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Technology-Based Learning Through Unity Application in Teaching Spatial Volume of Geometric Shapes for 6th Grade Elementary School Students

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ABSTRACT

Technological advancements require educators to be more innovative in the process of teaching mathematics. Therefore, this journal serves as a renewal in utilizing technological advancements, especially in the field of education. The purpose of this research is to create interactive multimedia that utilizes technology to develop a learning application using Augmented Reality (AR). This research utilizes the Multimedia Development Life Cycle (MDLC) method, which consists of concept, design, material, collecting, assembly, testing, and distribution. Based on the research findings, it can be concluded that the learning media in the form of a Unity application for the mathematical concept of spatial volume can be well-designed through its development method, enabling effective learning to achieve learning objectives.

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1. INTRODUCTION

The rapid development of science and technology necessitates constant updates in the utilisation of technological advancements, especially in the field of education (Mulyani and Haliza, 2021). Education is closely intertwined with the fast-paced technological advancements, often referred to as the Fourth Industrial Revolution (Spoettl and Tūtlys, 2020). This demands that we strive to balance and become knowledgeable about technology, harnessing its benefits to the fullest.

One area where technology is being utilized in education is through instructional media. Instructional media plays a crucial role in the teaching and learning process, contributing to its success and objectives. As time progresses and technology advances, instructional media has undergone significant development and introduced new innovative ideas. One such technological advancement used in instructional media is Augmented Reality (AR) technology.

AR is an information and communication technology that connects two-dimensional or three-dimensional (virtual) elements to the three-dimensional (real) world (LaFleur et al., 2013). Augmented reality was discovered by Morton Heilig, a cinematographer, and is now widely used in various applications such as Unity (Algarawi et al., 2018). Unity 3D is a software used for creating various applications such as presentations, websites, and AR experiences. It enables the creation of 3D objects for video games or other interactive contexts such as visualization or 3D animation.

In addition to Unity, Vuforia is also a software used in the creation of interactive instructional media (Okanovic et al., 2022). Vuforia is a software development kit for augmented reality. It is a plugin that integrates with 3D elements. Vuforia works by identifying and tracking target images and simple 3D objects such as boxes in real-time (Barrile et al., 2019). These technologies are widely used in educational contexts, including teaching the concept of spatial volume in mathematics (Amin and Govilka, 2015).

This research focuses on the topic of spatial volume. According to Diwata as cited in (Mu'adz, 2016:19), geometric shapes with volume are three-dimensional objects. In teaching the concept of spatial volume, interactive multimedia utilizing technology can be employed, such as developing a learning application using Augmented Reality (AR).

2. METHODS

The research utilizes the methodology of the Multimedia Development Life Cycle (MDLC) (Mustika et al., 2017), which consists of the following stages:

2.1. Concept

In this stage, the researcher determines the objectives and target users of the application. The application aims to display 3D objects, and the concept includes the following processes: displaying 3D objects, enabling rotation, displaying available features, providing user guidance, and application development (Rachmanto, 2018).

2.2. Design

The design process involves creating the design, layout, and program visualisation. In this stage, the researcher designs the concept that will be implemented in the application, including the initial interface, content, AR integration, and final appearance (Nee et al., 2022).

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2.3. Material collecting

This stage involves gathering materials, content, elements, hardware, and software required for the project. The application utilities tools such as Unity and Android, as well as other necessary components for designing the project (Nguyen et al., 2019).

2.4. Assembly

The assembly stage involves the actual creation of the application, following the concept, design, and material collecting stages (Pisano, 1994).

2.5. Testing

In this stage, the application is executed and tested to ensure its functionality. The researcher examines whether the AR scenes and application components are working correctly. Through testing, the researcher can determine if the application functions as intended (Henderson and Feiner, 2010).

2.6. Distribution

The distribution stage involves packaging the application into a deployable file, ready to be run and demonstrated (Gokhale et al., 2008).

