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How Augmented Reality Plays a Role in Increasing Elementary School Students' Learning Motivation

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ABSTRACT:
This study is based on the importance of Augmented Reality (AR) learning media in the 4.0 era for student learning motivation in science learning. The purpose of this study is to: 1). Explore student and teacher perceptions of the use of Augmented Reality (AR) in science learning. 2). Identify the success of the application of Augmented Reality (AR) in increasing student learning motivation in science learning. The type of research method is qualitative with a case study approach. The data sources for this study were 1 teacher and several fifth grade students of SD Muhammadiyah 1 Ketelan Surakarta. The data collection techniques for this study included in-depth interviews, direct observation, and documentation, with data validity through triangulation of sources and techniques. Data analysis was carried out using a thematic approach, which allowed the identification of key themes related to the impact of Augmented Reality (AR) on student learning motivation. The results of this study indicate that AR is able to provide a more interactive and visual learning experience, making previously abstract material easier to understand. However, there are challenges related to limited access to technological devices among students. In addition, group-based learning strategies and teacher training are key to optimizing the use of Augmented Reality (AR). Overall, the application of AR has great potential in motivating students in student understanding, but it needs to be supported by careful planning and provision of adequate resources.

Abstrak:
Penelitian ini didasari oleh pentingnya media pembelajaran yang berupa Augmented Reality (AR) pada era 4.0 untuk motivasi belajar siswa pada pembelajaran IPA. Dalam pelaksanaan penelitian ini bertujuan guna: 1). Menggali persepsi siswa dan guru terhadap penggunaan Augmented Reality (AR) dalam pembelajaran IPA. 2). Mengidentifikasi keberhasilan penerapan Augmented Reality (AR) pada menciptakan peningkatan motivasi belajar siswanya dalam pembelajaran IPA. Jenis penelitian menggunakan metode penelitian yang berupa kualitatif melalui suatu pendekatan berupa sebuah studi kasus. penelitiannya memiliki sumber data yang berupa 1 guru dan beberapa siswa yang berada di kelas V SD Muhammadiyah 1 Ketelan Surakarta. Metode dalam mengumpulkan data untuk jalannya penelitian ini meliputi wawancara mendalam, observasi langsung, beserta dokumentasi, dengan kevalidan data lewat triangulasi sumbernya serta melalui metode. Analisis data dilakukan menggunakan pendekatan tematik, yang memungkinkan identifikasi tema-tema kunci terkait dampak Augmented Reality (AR) dalam motivasi belajar siswa. Melalui sebuah hasil penelitiannya menampilkan bahwasanya AR sanggup memberi pengalaman belajar dengan lebih interaktif beserta visual membuat materi yang sebelumnya abstrak dengan akhirnya lebih mudha dipahami. Meskipun demikian, terdapat tantangan terkait keterbatasan akses perangkat teknologi di kalangan siswa. Selain itu strategi pembelajaran berbasis kelompok dan pelatihan guru menjadi kunci dalam mengoptimalkan penggunaan Augmented Reality (AR). Secara keseluruhan, penerapan AR memiliki potensi besar dalam motivasi siswa dalam pemahaman siswa, namun perlu didukung dengan perencanaan yang matang dan penyediaan sumber daya yang memadai..

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INTRODUCTION

The rapid advancement of technology has transformed the way learning is delivered in schools. According to Srelius et al (2014), digital technology now has a significant influence on education systems around the world. In line with this, research conducted by Cris Smaramanik Dwiqi et al., (2020) also explained that teachers still use dominant learning resources through conventional media, for example, teaching materials in printed form. Through a study produced by (Anam et al., 2021) shows that the use of technology-based or digital learning media can create a more dynamic classroom atmosphere and facilitate active communication and discussion. This technology also makes it easier for teachers to deliver material, making it easier for students to understand, and adding more interesting elements to learning, making it more efficient. There is a technology that is now developing and is being widely used in learning media, namely a technology in the form of AR or Augmented Reality where based on the explanation of Azuma, (1997), the definition of AR is to be a technology that combines the real world through a virtual world, with interactive properties based on three-dimensional animation. A similar issue is also explained by Vallino & Brown, (1998), the definition of Augmented Reality, also known as AR, which is a technology capable of combining virtual objects with two-dimensional or three-dimensional forms in a context.

