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DEVELOPING AUGMENTED REALITY FOR IMPROVING CONCEPT COMPREHENSION ON PHOTOGRAPHY LEARNING

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ABSTRACT

Integrating Augmented Reality (AR) in vocational high schools presents a transformative opportunity for vocational education; however, its efficacy hinges critically on teachers' acceptance and pedagogical adaptation. This study explores vocational high school teachers' views on using Augmented Reality (AR) to enhance practical learning and student engagement in vocational education. Augmented reality holds great potential as a learning tool, especially in the Visual Communication Design department at Vocational High School. This qualitative study employed a phenomenological research design to examine vocational teachers' lived experiences with augmented reality (AR) in instruction. Six purposively selected vocational teachers from West Sulawesi, Indonesia, participated in semi-structured in-depth interviews, enabling detailed exploration of their perceptions, challenges, and contextual adoption strategies. Thematic analysis was performed using ATLAS.ti 2023, revealing two key themes: the strengths and weaknesses of PowerPoint or Canva media, and the benefits of augmented reality. The study found that while PowerPoint or Canva had more weaknesses than strengths for photography subjects, augmented reality proved to be highly effective in improving student comprehension, thanks to its 3D features and new technology. Schools should prioritize teacher training programs, implement pilot projects in specific technical fields, and foster government-industry partnerships for resource support to maximize AR's potential. Future research should focus on longitudinal studies of AR's educational impact and the development of affordable, customizable AR solutions tailored to vocational training needs, ensuring this technology effectively bridges the gap between classroom learning and workplace skill requirements.

A. INTRODUCTION

The field of education is constantly evolving, with modern technologies and pedagogical methods developed to enhance the learning experience for students. As humanity and technology progressed, ideas became much more important, and they were represented symbolically, realistically (like literal images), or symbolically (like maps). Based on research results from (Krüger et al., 2022), 2D and 3D AR provide engaging, valuable learning for students' mental health. At this point, the world is made up of physical entities but also ideas and representations of those ideas in physical media. Augmented Reality (AR) and Virtual Reality (VR) technologies have revolutionized learning approaches through immersive digital experiences, interactive environments, simulation, and engagement. Zuo et al. (2023) conducted research showing that AR-based games can improve children's memory and learning effectiveness. However, these technologies are in the developing stage and require massive investment and mass customization to meet the high demand in education. Results reveal that the adoption of AR and VR in education has grown exponentially in recent years, with wearable devices playing a significant role in this development. Based on secondary data, results also reveal the gap in quickly implementing and customizing these technologies in educational institutions. As AR and VR technologies rapidly develop and become mature, more educational applications emerge in the learning process. Researchers are recommended to keep pace to discover gaps in AR and VR transition to education

and create practical adaptability approaches to gain more benefits from the development of these technologies (Al-Ansi et al., 2023). In their research, Rambli et al. (2013) said that fun learning also increases students' ability to memorize and understand. Therefore, AR is a medium that can be used in learning because it is a fun medium.

Augmented reality is a medium in which information is added to the physical world in registration with the world. However, as indicated earlier, information can be added, changed, or modified in the physical world in many ways. Takenaka & Soga (2019) conducted research using AR on Japanese History subjects and found that the learning process effectively promoted the willingness to learn Japanese history. It was easy for the learner to understand the position, relationship, and flow of warlords, etc. In addition, Ou Yang et al. (2023) conducted robotics research for Physical Education subjects and found that AR students who used AR Bot had higher enjoyment of learning, algorithm design skills, and algorithm efficiency skills, but not higher problem decomposition skills and academic achievement than students who used Scratch. Li et al. (2023) researched reading and writing Chinese among students in China using MAR (Motivational Augmented Reality) media and found results that the proposed MAR learning approach improved the students' writing performance in terms of feature descriptiveness and thinking innovation. This article combines the latest research, case studies, and best practices in augmented reality in education. Meanwhile, in research conducted by Radu et al. (2023) showed that students tutored with more complex AR content learn better and show a broader range of inquiry styles. This study aims to show how AR can support teaching and learning in various subjects and disciplines, ranging from Basic Photography subjects to learners majoring in Visual Communication Design (DKV).