3. RESULTS AND DISCUSSION

The developed learning application focuses on teaching the concept of spatial volume of geometric shapes, featuring 3D representations of shapes such as cubes, rectangular prisms, pyramids, spheres, prisms, and cylinders (Putra et al., 2021).

3.1. Concept

According to (Husniah et al., 2020), the concept for the development of this application includes the following:

a. User

The application is specifically designed for 6th-grade elementary school students who are learning about spatial volume. It is also intended for users who are interested in visualizing 3D objects.

b. Application Type

The application is designed to run on Android operating systems and utilizes augmented reality technology.

c. Objectives of the Application

The primary objective is to provide a learning medium that stimulates students' interest in learning, with visually appealing content and the implementation of augmented reality technology to display 3D objects.

d. General Specifications of the Application

The general specifications of the application include: (1) development using Unity, (2) creation of 3D geometric shape models using ProBuilder, (3) implementation of

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augmented reality using the Vuforia SDK plugin in Unity, (4) interaction with the 3D objects, allowing zooming and rotation, utilizing the Lean Touch plugin in Unity, and (5) displaying the 3D models by detecting target markers through image recognition.

3.2. Design

The design of this multimedia application is presented in the application's flowchart as follows:

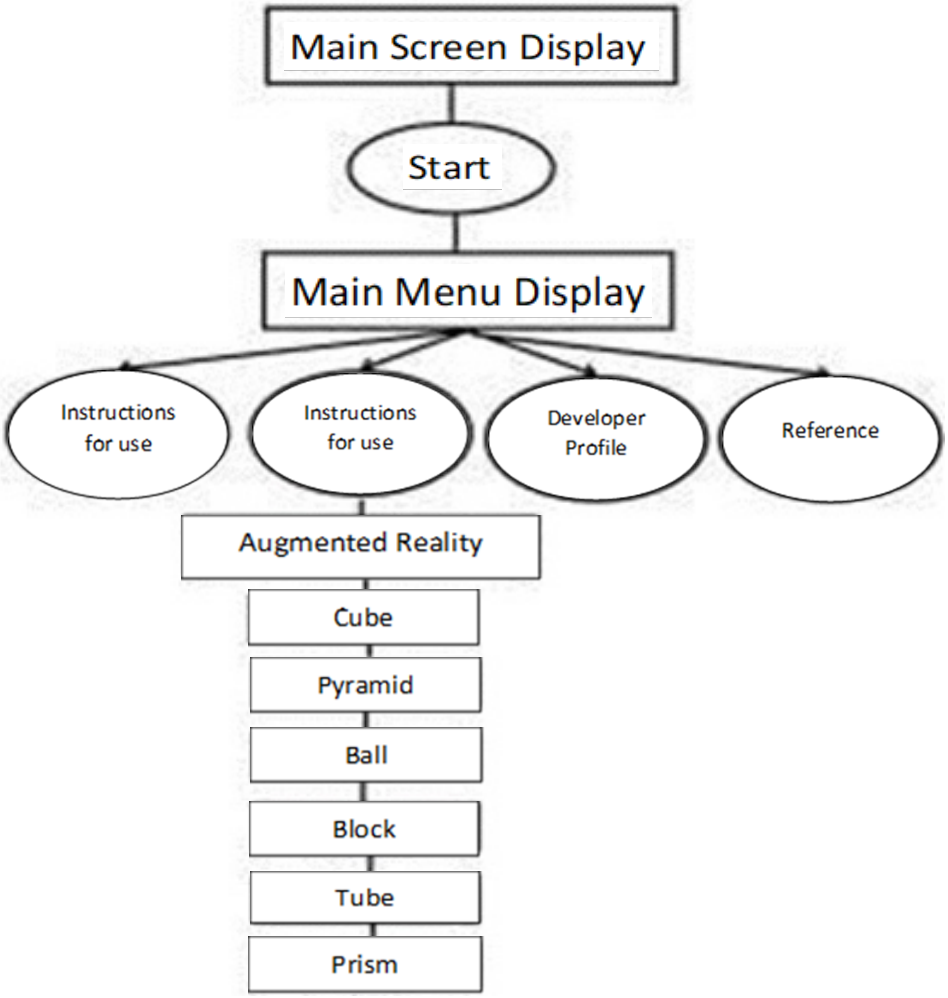

Figure 1. Application flowchart

3.3. Material collecting

