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Needs Analysis: STEM-Based Interactive Learning Using Unity 3D As An Innovative Learning Media Solution For Elementary School Students

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Abstract

This study aims to analyze the needs for developing an interactive learning media based on Science, Technology, Engineering, and Mathematics (STEM) using the Unity 3D application for elementary school education. The needs analysis was conducted to identify students' characteristics, teachers' needs, learning media requirements, and instructional design requirements as the foundation for developing effective and relevant learning media. This study employed a mixed-methods approach involving 103 students and 5 teachers. The data were analyzed using descriptive quantitative methods to obtain a comprehensive overview of instructional needs. The findings indicate that students' needs were categorized as high, with percentages ranging from 80.64% to 85.30%. The socio-cultural aspect showed the highest level of need (85.30%), followed by the pedagogical and technical aspects, while the cognitive aspect had the lowest percentage (80.64%). The analysis of teachers' needs also revealed high ratings across all aspects, ranging from 77% to 92%. The socio-cultural aspect was the most dominant (92%), whereas the aesthetic aspect received the lowest score (77%), although it remained within the good category. The learning media needs analysis showed percentages ranging from 80% to 85%, with the cognitive and aesthetic aspects receiving the highest scores (85%), while the pedagogical, technical, and evaluation aspects each obtained 80%. Regarding instructional design needs, the results ranged from 80% to 86%, with the pedagogical aspect receiving the highest score (86%) and the aesthetic aspect the lowest (80%). These findings demonstrate a strong need for STEM-based interactive learning media developed using Unity 3D to support more interactive,

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contextual, and student-centered learning. Such STEM-based media have the potential to enhance students' learning motivation, conceptual understanding, critical thinking, creativity, collaboration, and problem-solving skills in alignment with the objectives of the Merdeka Curriculum.

Keywords: STEM, Unity 3D, instructional design, learning needs, innovative learning media, elementary school, educational technology.

INTRODUCTION

Science education in elementary schools plays a fundamental role in developing scientific literacy, critical thinking, and problem-solving abilities that are essential for lifelong learning. In today's rapidly evolving technological landscape, educational systems are expected to prepare learners with competencies that extend beyond factual knowledge, including creativity, collaboration, communication, and digital literacy. These competencies have become central objectives of twenty-first-century education and are strongly emphasized in Indonesia's Merdeka Curriculum.

Despite these educational reforms, Indonesian students continue to demonstrate relatively low achievement in scientific literacy. According to the Programme for International Student Assessment (PISA) 2022, Indonesia obtained an average science score of 383, considerably below the OECD average of 485. Furthermore, only approximately one-third of Indonesian students reached the minimum level of scientific competency, indicating persistent difficulties in understanding scientific concepts and applying them in authentic contexts. These findings suggest that science instruction in elementary schools requires significant improvement, particularly in developing students' conceptual understanding and higher-order thinking skills.

One of the major contributing factors is the continued reliance on teacher-centered instructional approaches. Conventional classroom practices frequently emphasize lectures and textbook-based instruction, limiting students' opportunities to actively construct knowledge through exploration and experimentation. Consequently, learners often memorize scientific facts without fully understanding the relationships among scientific concepts or their application in everyday life. Such instructional practices reduce students' motivation, curiosity, and engagement throughout the learning process.

Recent educational research has consistently demonstrated that interactive learning media can substantially improve students' motivation, conceptual understanding, and

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participation in classroom activities. Digital learning environments provide opportunities for students to visualize abstract concepts, manipulate virtual objects, receive immediate feedback, and engage in inquiry-based learning experiences. These characteristics make technology-enhanced learning particularly suitable for science education, where many concepts cannot be directly observed through traditional classroom instruction.

Among various educational approaches, Science, Technology, Engineering, and Mathematics (STEM) education has gained international recognition as an effective framework for integrating interdisciplinary knowledge into authentic learning experiences. STEM education encourages learners to investigate real-world problems through scientific inquiry, engineering design, technological applications, and mathematical reasoning. Rather than studying each discipline separately, students develop integrated knowledge while simultaneously enhancing creativity, collaboration, communication, and critical thinking.