Vocational education is often positioned as preparing learners to perform specific jobs. However, given the constant changes in job and workplace performance requirements, such preparation needs to include experiences that equip vocational graduates to effectively translate their education into performance in the workplace and to be able to adapt what education has provided to the necessary change of circumstances of the existing and current (Billett, 2023). Most vocational schools still use 2D learning media in the learning process, where objects used as learning materials cannot be visualized into 3D objects, for example, PowerPoint media and Prezi. Teachers are challenged to have high creativity to develop learning in the classroom. This is emphasized by Boler et al. (2023) who say that educators are faced with new questions about how to teach regarding the media ecosystem and what should be included in their curriculum. Augmented Reality (AR) has rapidly increased in the last decade, especially in education. Koparan et al. (2023) showed that students could generally accept using AR to learn geometry, and AR-supported teaching methods significantly improved students' learning outcomes. Researchers are particularly concerned about students' low photography skills in basic photography subjects, especially in the Visual Communication Design department. Based on this problem, researchers elaborate on a solution to create new learning media that are expected to be helpful for students.

In the context of the DKV major, photography is a basic subject that must be programmed by students majoring in Visual Communication Design. Therefore, researchers focus on teaching basic photography subjects using augmented reality media. Augmented Reality (AR) is a variation of Virtual Environment (VE), or Virtual Reality (VR) as it is more commonly called. Several modeling software programs can be used to create augmented reality media in Windows, Macintosh, and Linux systems. Some of the more common 3D modeling packages are Maya from Autodesk, 3D Studio Max from Autodesk, SketchUp from Trimble, and Blender, an open-source 3D modeling and animation package.

Augmented reality has a vital role in student motivation. The application of augmented reality in mathematics learning can also encourage higher motivation, understanding, and engagement with the content to be learned. Of course, this can increase the use of information and access to knowledge (Coimbra et al., 2015). There are differences in the learning motivation of students who are taught using augmented reality media and students who are taught to use PowerPoint media, with an average result for PowerPoint media of 58.12% and augmented reality media with an average result of 65.76% (Syam et al., 2021). Applying conventional

media to chemistry learning does not provide good motivation for students, in contrast to when chemistry learning is carried out by applying augmented reality media (Bau et al., 2022). augmented reality technology positively impacts student learning motivation in various constructions, namely Mindfulness, Relevance, Self-Confidence, and Satisfaction, and shows excellent potential as an innovative pedagogical advance in chemical engineering education (Low et al., 2022). This indicates that using AR in teaching inside and outside the classroom significantly influences learning activities.

AR is more effective as a learning medium because learners can see real objects reproduced in learning and practicing. The modern way of AR technology in engineering education is a valuable tool for making teaching and learning effective, and an experimental setup to convert topics to Android Apps is also proposed. Therefore, from some of the results of these studies, it can be concluded that augmented reality significantly influences the success of learning, so it is interesting to study (Arulanand et al., 2020). Augmented reality has also begun to be widely used in television, and students majoring in DKV need it.

Furthermore, AR has had many positive implications in helping to improve learners' learning experience. Gao et al. (2023) found that the application of AR in Chemical Engineering has improved learners' learning experience. Blevins (2018) emphasizes how the concept of layers transcends the visual layer of AR to writing strategies and thus supports composers in developing critical media awareness and adaptability to multiple, potentially foreign, media approaches in current and future contexts. Ibáñez et al. (2014) showed that AR can be harnessed as an effective learning environment for learning the basic principles of electromagnetism in high school. Garzón & Acevedo (2019) compare the application of AR, as a pedagogical resource, with other types of pedagogical resources, including multimedia resources, traditional lectures, and traditional pedagogical tools. The comparison results show that learning gain is higher when interventions involve AR resources.

In their research, Kose et al. (2013) augmented reality has shown effective and successful performance in improving the learning experience and is accepted as a better and more enjoyable way. Chen & Tsai (2012) explained that applying the Augmented Reality Library Instruction System (ARLIS) produces equal learning achievement, and there is no gender difference in student learning achievement. In addition, the application of augmented reality in two game modes was carried out by López-Faican & Jaen (2020) shows that the application of augmented reality to the two game modes is satisfactory for children because it triggers positive emotions such as enthusiasm, pleasure, and curiosity. In addition, factors that improve learners' mood can help increase the degree of involvement. On a comparative level, after making observations, it was found that collaborative versions of games have a greater impact on emotional love, social interaction, and interest, as the game design makes learners collaborate in sync to recognize characters. Another opinion expressed by Diaz et al. (2015) that an augmented reality application that effectively uses dynamic and static content equipped with audio and text to teach the basic concepts of electronics courses.

Pedagogical strategies by implementing augmented reality in the ICT teaching and learning process shows that learners understand the support and content provided by prototypes and feel higher motivation when using them in doing tasks (Sampaio & Almeida, 2016). AR-based inquiry learning activities can involve more learner interactions for knowledge construction (Chiang et al., 2014). The application of augmented reality in the learning process contributes to increased conceptual learning acquisition (Georgiou & Kyza, 2018). The application of augmented reality in computer hardware courses has a positive effect on students' academic performance, and students also have a favorable view of the courses (Bal & Bicen, 2016). The advantages of augmented reality are an interesting issue to explore in vocational high school by looking at teachers' responses to the application of AR media.

