future application development.

The data analysis technique in this study followed the interactive qualitative model developed by Matthew B. Miles, A. Michael Huberman, and Johnny Saldaña (2014). The analysis process consisted of three simultaneous stages: data condensation to filter relevant information, data presentation in narrative text and matrices to map the interconnectedness of findings, and conclusion drawing and verification to formulate the urgency of product development (Miles, M. B., Huberman, A. M., & Saldaña, 2014). The analysis focused on identifying gaps in existing teaching materials and defining specific requirements for AR integration to visualize abstract science material in a more concrete way for students.

RESULTS AND DISCUSSION

Based on research conducted from November 25 to 30, 2025, by distributing questionnaires to 20 teachers in Laweyan District to analyze the need for Augmented Reality-based teaching materials in the Science subject, it was found that 85% of teachers stated that they had difficulty visualizing the Solar System material concretely. Many teachers have not used Augmented Reality-based teaching materials in the Science subject, especially for materials that require real experience. In reality, in schools, teachers and students still use textual-based teaching materials with textbooks for students.

Interviews with six selected respondents revealed that the primary obstacle faced was the lack of diverse digital content aligned with the national curriculum. Teachers expect the AR applications developed to be user-friendly and accessible offline to address internet network constraints at schools. The table below presents the findings.

Tabel 1. Results of the Teacher Needs Analysis Questionnaire

No	Indikator	4	3	2	1
1.	Current Condition of Science Learning	37,9%	25,8%	18,3%	18%
2.	The Need for Interactive Science Teaching Materials	89,60%	7,36%	3,04%	0%
3.	Perceptions of Augmented Reality (AR)	69,7%	0%	30,3%	0%

Sumber : Angket Kebutuhan Guru

Based on the results of the questionnaire, it was found that only 37.9% of teachers felt the current state of science and science learning was adequate, while 89.6% of teachers agreed that there was an urgent need for interactive teaching materials. A total of 69.7% of teachers had a positive perception of the use of AR, although they had not yet implemented it. This data indicates a significant need to effectively integrate AR technology into learning.

Solar System material involves understanding the orbits, rotations, and revolutions of planets, which are difficult to observe directly. AR technology can bring a three-dimensional simulation of the solar system into the classroom, enabling the transition from textual to contextual learning.

The findings regarding the gap between abstract material and the reliance on printed media align with Mayer's Cognitive Theory of Multimedia Learning (CTML). This theory posits that students learn more deeply from words and pictures than from words alone. The current dominance of printed texts in schools limits students' cognitive channels in processing complex spatial information. Previous research indicates that traditional media often fails to provide accurate mental representations of three-dimensional astronomical objects; thus, the integration of visual technology becomes a pedagogical necessity (Mayer, 2021).

The urgency for AR-based material development identified in this study (89.6%) reinforces prior research stating that immersive technology can reduce students' cognitive load when learning abstract concepts. Compared to two-dimensional media, AR allows for the real-time manipulation of virtual objects, which, according to research by Azuma et al., significantly enhances memory retention and spatial understanding (Azuma, R., 2001). This confirms that the field findings regarding the need for "concrete" materials are not merely a technological trend, but a fundamental requirement to bridge the limitations of students' imaginations regarding macro-scale objects like the solar system (Chen, P., 2020).

Regarding infrastructure constraints and the need for offline features, these findings reflect common challenges in educational technology adoption within developing regions. Although teacher perception of AR is highly positive (69.7%),

technical barriers remain a deciding factor for classroom implementation. This is consistent with the Technology Acceptance Model (TAM), where "perceived ease of use" and technical accessibility are critical to whether an innovation is adopted or abandoned. Research by (Akçayır, M., & Akçayır, 2017) also emphasizes that the sustainability of AR use in primary schools depends heavily on the availability of user-friendly content that does not rely entirely on high-speed internet connectivity.

The emphasis on aligning development with the national curriculum addresses a common critique in literature regarding the "content gap" in global educational applications. Many currently available AR applications are generic and do not align with specific learning objectives at the elementary level. Therefore, developing media specifically for Science (IPAS) with a localized approach is a strategic step supported by the Pedagogical Content Knowledge (PCK) framework, which suggests that technology must be deeply integrated with the subject matter and the teacher's instructional methods (Koehler, M. J., & Mishra, 2009)

CONCLUSION

Based on the results of a needs analysis conducted through a preliminary study of sixth-grade teachers in Laweyan District, Surakarta, it can be concluded that there is a significant urgency to develop Augmented Reality (AR)-based science teaching materials. Current learning conditions show a gap between the abstract characteristics of the material, especially on the topic of the Solar System, and the availability of teaching materials which are still dominated by printed texts (textbooks). Research data confirms that only 37.9% of teachers feel that the current learning conditions are adequate, while the majority of teachers (89.6%) stated an urgent need for more interactive and concrete teaching materials.