The next step in application development is to gather the necessary materials for creating the spatial volume application. The materials collected align with the established concept. These materials include backgrounds, buttons, and images used as augmented reality targets (Jhonson and Huang, 2009).

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Table 1. Application material

Background dan Material

Button

Augmented Reality Target Picture

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3.4. Assembly

According to (Rahman and Tresnawati, 2016), this stage involves the integration of the collected materials. In this stage, the application is developed using Unity Hub Editor software. Canva is used for designing backgrounds, and Visual Studio Code is utilized for coding purposes.

Figure 2. Development using unity hub editor.

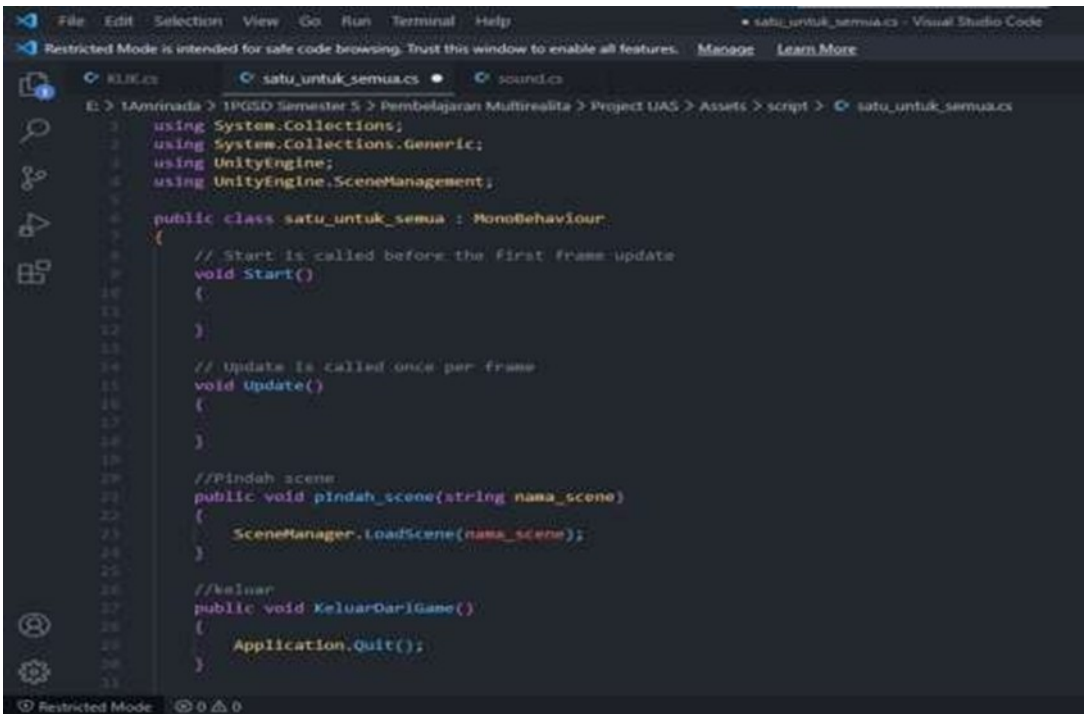

Figure 3. Coding with visual studio code

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Figure 4. Application display

3.5. Testing

In this stage, Black Box Testing technique is utilized. According to (Sugiarto, 2018), this testing technique involves running the application and observing if there are any errors or issues present after the development process. The following table presents the testing results:

Table 2. Test result

No	Test	Activity	Result
1	Image	Testing background image	Very Good
		Testing button image	Very Good
2	Button	Testing Start Button	Very Good
		Testing Menu Button	Very Good
		Testing Material Button	Very Good
		Testing Audio On/Off Button	Very Good
		Testing Close Button	Very Good
3	*Augmented Reality*	Testing *Augmented Reality*	Very Good
4	Sound	Testing background sound	Very Good
		Testing button sound	Very Good

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3.6. Distribution

In this stage, the application is saved in a storage medium. Microsoft OneDrive is used as the storage medium to facilitate access and distribution of the application to users in APK format.