The effectiveness of STEM learning can be further enhanced through the use of interactive digital technologies. Unity 3D has emerged as one of the most promising platforms for developing immersive educational media because it enables educators to create three-dimensional interactive environments without requiring advanced programming expertise. Unity 3D supports multimedia integration, interactive simulations, animations, and virtual exploration, allowing students to experience scientific phenomena more concretely than conventional instructional media.

Preliminary observations conducted in several elementary schools revealed that teachers still experience difficulties in teaching abstract science topics because available instructional media remain limited. Most teachers continue using worksheets, static images, PowerPoint presentations, and verbal explanations, while digital interactive media are rarely utilized. Students also expressed greater enthusiasm when learning activities involved animations, videos, and interactive visualizations, suggesting that innovative digital media have substantial potential to improve learning outcomes.

Based on these challenges, this study aims to analyze the instructional needs for developing STEM-based interactive learning media using Unity 3D in elementary schools. The needs analysis investigates learner characteristics, teachers' readiness, instructional media requirements, and instructional design considerations that serve as the foundation for developing an effective, engaging, and contextually relevant learning environment. The findings are expected to provide empirical evidence supporting the integration of STEM pedagogy and interactive technology in elementary science education while contributing to the implementation of

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Indonesia's Merdeka Curriculum.

METHOD

This study employed the Design-Based Research (DBR) approach, focusing on the needs analysis stage. This stage included both instructional content analysis and user needs analysis involving teachers and students. According to Amiel and Reeves (2008) in *Design-Based Research and Educational Technology: Rethinking Technology and the Research Agenda*, the DBR approach consists of several systematic phases that serve as guidelines for the development of educational products. These stages are illustrated in Figure 1.

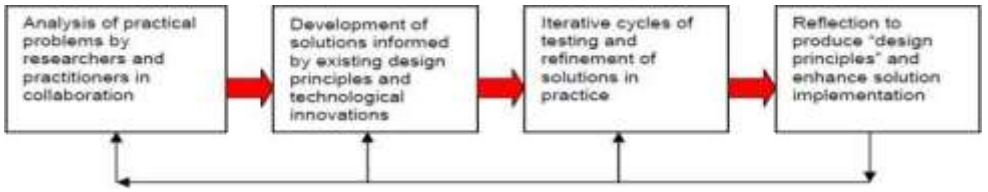


Figure 1. Design-Based Research Framework Adapted from Amiel and Reeves (2008)

The participants in this study consisted of five Grade V elementary school teachers and 103 students from three elementary schools located in Ilir Barat I District, Palembang, Indonesia. Participants were selected using purposive sampling based on several criteria: teachers had at least two years of experience teaching science, students had previously studied the Earth's structure topic, and the participating schools possessed basic technological facilities that supported the implementation of the research.

Data were collected using three primary techniques. First, document analysis was conducted to examine the curriculum and instructional materials in order to identify the key concepts related to the Earth's structure and to analyze their potential visualization through Unity 3D-based learning media. Second, classroom observations were carried out during science learning activities to obtain information regarding the existing instructional media, teaching strategies employed by teachers, and the challenges encountered during classroom instruction. Third, semi-structured interviews were conducted with both teachers and students using systematically developed interview guidelines to explore teachers' difficulties in explaining abstract concepts as well as students' needs, experiences, and expectations regarding the interactive learning media to be developed.

The research instruments consisted of document analysis sheets, observation sheets, and

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semi-structured interview guidelines. All qualitative data were analyzed using a descriptive qualitative approach through the classification of instructional content according to levels of concreteness and abstraction, triangulation of multiple data sources, and interpretation supported by relevant literature (Ariyanti, 2020). The results of the needs analysis served as the foundation for formulating the specifications of the STEM-based Unity 3D learning media, determining the instructional design principles to be implemented, and developing recommendations for instructional media that are appropriate to user characteristics and elementary school learning needs.

Throughout the research process, ethical considerations were carefully maintained. Prior to data collection, informed consent was obtained from all participants. Furthermore, the confidentiality of participants' identities and the information they provided was protected in accordance with established research ethics principles.

The needs analysis for the development of STEM-based Unity 3D learning media employed a mixed-methods approach, integrating both quantitative and qualitative methods. The quantitative component involved administering questionnaires to obtain an overview of users' needs and preferences. Meanwhile, the qualitative component consisted of classroom observations, interviews with teachers and students, and questionnaire distribution to obtain more comprehensive information regarding the existing learning conditions, student characteristics, the use of current instructional media, and the potential implementation of STEM-based Unity 3D learning media. All of these activities were conducted during the Analyze phase of the Design-Based Research process as the basis for designing instructional media that address the actual needs identified in the field.