In addition, Pratama et al (2023) state that AR in becoming a technology-based learning media, is very relevant and has potential as an efficient learning tool. as explained by (Rifa et al., n.d.) states that 21st century learning media must use information and communication technology such as multimedia, video, animation, internet and so on that can help facilitate the learning process. There is an example of learning media where the trend of digital technology in the education sector can develop more and affect the educational process including AR / virtual reality / mixed reality, redesigned learning spaces (smartboards), artificial intelligence, personalized learning, along with gamification (Yessi, n.d.). Given the explanation by Cabero & Barroso (2016) that the definition, AR or Augmented Reality stands for a technology by collaborating virtual objects that are two-dimensional or three-dimensional in a real environment and then projecting them on various virtual objects in real time. Nugraha et al., (2021) explained that AR applications can increase insight into a science then also technology, along with creating an increase in student understanding when learning. Based on the development of the cognitive stages of students, the existence of AR technology tends to be increasingly attractive in learning, which is mainly in providing various abstract concepts. It is shown through research that the use of AR technology in the science learning process creates an increase in learning achievement and then also the learning motivation of students. Applied by this research is AR technology in science learning and increasingly focusing on the use of interactive multimedia. There is also subsequent research that will later be carried out, namely regarding the use of AR technology, especially in science lessons in the form of production material in humans in line with the research explained by Hwang et al., (2016) this problem can be caused because AR has the advantage of being able to captivate the attention of students in reviewing and understanding the material. The use of AR can also make students' digital literacy increase even though it is not significant enough.

Based on what Iksan et al. explained, (2012) AR is a technology development by being able to collaborate an object with a three-dimensional form and then project it on the virtual object in real time. Shows the existence of 3D objects where it seems to exist in a real environment as an attraction that AR has. This is in line with the research of Liono et al, (2021) on learning activeness, actually AR can provide support to a learning process regarding student participation so that they can be active in their learning, but it must be underlined, their activeness has a correction and can be influenced by interest then also the learning motivation that students have by having interest and motivation through high levels tend to be more active in their learning because they feel they can be involved and become excited. The research submitted by Maulana Dkk explains that the use of AR in a learning process can provide stimulation to students in critical thinking and make their interest in learning increase Maulana et al., (2019) Like the quotation in the research conducted by Afifiah, Dkk explained that the development of teaching materials with a digital form of computer assembly through the use of AR obtained a value with a number of 86.3% and is suitable for creating increased activeness when learning is happening (Afifah et al., n.d.).

In the development of digital era technology at this time, although there have been many studies that have examined the application of Augmented Reality (AR) in learning, there is still little

research that discusses specifically about the teacher's strategy in the Application of Augmented Reality for Student Motivation in a Science Learning in elementary schools. Research from Mustaqim (2016) that in developing a teaching body with an AR base provides an ease to students in understanding material based on real situations and conditions. The issue is in line with research conducted by Setyawan et al., (2019) that in science lessons for elementary school level, optimizing the benefits of AR in a learning media can display results with a very good form and which is feasible in use, responses from students to the use of this media in the learning process are very good and students are more enthusiastic in participating in learning. The novelty in this research lies in the teacher's strategy as the main mediator in the application of AR technology in science learning in elementary schools. AR has the potential to overcome many shortcomings of conventional learning media and shape learning experiences in a more interesting, interactive, and optimal way. The utilization of AR in learning media can encourage innovation in education and improve the quality of teaching and learning (Rahma et al.,).

Abdul Hafid (2020) states that one of the characteristics of an elementary school with advanced conditions can be seen through its facilities and infrastructure. One of the elementary schools in Kartasura, precisely on Jln Kartini No. 1, Ketelan, Kec. Banjarsari, Surakarta City, namely SD Muhammadiyah 1 Ketelan Surakarta, has adequate facilities and infrastructure in the learning process. Owned by this school is in the form of complete IT facilities and infrastructure, including Virtual Reality (AR) devices, which are one of the innovative learning media. This AR facility is not owned by all schools, making MIM 1 Ketelan Surakarta as one of the primary schools that excel in the application of modern technology to support the teaching and learning process. The use of IT media such as AR at SD Muhammadiyah 1 Ketelan Surakrta provides an opportunity for in-depth research on student motivation.

RESEARCH METHOD

This research employed a field research approach with a case study design, aimed at providing an in-depth description of teachers' strategies in implementing Augmented Reality (AR) media to enhance students' motivation in science learning at SD Muhammadiyah 1 Ketelan Surakarta. As a qualitative study, the focus was on collecting rich, descriptive data in the form of oral statements, written materials, and observed behaviors within a natural setting, to gain a deeper understanding of the social phenomena under investigation.

The research site was SD Muhammadiyah 1 Ketelan Surakarta, located at Jl. Kartini No. 1, Ketelan, Kec. Banjarasari, Surakarta City, Central Java Province. The study was conducted in alignment with the school's academic calendar and classroom learning schedules. The object of the research was the implementation of AR-based learning strategies in fostering student motivation in science classes, while the subjects consisted of teachers who applied AR media and students actively involved in the learning process.

The data for this study comprised both primary data, obtained through direct observations and in-depth interviews with teachers and students, and secondary data, including relevant documents, prior research, and photographic evidence from observations. Data collection utilized three main methods: (1) Interviews, to explore detailed perspectives from teachers and students; (2) Observation, to directly examine classroom activities involving AR media; and (3) Documentation, to corroborate and strengthen the accuracy of findings obtained from interviews and observations.

To ensure data validity, the study employed triangulation techniques, specifically source triangulation and method triangulation. Source triangulation involved gathering information from multiple perspectives—teachers, students, and relevant school documents—while method triangulation entailed cross-checking data through comparing observation results with interview accounts and documentation records.