4. CONCLUSION

Based on the results and discussions, it can be concluded that technology-based learning through the Unity application for teaching the volume of spatial structures in 6th grade elementary school provides positive benefits in education. This technology helps to stimulate students' interest in learning by providing attractive visuals and implementing augmented reality technology to display 3D objects. It is expected to assist teachers in delivering the material and enable students to easily learn about the volume of spatial structures. Students can engage in the learning process without feeling bored and utilize technology as a valuable learning tool.

5. AUTHORS' NOTES

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirm that this paper is free from plagiarism.

6. REFERENCES

Algarawi, F. K., Alslamah, W. A., Alhabib, A. A., Alfehaid, A. S., and Ibrahim, D. M. (2018). Applying augmented reality technology for an e-learning system. *International Journal of Computer and Information Engineering*, *12*(3), 182-187.

Amin, D., and Govilkar, S. (2015). Comparative study of augmented reality SDKs. *International Journal on Computational Science and Applications*, *5*(1), 11-26.

Arina, D., Mujiwati, E. S., and Kurnia, I. (2020). Pengembangan multimedia interaktif untuk pembelajaran volume bangun ruang di kelas V sekolah dasar. *Prima Magistra: Jurnal Ilmiah Kependidikan*, *1*(2), 168-175.

Barrile, V., Fotia, A., Bilotta, G., and De Carlo, D. (2019). Integration of geomatics methodologies and creation of a cultural heritage app using augmented reality. *Virtual Archaeology Review*, *10*(20), 40-51.

Dewi, A. R., Isnanto, R. R., and Martono, K. T. (2015). Aplikasi multimedia sebagai media pembelajaran ilmu pengetahuan sosial materi budaya di indonesia menggunakan unity engine untuk sekolah dasar. *Jurnal Teknologi dan Sistem Komputer*, *3*(4), 471-480.

Gokhale, A., Balasubramanian, K., Krishna, A. S., Balasubramanian, J., Edwards, G., Deng, G., and Schmidt, D. C. (2008). Model driven middleware: A new paradigm for developing distributed real-time and embedded systems. *Science of Computer programming*, *73*(1), 39-58.

Henderson, S., and Feiner, S. (2010). Exploring the benefits of augmented reality documentation for maintenance and repair. *IEEE transactions on visualization and computer graphics*, *17*(10), 1355-1368.

DOI: https://doi.org/10.17509/seict.v3i1.59651
p- ISSN 2774-1656 e- ISSN 2774-1699

Husniah, L., Nugraha, Y. B. S., Kholimi, A. S., Yuhana, U. L., Yuniarno, E. M., and Purnomo, M. H. (2020, November). GemAR: Geometry Augmented Reality Application for Elementary School Students. In *2020 IEEE Graphics and Multimedia (GAME)* (pp. 25-30). IEEE.

Johnson, C. R., and Huang, J. (2009). Distribution-driven visualization of volume data. *IEEE Transactions on Visualization and Computer Graphics*, *15*(5), 734-746.

LaFleur, K., Cassady, K., Doud, A., Shades, K., Rogin, E., and He, B. (2013). Quadcopter control in three-dimensional space using a noninvasive motor imagery-based brain–computer interface. *Journal of neural engineering*, *10*(4), 1-13.

Mulyani, F., and Haliza, N. (2021). Analisis perkembangan ilmu pengetahuan dan teknologi (IPTEK) dalam pendidikan. *Jurnal Pendidikan Dan Konseling (JPDK)*, *3*(1), 101-109.