RESULTS AND DISCUSSION

RESULTS

The data collection instruments consisted of needs analysis questionnaires (administered to both students and teachers) and semi-structured interviews. Quantitative data obtained from the questionnaires were analyzed descriptively using percentage analysis, whereas qualitative data collected through interviews and classroom observations were analyzed using the Miles and Huberman model, which includes data reduction, data display, and conclusion drawing/verification.

The quantitative instrument employed a Likert-scale questionnaire to measure students' needs for Unity 3D-based learning media. The questionnaire data were analyzed using descriptive

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statistics, while thematic analysis was applied to the interview transcripts to identify qualitative patterns related to students' motivation and the challenges of implementing STEM learning in elementary schools.

Table 1. Blueprint of the Needs Analysis Instrument

No	Sub- Aspek	No. Pernyataan	Guru	Media Desain Instruksional	
I	Pedagogis	1–6	1–4	1–4	1,2
II	Teknik	7–10	5–8	5–8	3,4
III	Kognitif	11–14	9–12	9–11	5
IV	Estetika	15–18	13–16	12–15	6
V	Sosial Budaya	19–20	17–19	16–21	7,8
VI	Evaluasi	21–24	20–23	22–25	9,10

The data were analyzed using percentage analysis based on the following formula:

$$P = \frac{}{N} \times 100\ \%$$

where:

- P = Percentage
- f = Total score obtained
- N = Maximum possible score

The resulting percentages were then classified into four levels of needs: very low, low, moderate, and high.

Table 2. Needs Classification Criteria

Percentage (%)	Needs Category
0–25	**Very Low**
26–50	**Low**
51–75	**Moderate**
76–100	**High**

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RESULTS AND DISCUSSION

This section presents the findings of the study conducted to identify the requirements for developing interactive learning media. The analysis was carried out comprehensively through four major dimensions: students' needs, teachers' needs, learning media needs, and instructional design needs. These four dimensions served as the basis for formulating learning solutions that are appropriate, effective, and aligned with the characteristics and conditions of the elementary school learning environment.

Students' Needs Analysis



Figure 2. Students' Needs Analysis across Different Aspects

Based on Figure 2, all assessed aspects achieved percentages within the high category, ranging from 80.64% to 85.30%. The socio-cultural aspect obtained the highest percentage (85.30%), followed by the technical and pedagogical aspects, indicating that the proposed learning media are well aligned with students' learning contexts and instructional requirements. Although the cognitive aspect recorded the lowest percentage (80.64%), it remained within the high category. Overall, these findings indicate that the proposed learning media are considered feasible and meet quality standards across multiple dimensions, although several aspects could still be further improved.

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Teachers' Needs Analysis

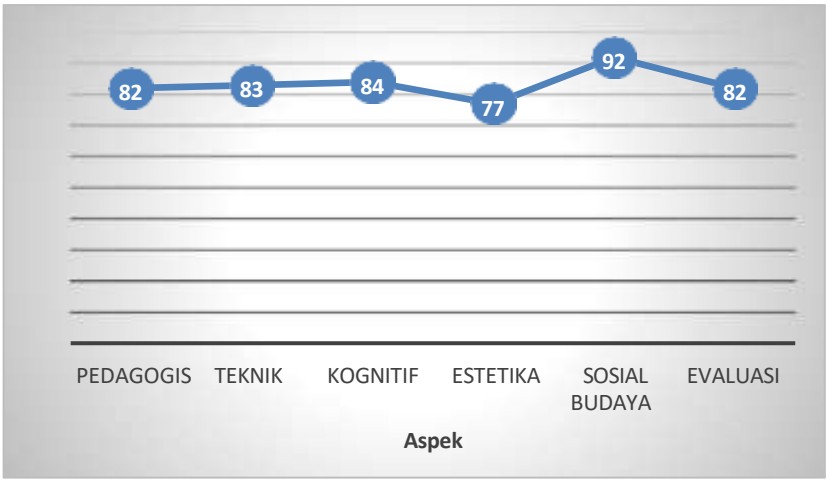


Figure 3. Teachers' Needs Analysis across Different Aspects

As illustrated in Figure 3, all evaluation aspects demonstrated relatively high levels of need, with percentages ranging from 77% to 92%. The socio-cultural aspect achieved the highest percentage (92%), indicating that the proposed learning media are highly compatible with the social context and characteristics of elementary school students. The technical and cognitive aspects also produced strong results, with percentages of 83% and 84%, respectively, suggesting that the media meet the required technical standards while effectively supporting students' cognitive development.