Once collected, the data were analyzed using thematic analysis, a method that emphasizes identifying, analyzing, and interpreting recurring patterns or themes within the dataset, enabling the researcher to formulate conclusions that directly address the research objectives

FINDINGS AND DISCUSSION

AR media is a technology by combining 2 and three-dimensional objects in the real period. AR application is an application with unique properties because it can increase the reality of its users. The problem is carried out visually by combining digital accompanied by a real display of the existing

real world. Ramadhan et al., (2021). With the use of AR in the learning process, it has the hope of being able to attract students at the learning stage. For other benefits of using AR media, namely learning media with its use is increasingly advanced because it optimizes the benefits of existing technology at this time. Certainly this media has advantages and disadvantages : 37 Based on what is explained by Hakim, n.d. (2018)) the advantages include: 1) learning can be more interactive; 2) can be used more widely through other media bases; 3) the model is simple; 4) the creation of the media is fairly cheap; 5) it is not difficult to operate. Meanwhile, the disadvantages of using AR media are: 1 is very sensitive to changes due to the angle of view; 2) the creation of the media is small; 3) requires a lot of equipment in installing it. AR media has a role in cognitive learning produced by students. Can fish space by the existence of this media for students to imagine then able to provide motivation to the learning of students. Based on what is explained by Lianti et al., (2018) by explaining that the resulting cognitive learning can create a good increase in the aspect of remembering, then understanding, applying, and analyzing a lesson. In his research, it is also presented that in the aspect of remembering students are able to remember various forms of Japanese letters through different steps. Through an aspect of understanding, it can be understood by students directly in a longer time. Through the aspect of applying, students can solve various problems by applying the existing AR media. Through the aspect of analyzing, students are able to conduct discussions with friends and teachers on problems in the right group.

The use of interactive learning media based on AR through the application in the form of Assemblr provides assistance in creating increased interest in learning and giving the impression of learning with more interesting for students. Based on the evaluation of the resulting activities, it shows that there is an increase in the interest of students in a learning process using interactive learning media based on AR. This issue is in line with research conducted by Pramono & Setiawan, (2019) by showing that 86% or a total of 30 respondents in the form of children explained that the application whose development was carried out on an AR basis had a very positive impact. In addition, research conducted by (Julianti et al., 2018) shows that the development of learning media with an AR base is included in a group that is very valid, feasible, and efficient to use. Based on the results of the feasibility test according to the media expert, the overall percentage is 90%, for testing the feasibility of the material expert is 88.6%, while in the application of learning media it can increase the average value of the class, namely at 89.24%. Thematic analysis of the results of interviews and observations conducted at SD PK 1 Ketelan Surakarta shows clear information. As seen through the picture below with this:

Picture 1.1
Thematic Analysis Findings

A. Teachers' Understanding of the Concept and Application of Augmented Reality in Science Learning at SD Muhammadiyah 1 Ketelan Surakarta

Based on Figure 1, the use of AR in science learning at SD Muhammadiyah 1 Ketelan Surakarta shows a positive impact on students' cognitive understanding. Teachers stated that AR can create an increase in students' interest in learning because students are more attracted to new technologies that they consider more fun than traditional methods such as textbooks or regular

discussions. AR provides a more interactive and visual learning experience, making the subject matter easier to understand. For example, when studying ecosystems, students can see real-world illustrations such as populations and individuals in ecosystems more clearly through AR. This makes material that previously felt abstract more vivid and relevant.

Before implementing a new learning method, the teacher usually gives instructions to the students to read the material or uses lecture techniques while remaining teacher-centered, which ultimately looks monotonous. During the learning process, the students remained noisy and talked to themselves several times. Based on Figure 1, it is found that students do not focus their attention enough during learning, and are not enthusiastic enough about learning. This issue is in line with research conducted by Supardi et al., (2015) that the optimal use of technological media creates enthusiastic rituals and has a passion for learning, because the material is presented in part visually which ultimately creates much more enjoyable learning. The existence of an interest in learning makes students move to give their attention spontaneously. His attention encourages the brain to process the determination of various information on an existing media (Khotimah, 2019), thus providing cognitive confrontation stimulation to students to think more critically, then more creatively, and have high imagination (Habib et al., 2020). So, the use of interactive multimedia has a positive effect on an increased interest and makes students' attention increase by giving an impact on the initiative to continue learning.