The study results show that 69.7% of teachers have a positive perception of the potential of AR technology, but its implementation in the field is still hampered by the limited availability of digital content relevant to the national curriculum. Therefore, future AR application development must meet specific specifications, namely being user-friendly for teachers and students, and having offline access features to overcome internet network infrastructure constraints in schools. Thus, the integration of AR technology is expected to not only be a digital innovation but also be an effective solution in visualizing abstract science and science material to improve the quality of students' learning experiences in elementary schools.

REFERENCES

- Akçayır, M., & Akçayır, G. (2017). "Advantages and challenges associated with augmented reality for education: A systematic review of the literature." *Educational Research Review*, 20, 1–11. <https://doi.org/https://doi.org/10.1016/j.edurev.2017.02.002>
- Alfina, Z. T., S., & Rusilowati, A., Subali, B & Lestari, W. (2024). "Analysis of the Needs for Science Learning Media Based on QR-TET Plant Cards Integrated with Augmented Reality." *SAP (Susunan Artikel Pendidikan)*, 9(1), 102. <https://doi.org/10.30998/sap.v9i1.23721>
- Amirahma, S., & Setyasto, N. (2024). "Development of Augmented Reality-Assisted Teaching Materials in Science Subjects: Solar System Topic." *Jurnal Penelitian Pendidikan IPA*, 10(5), 2346–2355. <https://doi.org/10.29303/jppipa.v10i5.7027>
- Arikunto, S. (2013). *Prosedur Penelitian : Suatu Pendekatan Praktik*. Rineka Cipta.
- Azuma, R., et al. (2001). "Recent advances in augmented reality." *IEEE Computer Graphics and Applications*, 21(6), 34–47. <https://doi.org/https://doi.org/10.1109/38.963459>
- Bacca et al. (2018). "Framework for designing motivational augmented reality learning experiences in STEM." *Journal of Computer Assisted Learning*, 34(6), 799–813.

- <https://doi.org/https://doi.org/10.1111/jcal.12289>
- Cahdriyana, R. A & Nurnugroho, B. A. (2023). "Analisis Kebutuhan Pengembangan Multimedia Pembelajaran Berbasis Augmented Religiusitas Anak (Studi Kasus di Desa Ketitang Jawa Tengah) Reality Untuk Mengembangkan Keterampilan Berpikir Komputasi." *LITERASI (Jurnal Ilmu Pendidikan)*, XV(1). [https://doi.org/10.21927/literasi.2022.13\(1\).1-12](https://doi.org/10.21927/literasi.2022.13(1).1-12)
- Cano et al. (2020). "A framework for the design of educational augmented reality experiences for children." *Proceedings of the 21st International Conference on Human Computer Interaction*, 1–8.
- Chen, P., et al. (2020). "A review of using augmented reality in education from 2011 to 2016." Springer, Singapore. https://doi.org/https://doi.org/10.1007/978-981-10-2419-1_2
- Creswell, J. W., & Poth, C. N. (2018). "Qualitative inquiry and research design: Choosing among five approaches." SAGE Publications.
- Garzón, J. (2021). "An Overview of Twenty-First Century Skills Through Augmented Reality: A Case Study." *Interactive Learning Environments*, 32(1), 74–88.
- Huang, C. Y., Chou, Y. Y., Chen, C. H. & Tsai, Y. H. (2022). "Applying Activity System-Based Process Model in Augmented Reality-Based Learning for Natural Science Course in Elementary School." *Hindawi Mobile Information Systems*, 2022. <https://doi.org/10.1155/2022/9579766>
- Koehler, M. J., & Mishra, P. (2009). "What is technological pedagogical content knowledge (TPACK)?" *Contemporary Issues in Technology and Teacher Education.*, 9(1).
- Mayer, R. E. (2021). "Multimedia Learning (3rd Edition)." Cambridge University Press.
- Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). "Qualitative Data Analysis: A Methods Sourcebook (3rd ed.)." SAGE Publications.
- Moleong, L. J. (2017). "Metodologi penelitian kualitatif." Remaja Rosdakarya.
- Pombo, L., & Marques, M. M. (2019). "Augmented reality in education: Main trends and challenges." Springer Nature.
- Sirakaya, M., & Sirakaya, D. A. (2022). "Trends in Educational Augmented Reality Studies: A Systematic Review." *International Journal of Contemporary Educational Research (IJCER)*, 9(2), 311–326. <https://doi.org/https://www.google.com/search?q=https://doi.org/10.33200/ijcer.1032152>
- Sugiyono. (2020). *Metodologi Penelitian Kuantitatif, Kualitatif dan R & D*. Alfabeta Bandung.
- Zahro, F & Fauziah, A. N. M. (2024). "Peran dan tantangan guru IPA dalam pengimplementasian kurikulum merdeka untuk konservasi alam dan kearifan lokal." *Prosiding Seminar Nasional* <https://proceeding.unesa.ac.id/index.php/semnasipa/article/view/729%0Ahttps://proceeding.unesa.ac.id/index.php/semnasipa/article/download/729/547>