Both the pedagogical and evaluation aspects obtained scores of 82%, indicating that the proposed media are considered effective in supporting instructional activities and assessment processes. The aesthetic aspect received the lowest percentage (77%). Although it remains within the high category, this result suggests that improvements in visual appearance, interface design, and overall attractiveness should be considered during future development.

Teacher Interviews

Interviews conducted with elementary school teachers in Palembang revealed that lecture-based instruction and group discussions remain the most frequently implemented teaching methods because they are considered practical and compatible with classroom conditions. Teachers also reported that the scientific approach and thematic learning approach are widely adopted since both are consistent with the objectives of the Merdeka Curriculum and

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encourage students to actively observe, question, experiment, and draw conclusions during the learning process.

Regarding instructional media, teachers explained that they primarily utilize student worksheets, printed images, educational videos, and PowerPoint presentations. Although digital learning media such as Unity 3D were perceived as highly attractive and potentially beneficial, their implementation remains limited due to teachers' insufficient experience in developing STEM-based instructional media.

Teachers also identified several challenges encountered during classroom instruction. The primary obstacles include limited technological facilities, particularly the availability of tablets and smartphones capable of supporting digital educational applications. Furthermore, students demonstrate varying levels of digital literacy, requiring teachers to allocate additional instructional time when integrating digital technologies into classroom activities.

Despite these challenges, teachers observed that students are generally familiar with technology in their daily lives, particularly through the use of their parents' smartphones for watching videos. However, when technology is used as a learning tool, students still require guidance to operate educational applications effectively.

Teachers further emphasized that students' enthusiasm and engagement increase considerably whenever visual and interactive media are incorporated into classroom instruction. Students respond positively to animations, moving images, and multimedia presentations. Therefore, teachers believe that implementing innovative instructional media such as Unity 3D has strong potential to improve students' motivation, participation, and overall learning experiences.

Learning Media Needs Analysis

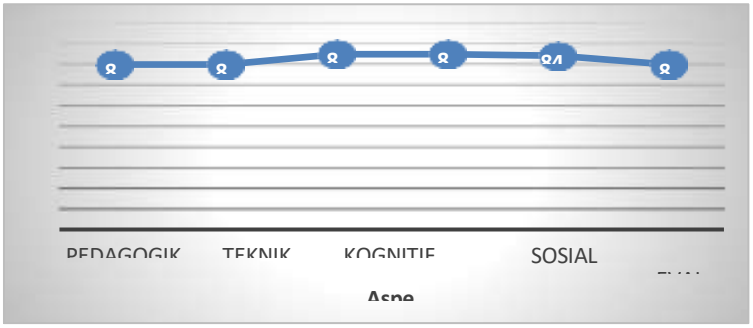


Figure 4. Learning Media Needs Analysis across Different Aspects

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Based on Figure 4, the need for instructional media across all evaluated aspects demonstrated consistently positive results, with percentages ranging between 80% and 85%. The pedagogical, technical, and evaluation aspects each obtained 80%, indicating that instructional media continue to play an important role in supporting classroom learning.

The cognitive and aesthetic aspects achieved the highest percentages (85%), suggesting that students strongly require learning media capable of facilitating conceptual understanding while providing attractive and interactive visual presentations. Meanwhile, the socio-cultural aspect reached 84.3%, indicating that integrating cultural values and local contexts into instructional media is also considered important, although slightly less than cognitive and aesthetic considerations.