In its foundation, there are two techniques to understand students, namely in the form of tet techniques and non-tests. Which method to use depends on what kind of data the teacher will understand. There is valid data to be explored through tests, but there is data and information accurately explored and understood through a non-test technique Prayitno et al. (2020). Another thing shows that when the students of SD Muhammadiyah 1 Ketelan Surakarta where the teacher describes the opinions he has regarding the material and when the teacher gives oral questions to the students reluctantly and who are active by volunteering to answer the questions that have been given, there are also students who want to describe their opinions only dominated by some of the same students.Nurul Khomariyah et al., (2022). Based on Figure 2, it was found that teachers stated that the use of AR in science has a positive impact on student understanding. With AR, students become more focused as this method introduces a more enjoyable way of learning compared to traditional methods such as lectures or discussions. AR allows students to see interactive live visualizations, such as a rice field ecosystem with various living things, which helps them understand the relationship between biotic and abiotic components concretely. Teachers also considered AR-based activities, such as scanning barcodes to view additional materials, to be useful activities in developing students' cognitive abilities. Although most students do not use their own gadgets, teachers ensure the visualizations are displayed through school devices such as LCDs and loudspeakers to create a well-rounded learning experience. In line with the research of Kuncoro & Hidayati (2021) in their research, they also found that learning videos can create an increase in cognitive learning produced by students in material in the form of life cycles of animals. There is a form of video display that is more interesting, which is in the form of animation. So IT-based technology can improve student cognition.

Based on Figure 1, the difficulty in developing students' learning motivation is the difference in character and level of activeness. To overcome this, teachers use group-based learning strategies. In the division of groups such as: 1) The teacher mixes active students with less active students, 2) Groups are not self-selected, but rather determined by the teacher to ensure optimal collaboration, 3) This strategy helps less active students be inspired by more active friends, thus indirectly increasing their involvement. Based on figure 2, it explains that students at SD Muhammadiyah 1 Ketelan show a very positive response to the use of AR They are more interested and curious about the material presented visually and interactively. For example, when learning about ecosystems, students can see animations of animal populations such as frogs, snakes, and lions in their habitats. This makes the material more vivid and relevant to students, making it easier for them to remember the concepts. In line with the research of Magdalena et al., (2020) arranged more systematically and completely through a principle that will be utilized by a teacher as well as students in their learning activities. Not only that, the use of AR gives students a new perspective that gadgets can be used for educational purposes, not only for entertainment such as playing games. This creates an increase in student enthusiasm for learning.

Based on Figure 1, the teacher evaluates the success of AR through various ways including by conducting written evaluations such as through exam questions to assess student understanding

directly, oral question and answer where the teacher holds an interactive quiz session after using AR to determine the level of student understanding spontaneously, then direct observation where the teacher monitors student involvement during AR-based learning. Teachers also emphasize the importance of managing the use of gadgets well. Only certain groups are given the responsibility of using the gadgets to ensure discipline and focus during the learning. When the activity was run they looked active enthusiastic map, which they ran the presentation way more enthusiastically. Meanwhile, other students as the audience participated in giving questions and responding to questions given by the teacher as well as students who were presenting. Not only that, students need to participate in giving opinions and arguments when asked for their opinions. So they look more active than in the previous cycle. The existence of students who have increased motivation, looks to have progress in their learning, where students have an impetus that comes from themselves or through outside strongly for learning and better mastering the material. Students look more active in exploring knowledge that has not been obtained in the previous time. Not only that, it can be seen that there is involvement and presence from students when learning, this problem is evident during presentation activities where they look more active and more enthusiastic Rahmani & Abduh, (2022).

Based on Figure 2, it explains the importance of developing a special approach to optimize the use of AR in science learning, this approach includes AR-based material scheduling where teachers plan the use of AR according to the schedule and relevant material topics, and giving group assignments. Teachers provide structured group assignments, including preparation of devices and materials to be discussed, to maintain student enthusiasm. This approach is considered optimal in maintaining the consistency of AR use and ensuring that student engagement remains high. The teacher's strategy in using AR to create increased learning motivation in students in science lessons involves a combination of technology and a planned pedagogical approach. Teachers at SD Muhammadiyah 1 Ketelan do not only rely on AR as a visual medium, but also combine it with group-based learning, good classroom management, and various evaluations. This is in line with the research conducted (Sari & Ningsih, 2022) by explaining that the AR application which provides the possibility for students to join a virtual environment also provides efficient evidence in creating increased social interaction and collaborative skills of students who can work together on various learning projects by including various AR elements, even though they are in different locations. This provides assistance with social and collaborative skills which are important for a more connected population. With a structured approach, AR has been shown to be able to improve students' cognitive understanding, increase enthusiasm, and create an interesting and efficient learning experience.

B. Strategies implemented by teachers in using augmented reality to motivate students to learn in science subjects

Teachers play an important role in improving positive attitudes of students so that the objectives and various learning processes that are carried out can instill various forms of positive values for their students. Through the presence of media and strategies with more innovative in a lecture atmosphere that is increasingly conducive, interesting, then also creative, and exciting Cahyo Utomo et al., (2020). Based on Figure 3, the use of real-time overlay in AR helps students understand science concepts more visually and directly. In line with the research of Sanderzon Makapedua et al., (2021) that AR can provide stronger and more interactive visual support, helping students overcome obstacles in the learning they are undergoing. However, teachers realize the importance of integrating learning inside and outside the classroom. For example, for materials such as ecosystems, teachers can use AR in class to provide an initial overview, then continue learning with direct activities in the field, such as a botanical garden or reading pond. This strategy is considered to provide a more concrete experience for students. Learning motivation is very important for all students to be more interested in learning. The existence of a low level of motivation can result in low success in learning, which will later affect the cognitive learning produced by students. An increase in student learning motivation can be created by optimizing the benefits of using media in an attractive form Widhayanti & Abduh, (2021) which ultimately attracts students to their learning. In this question, the teacher uses an approach by combining AR technology through direct learning. In the initial stage, students are given a visualization of the ecosystem through a screen using AR, in the advanced stage, the teacher takes students to the fish pond to provide direct experience that is in line with the AR material. This strategy creates a more interesting learning experience and helps

students to create a deeper understanding.