AR has practical and benefits and opportunities to addresses educational challenges. Vocational education often involves students with diverse educational needs. AR can help address these by providing interactive and engaging learning experiences that cater to different learning styles

and needs (Bacca et al., 2015; Bernsteiner et al., 2023). AR aids in the comprehension of complex and abstract concepts, making it a valuable tool in vocational training where practical and theoretical knowledge must be integrated (Nadzeri et al., 2023; Tiede et al., 2022). AR offers interactive and immersive learning experiences, which can make vocational training more effective and enjoyable. AR also can simulate real-world scenarios, providing students with hands-on experience without the associated risks or costs (Bernsteiner et al., 2023; Candido et al., 2023). Hence, understanding teachers' perspectives on AR in vocational high schools is important. This understanding is crucial for addressing the practical challenges, leveraging the benefits, and ensuring the successful integration of AR in vocational education.

Furthermore, exploring teachers' perspectives on augmented reality is vital. Teachers play a pivotal role in adopting and integrating AR in educational settings. Their perspectives can significantly influence the success of AR implementation in classrooms (Nadzeri et al., 2023; Perifanou et al., 2023; Tiede et al., 2022). Teachers' positive attitudes towards AR can enhance student motivation and engagement, which is crucial in vocational education where practical skills are emphasized (Bernsteiner et al., 2023; He & Li, 2024). Therefore, this article will qualitatively explore the views of teachers based on their experience using various learning media in the Visual Communication Design department. In this way, in-depth information about their response to new media, augmented reality media, is expected to be obtained in basic photography subjects.

B. METHODS

This study employs a phenomenological approach using a qualitative methodology to describe an individual's experiences (Alhazmi & Kaufmann, 2022). In this study, several aspects of the phenomenological method were adopted and modified based on the characteristics of the collected data. Specifically, this study involved thematic analysis procedures to explore data regarding teachers' experiences.

Five teachers participated in this study after signing a consent form. These five teachers teach Visual Communication Design subjects. These teachers were selected based on the criteria of having previously used augmented reality in classroom activities. These criteria were established to ensure that teachers' experiences in interpreting meaningful augmented reality results were investigated. In phenomenology, Creswell (2013) explained that data are collected from the individuals who have experienced the phenomenon, and often data collection in phenomenological studies consists of in-depth and multiple interviews with participants. The participants in this research were five vocational teachers, two male teachers and three female teachers from the Visual Communication Design department. This is compatible with Creswell (2013), who stated that the exploration of this phenomenon should be conducted with a group of individuals who have all experienced the phenomenon. Thus, a heterogeneous group is identified that may vary in size from 3 to 4 individuals to 10 to 15. The participants have much experience with multimedia learning, especially augmented reality in vocational school, because they have at least three years of experience as vocational teachers for the Visual Communication Design subject.

It was conducted in April-May 2023 through an in-person interview. The instrument in qualitative research is the researcher themselves. Two experts had validated the interview question before it was used in the in-depth interview. In qualitative research, the researcher plays a central role in data collection and analysis. This is because qualitative methods focus on understanding phenomena from the participants' perspectives, which requires the researcher to be deeply involved in the process (Polkinghorne, 2006; Wa-Mbaleka, 2020). Qualitative research often involves the researcher themselves as the primary instrument for data collection and analysis.

In analyzing data, Bogdan, R., & Biklen (2007) explained that analysis is a process of data reduction. Decisions to limit codes are imperative. Codes categorize information at different levels. Principal codes are more general and sweeping, incorporating various activities, attitudes, and behaviors. Subcodes break these principal codes into smaller categories. Creswell (2013) argues that phenomenology emphasizes recognizing how people interpret the world and what they experience. Furthermore, to analyze the data, the researcher categorized the

observation field notes and the interview transcriptions into relevant themes.

The initial step in analyzing data is transcribing each participant's interview. The transcript is arranged for the coding process, which was conducted by combining a help table (manual) and ATLAS.ti. The data analysis generated data reduction, and the interview transcriptions were categorized and analyzed into relevant themes. Data reductions are in ATLAS.ti. Relationships or code groups generate conclusions or themes. Therefore, this analysis used thematic analysis.

This research followed the Braun & Clarke (2006) theory, explaining that thematic analysis has advantages: (1) Flexibility. (2) Relatively easy and quick method to learn and do. (3) Accessible to researchers with little or no experience in qualitative research. (4) Results are generally accessible to the educated general public. (5) A valuable method for working within a participatory research paradigm, with participants as collaborators. (6) Can usefully summarize key features of a large body of data and/or offer a 'thick description' of the data set. (7) Can highlight similarities and differences across the dataset. (8) Can generate unanticipated insights. (9) Allows for social as well as psychological interpretations of data. (10) Can be useful for producing qualitative analyses to inform policy development.