Instructional Design Needs Analysis

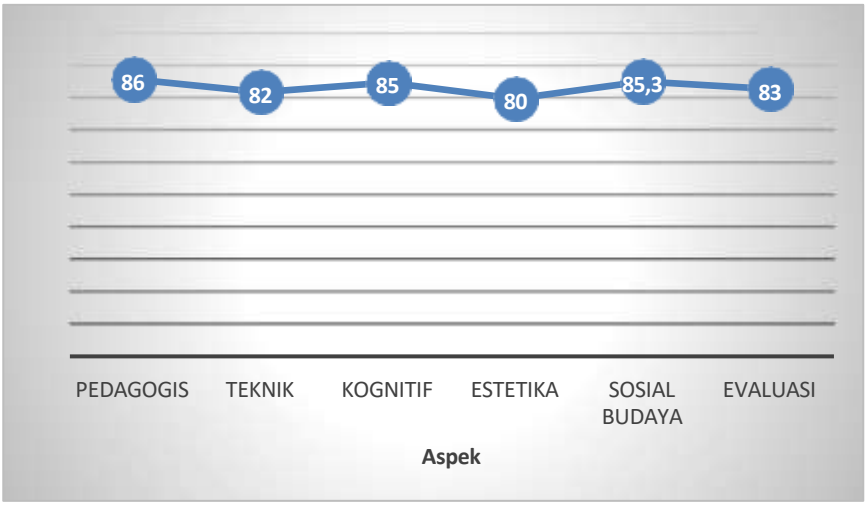


Figure 5. Instructional Design Needs Analysis across Different Aspects

Based on Figure 5, the instructional design needs demonstrated relatively consistent percentages ranging from 80% to 86% across all evaluated dimensions. The pedagogical aspect achieved the highest percentage (86%), indicating that students require instructional media capable of directly supporting learning objectives and competency achievement.

The cognitive and socio-cultural aspects also demonstrated high percentages (85% and 85.3%, respectively), emphasizing the importance of instructional media that facilitate the understanding of complex scientific concepts while remaining relevant to students' cultural

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backgrounds and everyday experiences.

Meanwhile, the technical aspect obtained 82%, and the aesthetic aspect achieved 80%. Although comparatively lower, these results still indicate substantial needs for reliable technological performance and visually appealing instructional design. Finally, the evaluation aspect reached 83%, demonstrating that students also expect instructional media to incorporate effective assessment features capable of supporting the overall learning process.

DISCUSSION

Based on the analysis of the four graphs covering the pedagogical, technical, cognitive, aesthetic, socio-cultural, and evaluation aspects, all dimensions demonstrated high levels of need, with average percentages ranging from 77% to 92%. The highest scores were consistently observed in the socio-cultural aspect and students' interest, indicating that the proposed learning media are well aligned with students' learning contexts and are capable of attracting their attention. Overall, the findings from the four analyses suggest that teacher readiness, student preparedness, media feasibility, and instructional design requirements collectively provide a strong foundation for the development of innovative learning media.

The findings further confirm that STEM-based interactive learning has considerable potential for implementation in elementary education. The high percentage observed in the students' interest dimension indicates that STEM-based instruction can create an engaging, enjoyable, and motivating learning environment that encourages active participation throughout the instructional process. Moreover, the positive results in the cognitive and instructional process dimensions suggest that STEM-based learning supports students in understanding abstract scientific concepts through three-dimensional visualization and interactive simulations.

The availability of technological facilities and adequate infrastructure also strengthens the feasibility of implementing Unity 3D-based instructional media. The participating schools possessed sufficient technological resources, enabling both teachers and students to utilize the proposed learning media without major technical barriers. Consequently, the integration of STEM pedagogy with Unity 3D technology has the potential to enhance instructional quality by providing meaningful visualization, interactivity, and contextual learning experiences for elementary school students.

These findings are consistent with previous studies reporting that STEM-based learning promotes students' motivation, conceptual understanding, and higher-order thinking skills. By integrating science, technology, engineering, and mathematics within authentic learning contexts,

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STEM encourages learners to investigate problems, develop creative solutions, and apply scientific knowledge in real-life situations. Such learning experiences contribute not only to improved academic achievement but also to the development of twenty-first-century competencies, including critical thinking, creativity, communication, and collaboration.

From a pedagogical perspective, the implementation of STEM-based interactive learning provides numerous educational benefits. Interactive learning activities encourage students to participate actively rather than passively receiving information from teachers. Through direct interaction with virtual objects and multimedia simulations, learners become more motivated, focused, and engaged during classroom activities. This finding supports the argument that technology-enhanced learning environments create more meaningful educational experiences than conventional instructional approaches.