Based on Figure 4, teachers at SD Muhammadiyah 1 Ketelan also mentioned that the school already has adequate supporting devices, such as LCDs in each class, making it easier to use AR in learning. The teacher also emphasized that the majority of students already have devices such as gadgets, which can be used to support technology-based learning. This can also be developed through Djamarah's research (2010) that facilities are a completeness that supports student learning at their school. With the existence of learning facilities where more adequate will later create an increase in student learning motivation and support students in achieving their learning achievements. If the facilities available at school and at home are not complete enough, it will later create a learning process that is not optimal enough, hampered or even cannot be held. Khairun Nisa et al., (2018) This is due to differences in the level of teacher understanding of technology. Although technology can be learned independently, formal training will help increase the impact of AR implementation. In addition, support from ICT teachers at school is a practical solution in overcoming technical constraints.

Learning more enjoyable can be done in various ways, depending on how the teacher determines the techniques in the learning that will be carried out Jayanti et al., (2021) Because of this, the determination and use of techniques in the learning process need to involve students actively in their learning, either mentally, physically, or socially Arianti, (2018). Techniques in delivering learning materials are also very much needed so that the material or the main points of the discussion are not difficult to accept and understand for students Nurrita, (2018). Not only that, teachers need to make learning more enjoyable for their students Setiawan & Martin, (2023) therefore in its application, teachers ensure that students are actively involved in the use of AR Ardya Crisdian et al., (2023). Based on Figure 2, the teacher emphasizes the importance of direct practice in class, where students are not only spectators, but also interact with the material presented through AR.

Based on Figure 2, teachers at SD Muhammadiyah 1 Ketelan realize that AR integration in learning requires commitment from all parties, including teachers, students, and the school. This can be developed through research from Dwi Afriyanto (2022) that the educational community includes teachers, students, then parents, and those who have other interests by participating in the education process. Their participation can be initiated by supporting the implementation of strategies in technology-based learning through moral support, then financial support, then logistics. Teachers at SD Muhammadiyah 1 Ketelan Surakarta suggested that AR be officially included in the curriculum, for example through additional material in ICT lessons. This is expected to provide long-term benefits in improving students' learning abilities. The use of AR in science learning that can be done in SD Muhammadiyah 1 Ketelan Surakarta is considered to have a positive impact on students' learning motivation. The strategy implemented involves a combination of the use of technology and direct learning, training for teachers, and technical support from the school. With good integration, AR has the potential to become an optimal and interesting learning medium for students.

The use of AR in science learning in SD Muhammadiyah 1 Ketelan Surakarta shows that this technology can create increased learning motivation and improve students' understanding of learning materials. In order to motivate students to participate in learning activities, teachers need to determine various techniques for learning activities that are more enjoyable but still relevant. Because of this, teachers need to be able to determine learning media more appropriately. Based on Bruner's theory, there are three main levels of a learning mode, namely in the form of direct experience or known as enactive, then also pictorial experience or with images known as iconic, and through abstract experience also known as symbolic. Although the level of physical participation is reduced, imaginative participation is increasing and developing. In fact, a concrete experience and an abstract experience occur alternately, then for learning outcomes and direct experience also provide changes along with making the individual's abstraction reach wider and comparable to the competence of interpreting the symbols of his words which provide assistance to someone in better understanding the experience where it occurs directly Arsyad Lincolin, (2006). Through this can be seen in interviews with teachers and students by explaining that AR makes them more focused, interested, and understands the material through steps that are more enjoyable and real. However, the main challenge faced is the limited access to technological devices among students. Although AR provides a more interactive learning experience, not all students can access the technology optimally. Because of this, there needs to be a policy or further support in providing more equitable devices for all students, so that they can be fully involved in AR-based learning.

In addition, although AR can increase learning motivation and interest in learning, teachers also need to plan a more structured approach and tailor it to the needs of each student. The use of AR in learning must be balanced with relevant and efficient teaching methods in order to achieve optimal learning objectives. For example, learning that is carried out outside the classroom or directly in the natural surroundings can be more in-depth and provide real experiences for students. It is also important to note that although AR brings many benefits, its implementation must be supported by sufficient training for teachers and the presence of a support team to ensure that this technology is used properly and efficiently. Teachers who are not yet familiar with AR technology need to receive training so that they can optimize this device in their teaching. Overall, the use of AR at SD Muhammadiyah 1 Ketelan Surakarta shows great potential in improving students' understanding and motivation in science learning. For this reason, there needs to be ongoing planning and support so that the implementation of AR in education can continue to develop and provide optimal benefits for students. In order to provide certainty that the technology can be applied through steps that support educational goals and provide optimal benefits for students, an accurate strategy and training are needed for teachers. In line with the research of Ardya Crisdian et al., (2023), namely in the form of training regarding the development of learning media through the basis of information technology, it provides support for educators when creating learning materials that are more interesting and relevant to students using existing information technology.