Mustika, M., Sugara, E. P. A., and Pratiwi, M. (2018). Pengembangan media pembelajaran interaktif dengan menggunakan metode multimedia development life cycle. *Jurnal Online Informatika*, *2*(2), 121-126.

Nee, A. Y., Ong, S. K., Chryssolouris, G., and Mourtzis, D. (2012). Augmented reality applications in design and manufacturing. *CIRP annals*, *61*(2), 657-679.

Nguyen, V. T., Hite, R., and Dang, T. (2019). Learners' technological acceptance of vr content development: A sequential 3-part use case study of diverse post-secondary students. *International Journal of Semantic Computing*, *13*(03), 343-366.

Nugroho, N. A., and Ramadhani, A. (2015). Aplikasi pengenalan bangun ruang berbasis augmented reality menggunakan android. *Jurnal Sains dan Informatika*, *1*(1), 20-24.

Okanovic, V., Ivkovic-Kihic, I., Boskovic, D., Mijatovic, B., Prazina, I., Skaljo, E., and Rizvic, S. (2022). Interaction in extended reality applications for cultural heritage. *Applied Sciences, 12*(3), 1241.

Pisano, G. P. (1994). Knowledge, integration, and the locus of learning: An empirical analysis of process development. *Strategic management journal*, *15*(S1), 85-100.

Putra, Z. H., Hermita, N., Alim, J. A., and Hidayat, R. (2021). GeoGebra Integration in Elementary Initial Teacher Training: The Case of 3-D Shapes. *International Journal of Interactive Mobile Technologies*, *15*(19), 21-32.

Putra, M. T. M., Sari, A. K., and Risnasari, M. (2018). Pengembangan game educative berbasis android pada materi bangun ruang untuk siswa sekolah dasar. *Jurnal Ilmiah Edutic: Pendidikan dan Informatika*, *5*(1), 39-47.

Rachmanto, A. D. (2018). Implementasi Augmented Reality Sebagai Media Pengenalan Promosi Universitas Nurtanio Bandung Menggunakan Unity 3D. *Jurnal Teknologi Informasi dan Komunikasi*, *8*(1), 29-37.

Rahman, R. A., and Tresnawati, D. (2016). Pengembangan game edukasi pengenalan nama hewan dan habitatnya ddalam 3 bahasa sebagai media pembelajaran berbasis multimedia. *Jurnal Algoritma*, *13*(1), 184-190.

Ramadhani, N. F., Lamada, M., and Riska, M. (2021). Pengembangan aplikasi game edukasi 3d "finding geometry" berbasis unity sebagai media pembelajaran bangun ruang matematika. *Jurnal MediaTIK*, *4*(2), 21-26.

DOI: https://doi.org/10.17509/seict.v3i1.59651
p- ISSN 2774-1656 e- ISSN 2774-1699

Rusnandi, E., Sujadi, H., and Fauzyah, E. F. N. (2016). Implementasi augmented reality (AR) pada pengembangan media pembelajaran pemodelan bangun ruang 3D untuk siswa sekolah dasar. *INFOTECH Journal*, *1*(2), 24-31.

Spoettl, G., and Tūtlys, V. (2020). Education and training for the fourth industrial revolution. *Jurnal Pendidikan Teknologi dan Kejuruan, 26*(1), 83-93.

Sugiarto, H. (2018). Penerapan multimedia development life cycle pada aplikasi pengenalan abjad dan angka. *IJCIT (Indonesian Journal on Computer and Information Technology)*, *3*(1), 26-31.

Wedayanti, L. A., and Wiarta, I. W. (2022). Multimedia interaktif berbasis problem based learning pada muatan matematika kelas IV SD. *MIMBAR PGSD Undiksha, 10*(1), 113–122.

DOI: https://doi.org/10.17509/seict.v3i1.59651
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