From the cognitive perspective, Unity 3D-based learning media facilitate conceptual understanding by transforming abstract scientific phenomena into concrete visual representations. Three-dimensional objects, animations, and interactive simulations enable students to observe scientific processes that are otherwise difficult to visualize using traditional instructional materials. Consequently, students are better able to construct conceptual understanding, retain learning content, and transfer knowledge to real-world situations.

The findings also highlight the importance of visual design and user experience in educational media development. Although the aesthetic aspect obtained the lowest percentage among all dimensions, it remained within the high category, indicating that visual appearance should receive greater attention during future development. Improving interface design, animation quality, navigation, and user interaction will likely increase students' engagement and optimize learning effectiveness.

For teachers, the proposed STEM-based Unity 3D learning media provide practical advantages by facilitating the presentation of instructional materials in a more engaging, innovative, and technologically relevant manner. Interactive visualization reduces teachers' difficulties in explaining abstract scientific concepts while simultaneously creating richer learning experiences for students. Therefore, integrating STEM pedagogy with Unity 3D technology represents an effective strategy for improving elementary science education and supporting the implementation of the Merdeka Curriculum.

CONCLUSION

This study analyzed the instructional needs for developing STEM-based interactive learning

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media using Unity 3D for elementary school science education. The findings indicate that all evaluated dimensions—including pedagogical, technical, cognitive, aesthetic, socio-cultural, and evaluation aspects—achieved high levels of need, with percentages ranging from 77% to 92%. These results demonstrate that the current learning environment, teacher readiness, technological infrastructure, and student characteristics provide favorable conditions for implementing innovative STEM-based instructional media.

The highest scores were observed in the socio-cultural and students' interest dimensions, indicating that elementary school students respond positively to technology-supported learning environments. Meanwhile, the relatively lower scores in the aesthetic dimension suggest that future media development should prioritize improvements in interface design, visual presentation, and instructional flow to maximize learning effectiveness.

Overall, the results of the needs analysis confirm that the development of Unity 3D-based STEM learning media is both relevant and necessary for elementary education. Such media have the potential to enhance students' motivation, conceptual understanding, engagement, and higher-order thinking skills while supporting teachers in delivering science instruction more effectively through interactive and contextual learning experiences.

The findings also provide important implications for instructional media development. First, the positive responses from both teachers and students indicate that STEM-based interactive learning media can serve as an effective strategy for improving science education in elementary schools. Second, the availability of adequate technological facilities suggests that schools are increasingly prepared to integrate digital technologies into classroom instruction. Finally, future development should emphasize user-centered interface design, improved multimedia quality, and well-structured instructional sequences to ensure that STEM-based Unity 3D learning media provide meaningful, engaging, and effective learning experiences.

Furthermore, future research is recommended to proceed beyond the needs analysis stage by developing, validating, and evaluating the effectiveness of the proposed Unity 3D-based STEM learning media through classroom implementation. Such studies will provide empirical evidence regarding the impact of the developed media on students' scientific literacy, conceptual understanding, critical thinking, creativity, and overall learning outcomes in elementary science education.

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the completion of this research article. The authors hope that this study will be accepted and provide valuable benefits to readers. The authors acknowledge that this work still has several limitations and therefore welcome constructive suggestions and feedback for future improvement. The authors also hope that the STEM-based learning media developed using the Unity 3D application for the topic of Energy and Its Changes can serve as an innovative learning medium that enhances students' understanding, learning motivation, and engagement in elementary science education.

REFERENCES

Adiputra, D. K. (2025). *Transformasi Pembelajaran Abad 21* (K. Khatima, Ed.). Goresan Pena.