CONCLUSION

The use of AR in a science learning in SD Muhammadiyah 1 Ketelan Surakarta shows a positive impact with a significant form on motivation and also student understanding. Success is given by this technology, namely learning that is increasingly interactive, fun, and visual, so it makes it easier for students to understand the material which previously had an abstract impression. Through AR, various science concepts that are known to be difficult can be visualized in the form of interesting animations, making students more focused and interested in following their learning. The problem is in line with the theory of constructivism by explaining that learning that includes direct experience and interaction through material can help create deeper understanding for students. However, the application of AR in learning still has some obstacles, which are mainly related to limited access by students. Not all students have personal devices such as smartphones or tablets that are needed to optimize the AR experience. Because of this, schools must ensure that the distribution of their devices is more evenly distributed to students and provide training to teachers so that they can maximize the use of AR in their learning. Not only that, in order to create an increase in learning success, a group-based approach can be a solution in providing encouragement for students who are not active enough to be much more involved. Overall, AR has great potential in creating increased motivation and understanding of its students, but it needs to be supported by empowerment policies and more adequate training.

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REFERENCES

Hafid, A. (2020). *Pendidikan Multikultural Dalam Masyarakat Transisi : Studi Interaksi Nilai Agama Dan Budaya Di Batam*. UIN Syarif Hidayatullah Jakarta.

Afifah, B., Widiyaningtyas, T., & Pujianto, U. (n.d.). *TEKNO Jurnal Teknologi Elektro dan Kejuruan Pengembangan bahan ajar perakitan komputer bermuatan augmented reality untuk menumbuhkan keaktifan belajar siswa*. http://journal2.um.ac.id/index.php/tekno|

Anam, K., Mulasi, S., & Rohana, S. (2021). Efektifitas Penggunaan Media Digital dalam Proses Belajar Mengajar. *Genderang Asa: Journal of Primary Education*, *2*(2), 76–87.