Arce, C. L., Cabuyaban, J. J., Gaces, S. K., & Pagtaconan, W. C. (2018). *ARSci: Unity 3D-Based Learning Tool in Earth Science*. https://doi.org/10.56278/apherj.v5i1.866

Ariyanti, Y. (2020). *Keterampilan Manajerial Kepala Sekolah dalam Meningkatkan Kinerja Guru*. *AKSES: Jurnal Ekonomi dan Bisnis, 14*(1). https://doi.org/10.31942/akses.v14i1.3265

Audie, N. (2019). *Peran Media Pembelajaran Meningkatkan Hasil Belajar Peserta Didik*. *Prosiding Seminar Nasional Pendidikan FKIP, 2*(1), 586–595. https://jurnal.untirta.ac.id/index.php/psnp/article/view/5665

Azuma, R. T. (1997). *A Survey of Unity 3D*. In *Presence: Teleoperators and Virtual Environments* (Vol. 6). http://www.cs.unc.edu/~azumaW

Belva Saskia Permana, Lutvia Ainun Hazizah, & Yusuf Tri Herlambang. (2024). *Teknologi Pendidikan: Efektivitas Penggunaan Media Pembelajaran Berbasis Teknologi di Era Digitalisasi*. *Khatulistiwa: Jurnal Pendidikan dan Sosial Humaniora, 4*(1), 19–28. https://doi.org/10.55606/khatulistiwa.v4i1.2702

Bybee, R. W. (2013). *The Case for STEM Education: Challenges and Opportunities*. National Science Teachers Association.

Faria, A. (2024). Unity 3D and teaching strategies in the study of volcanism in elementary and secondary schools. *Journal of New Approaches in Educational Research, 13*(1). https://doi.org/10.1007/s44322-024-00018-5

Fitriyeni, F. (2023). Pengembangan LKPD Digital Berbasis Etnosains Melayu Riau pada Muatan IPA Sekolah Dasar. *Jurnal Basicedu, 7*(1), 441–451. https://doi.org/10.31004/basicedu.v7i1.4399

Hermanto, Bariroh, W., Muzakki, M. A., & Hendi Ade. (2024). Teknologi Unity 3D sebagai Media Pembelajaran Geografi Struktur Lapisan Bumi. *Jurnal Ilmu Komputer dan Desain*

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Komunikasi Visual. https://doi.org/10.55732/jikdiskomvis.v9i2.1458

Hermawan, A., & Hadi, S. (2024). Realitas Pengaruh Penggunaan Teknologi Unity 3D dalam Pembelajaran terhadap Pemahaman Konsep Siswa. *Jurnal Simki Pedagogia, 7*(1), 328–340. https://doi.org/10.29407/jsp.v7i1.694

Ibáñez, M. B., & Delgado-Kloos, C. (2018). Unity 3D for STEM learning: A systematic review. *Computers & Education, 123*, 109–123. https://doi.org/10.1016/j.compedu.2018.05.002

Irsan, I. (2021). Implementasi Literasi Sains dalam Pembelajaran IPA di Sekolah Dasar. *Jurnal Basicedu, 5*(6), 5631–5639. https://doi.org/10.31004/basicedu.v5i6.1682

Imawati, Y., & Chamidah, A. N. (2018). Efektivitas media berbasis Unity 3D terhadap kemampuan anak tunarungu mengenal kebudayaan Yogyakarta. https://doi.org/10.21831/jpk.v14i1.25164

Kamila, U. S., & Sukartono. (2023). Penerapan Media Pop-Up Book pada Pembelajaran IPAS Materi *Ayo Berkenalan dengan Bumi Kita* pada Siswa Kelas V SD Negeri 2 Kalirejo. *Jurnal Elementaria Edukasia, 6*(4), 1872–1882. https://doi.org/10.31949/jee.v6i4.7610

Komariah, M., As'ary, M. Y., Hanum, C. B., & Maftuh, B. (2023). IPAS implementation in elementary schools: How teachers build student understanding. *Edunesia: Jurnal Ilmiah Pendidikan, 4*(3), 1399–1412. https://doi.org/10.51276/edu.v4i3.533

Kusyana, K., Muzfirah, S., & Haryadi, R. N. (2024). Efektivitas dan Kendala Penggunaan Media Digital dalam Pengajaran Bahasa. *Wistara: Jurnal Pendidikan Bahasa dan Sastra, 5*(1), 92–102. https://doi.org/10.23969/wistara.v5i1.13954

Lidinillah, D. A. M., Mulyana, E. H., Karlimah, K., & Hamdu, G. (2019). Integration of STEM learning into the elementary curriculum in Indonesia: An analysis and exploration. *Journal of Physics: Conference Series, 1318*(1). https://doi.org/10.1088/1742-6596/1318/1/012053

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