https://doi.org/10.47766/ga.v2i2.161
Ardya Crisdian, H., Prawistyasari, A., Taufik Turahman, dan, Ilmu Kesehatan, F., & Kusuma Husada Surakarta, U. (2023). *Penyuluhan dan pelatihan pembuatan minyak telon untuk perawatan bayi dan anak di Desa Kalisoro Kecamatan Tawangmangu Kabupaten Karanganyar*. *6*(1), 83–89. https://doi.org/10.22460/as.v6i1.13798
Arsyad Lincolin. (2006). *Assessing Factors Affecting The Repayment Rate of Microfinance Institustions*.
Azuma, R. T. (1997). A Survey of Augmented Reality. *In Presence: Teleoperators and Virtual Environments 6, 6*(4), 355–385. https://doi.org/10.1561/1100000049
Cahyo Utomo, A., Abidin, Z., Aditya Rigiyanti, H., Guru Sekolah Dasar, P., Keguruan dan Ilmu Pendidikan, F., Muhammadiyah Surakarta, U., Yani Tromol Pos, J. A., & Kartasura, K. (2020). *Keefektifan Pembelajaran Project Based Learning terhadap Sikap Ilmiah pada Mahasiswa PGSD*. *1*(1), 1–12. http://ejurnal.ubharajaya.ac.id/index.php/EDUKARYA
Cabero, J., & Barroso, J. (2016). ICT Teacher Training: A View of The TPACK Model / Formación Del Profesorado en TIC: Una Visión Del Modelo TPACK. *Cultura y Educacion*, *28*(3), 633–663. https://doi.org/10.1080/11356405.2016.1203526
Cris Smaramanik Dwiqi, G., Gde Wawan Sudatha, I., & Studi, P. (2020). Pengembangan Multimedia Pembelajaran Interaktif Mata Pelajaran IPA Untuk Siswa SD Kelas V Adrianus I Wayan Ilia Yuda Sukmana. In *Jurnal EDUTECH Universitas Pendidikan Ganesha* (Vol. 8, Issue 2). https://ejournal.undiksha.ac.id/index.php/JEU
Elektro, J. E., Chandra Nugraha, A., Bachmid, K. H., Rahmawati, K., Putri, N., Raihan, A., Hasanah, N., & Rahmat, A. (2021). *Rancang Bangun Media Pembelajaran Berbasis Augmented Reality Untuk Pembelajaran Tematik Kelas 5 Sekolah Dasar* (Vol. 05, Issue 2). https://journal.uny.ac.id/index.php/jee
Habib, Astra, & Utomo. (2020). *Media Pembelajaran Abad 21: Kebutuhan Multimedia Interaktif Bagi Guru dan Siswa Sekolah Dasar*. *3*(1), 25–35.
Hakim, L. (2018). Pengembangan Media Pembelajaran PAI Berbasis Augmented Reality. *Lentera Pendidikan*, *2*(1), 59–72.
Hwang, G.-J., Yang, M.-L., & Chen, C.-H. (2016). Impacts of Integrating The Repertory Grid Into an Augmented Reality-Based Learning Design on Students' Learning Achievements, Cognitive Load and Degree of Satisfaction. *Interactive Learning Environments*, *26*(2), 221–234. https://doi.org/10.1080/10494820.2017.1294608
Iksan, N., & Djuniadi, D. (2017). Media Pembelajaran Interaktif Berbasis Augmented Reality (AR) Untuk Meningkatkan Motivasi Belajar Anak. *ITEJ (Information Technology Engineering Journals)*, *2*(1), 36–39. https://doi.org/10.24235/itej.v2i1.15
Jayanti, D., Septiani, J. I., Sayekti, I. C., Prasojo, I., & Yuliana, I. (2021). Pengenalan Game Edukasi sebagai Digital Learning Culture pada Pembelajaran Sekolah Dasar. *Buletin KKN Pendidikan*, *3*(2), 184–193. https://doi.org/10.23917/bkkndik.v3i2.15735
Julianti, K. S., Suyasa, P. W. A., & Putrama, I. M. (2018). Pengaruh Media Augmented Reality Tata Cara Penulisan Huruf Jepang (Hiragana dan Katakana) Pada Mata Pelajaran Bahasa Jepang Terhadap Hasil Belajar Siswa. *Kumpulan Artikel Mahasiswa Pendidikan Teknik Informatika (KARMAPATI)*, *7*(3), 184. https://doi.org/10.23887/karmapati.v7i3.16074
Khairun Nisa, Mambela, S., & Badiah, L. I. (2018). Karakteristik Dan Kebutuhan Anak Berkebutuhan Khusus. *Jurnal Abadimas Adi Buana*, *2*(1), 33–40. https://doi.org/10.36456/abadimas.v2.i1.a1632
Khotimah, D. N. (2019). Implementasi Program Penguatan Pendidikan Karakter (PPK) Melalui Kegiatan 5S di Sekolah Dasar. *INOPENDAS: Jurnal Ilmiah Kependidikan*, *2*(1), 28–31. https://doi.org/10.24176/jino.v2i1.2928
Kuncoro, I. A., & Hidayati, Y. M. (2021). Learning Videos Increase Students' Cognitive Learning Outcomes on Animal Life Cycle Materials. *Jurnal Ilmiah Sekolah Dasar*, *5*(2), 299–306.
Liono. (2021). Using a graph database for the ontology-based information integration of business objects from heterogenous Business Information Systems. *Procedia Computer Science*, *196*, 314–323. https://doi.org/10.1016/j.procs.2021.12.019
Magdalena, I., Prabandani, R. O., Rini, E. S., Fitriani, M. A., & Putri, A. A. (2020). Analisis Pengembangan Bahan Ajar. *Jurnal Pendidikan Dan Ilmu Sosial*, *2*(2), 170–187. https://ejournal.stitpn.ac.id/index.php/nusantara

Maulana, I., Suryani, N., & Asrowi, A. (2019). Augmented Reality: Solusi Pembelajaran IPA di Era Revolusi Industri 4.0. *Proceedings of The ICECRS*, *2*(1), 19–26. https://doi.org/10.21070/picecrs.v2i1.2399

Maulana, M. A., Sujana, Y., & Budianto, A. (2019). Development of Module and Augmented Reality Based Android Aplication Computer Assembly For Vocational High School Student. *Journal of Informatics and Vocational Education*, *2*(2), 121–134. https://doi.org/10.20961/joive.v2i2.35751

Mustaqim, I. (2016). Pemnafaatan Augmented Reality Sebagai Media Pembelajaran. *Jurnal Pendidikan Teknologi Dan Kejuruan*, *13*(3), 121–145. https://doi.org/10.23887/jptk-undiksha.v13i2.8525

Nugraha, A. C., Bachmid, K. H., Rahmawati, K., Putri, N., Hasanah, A. R. N., & Rahmat, F. A. (2021). Rancang Bangun Media Pembelajaran Berbasis Augmented Reality Untuk Pembelajaran Tematik Kelas 5 Sekolah Dasar. *Jurnal Edukasi Elektro*, *5*(2), 138–147. https://doi.org/10.21831/jee.v5i2.45497

Nurul Khomariyah, E., Candra Sayekti, I., Khanifah, S., Muhammadiyah Surakarta, U., & Kunci, K. (2022). Penerapan Aplikasi Liveworksheet Untuk Meningkatkan Hasil Belajar Kelas V Sekolah Dasar. In *Educatif : Journal of Education Research* (Vol. 4, Issue 3). http://pub.mykreatif.com/index.php/educatif

Pratama, A. J., Irfan, D., & Effendi, H. (2023). Studi Literature Penggunaan Media Pembelajaran Menggunakan Teknologi Augmented Reality Pada Sekolah Kejuruan. *Jurnal Vokasi Informatika*, *3*(1), 47–55. https://doi.org/10.24036/javit.v3i1.135

Prayitno, H. J., Wulandari, M. D., Widyasari, C., Nursalam, N., Malaya, K. A., Bachtiar, F. Y., Hermawan, H., Wulandari, D. T., & Aditama, M. G. (2020). Pemberdayaan Guru dalam Peningkatan Layanan Bimbingan Konseling di SD/MI Muhammadiyah Se-Surakata pada Era Komunikasi Global. *Buletin KKN Pendidikan*, *2*(2). https://doi.org/10.23917/bkkndik.v2i2.11853

Rahmah, R., Susilo, H., & Yuliati, L. (2021). Pengembangan Media Interaktif Tema "Sehat itu Penting" untuk Meningkatkan Literasi Digital pada Kelas V Sekolah Dasar. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *6*(1), 70. https://doi.org/10.17977/jptpp.v6i1.14388

Rahmani, R. A., & Abduh, M. (2022). Efektivitas Media PowerPoint Interaktif Terhadap Motivasi dan Hasil Belajar Kognitif Masa Pandemi. *Jurnal Basicedu*, *6*(2), 2456–2465. https://doi.org/10.31004/basicedu.v6i2.2378

Ramadhan, M. A. N., & Waluyo, A. F. (2021). Development of Android-Based 3D Building Augmented Reality Application at Jogja Student Islamic Boarding School 2. *International Journal Software Engineering and Computer Science (IJSECS)*, *3*(3), 205–212. https://doi.org/10.35870/ijsecs.v3i3.1674

Sanderzon Makapedua, C., Wonggo, D., Komansilan, T., Pendidikan, J., Informasi, T., Komunikasi, D., & Teknik, F. (2021). Pengembangan Media Pembelajaran Pengenalan Hewan Berbasis Augmented Reality Untuk Anak Usia Dini. In *Jurnal Pendidikan Teknologi Informasi dan Komunikasi* (Vol. 1, Issue 4).

Sari, M. N., & Ningsih, E. A. (2022). *An Analysis Of Students' Motivation And Anxiety On Learning English At Sma Negeri 6 Kerinci*. *5*(3), 181–188. https://doi.org/10.31764

Setiawan, I., & Martin, N. (2023). *Pengembangan Bahan Ajar Bahasa Indonesia Berbasis Augmented Reality Pada Guru Sdn 2 Pancor*. *7*(2).

Setyawan, B., Rufii, Nf., & Fatirul, Ach. N. (2019). Augmented Reality Dalam Pembelajaran Ipa Bagi Siswa Sd. *Kwangsan: Jurnal Teknologi Pendidikan*, *7*(1), 78–90. https://doi.org/10.31800/jtp.kw.v7n1.p78--90

Srelius, K., Mani, K., Bjrck, M., Sedivy, P., Wahlgren, C. M., Taylor, P., Clough, R. E., Lyons, O., Thompson, M., Brownrigg, J., Ivancev, K., Davis, M., Jenkins, M. P., Jaffer, U., Bown, M., Rancic, Z., Mayer, D., Brunkwall, J., Gawenda, M., … Wanhainen, A. (2014). Endovascular Treatment Of Mycotic Aortic Aneurysms a European Multicenter Study. *Circulation*, *130*(24), 2136–2142. https://doi.org/10.1161/CIRCULATIONAHA.114.009481

Faidah, S. T. R., Salsabila, A., & Riandi. (2022). Desain Inovasi Media Pembelajaran dengan Penerapan Augmented Reality pada Materi Sistem Pencernaan. *Jurnal Ilmiah Pendidikan Biologi*, *08*(04), 76–83. https://online-journal.unja.ac.id/biodik

Vallino, J. R., & Brown, C. M. (1998). *Interactive Augmented Reality*. University Of Rochester.
Widhayanti, A., & Abduh, M. (2021). Peningkatan Motivasi Belajar Melalui Media Audiovisual Berbantuan Power Point Pada Peserta Didik Di Sekolah Dasar. *EDUKATIF : JURNAL ILMU PENDIDIKAN*, *3*(4), 1587–1593. https://doi.org/10.31004/edukatif.v3i4.627
Yessi, M. (2021). Pedagogical Content Knowledge (PCK) Dalam Pemiliah Media Pembelajaran yang Relevan. *Prosiding Seminar Nasional Kimia Dan Pendidikan Kimia Xii (Sn-Kpk Xii)*, *3*(2), 176–190. https://jurnal.uns.ac.id/snkpk
Yuliono, T., Sarwanto, S., & Rintayati, P. (2018). The Promising Roles of Augmented Reality in Educational Setting: A Review of the Literature. *International Journal of Educational Methodology*, *4*(3), 125–132. https://doi.org/10.12973/ijem.4.3.125