C. RESULT AND DISCUSSION

The data analysis process utilized the Bogdan and Bigken Technique, which yielded two significant themes regarding the application of PowerPoint or Canva and the use of AR in the Visual Communication Design department. These themes were opinions expressed by the participants, providing valuable insights for decision-makers in this field.

Tabel 1. Opinion about PowerPoint or Canva

Data of Reduction Result	Relationship	Conclusion/ Theme
PPT or Canva is a limited visual PPT or Canva is Less accessible PPT or Canva has Less Interaction with Students Not all content is suitable for PPT or Canva PPT or Canva is Less Flexible	PPT or Canva has some weaknesses	*Opinion about applying PPT or Canva*

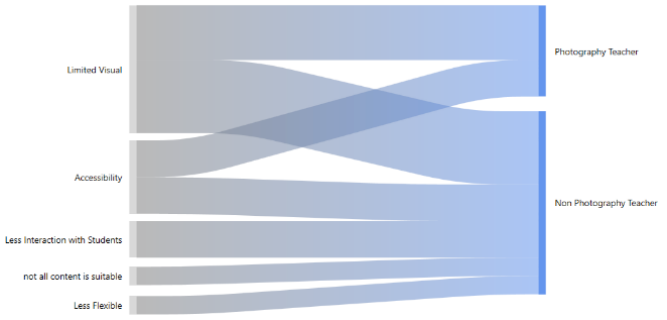

Figure 1. Sankey of The Weakness of PPT or Canva

Interviews conducted by six teachers in the Visual Communication Design department at SMKN 1 Rangas, show that PowerPoint or Canva learning media are effective but still have some weaknesses in their application. Eli said that the learning media used so far were still very rigid. The same thing was expressed by Gilang, who explained that it was very applicable in Visual Communication Design lessons because I said earlier that PowerPoint or Canva are still conventional, while AR can display images in real terms. Furthermore, Sarah revealed that PowerPoint or Canva are effective but have drawbacks. For example, Canva must be connected to an internet network and have an account to access it.

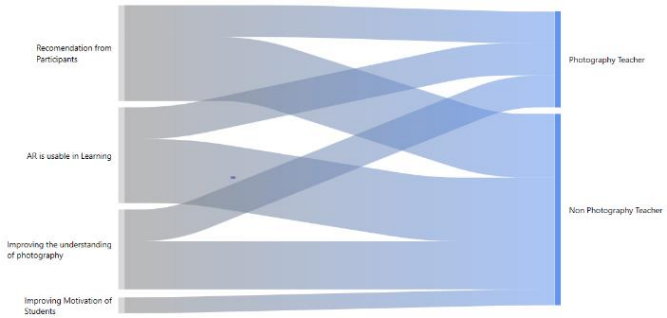

Figure 2. Sankey of Applying AR in the Visual Communication Design Department

In its application to the Visual Communication Design major, all participants agreed that AR would be applied to the Visual Communication Design major because this DKV major is a department that is close to technology. Besides that, students must also be familiarized with technology in the classroom so

that learning is not left behind. era. As revealed by Gilang, if AR is applied in the classroom, it will increase students' understanding of learning because students feel more interested if learning is carried out using new media. The same thing was also expressed by Eli and Sarah, who said that AR is very suitable to be applied to the Visual Communication Design major because if learning is carried out using interesting media and displays 3D objects, students will be more interested in participating in learning in the classroom.

The participants also provided recommendations about the future use of AR. Elish recommends that AR be immediately used in learning so that the media does not stick to just one medium. Gafur and Sarah also recommended that AR be applied to all school subjects.

DISCUSSION

This study discusses qualitatively the teacher's response to the application of Augmented Reality-based learning media in the Visual Communication Design Department. This study uses a qualitative approach, namely the phenomenological type, in which Creswell (2013) stated that the exploration of this phenomenon should be conducted with a group of individuals who have all experienced the phenomenon. The individuals referred to in this study are teachers who have experience in learning using multimedia PowerPoint, Canva, or Augmented Reality.

Teachers' Perspectives on Traditional vs. AR-Based Learning Media

The study highlights a divergence in how photography and non-photography teachers perceive traditional digital tools (PowerPoint, Canva) versus AR. Photography teachers primarily critique static visuals and accessibility constraints in conventional media, suggesting that 2D representations limit depth perception, a crucial element in photography education. This aligns with Mayer's Cognitive Theory of Multimedia Learning (Mayer, 2005), which posits that spatial contiguity (integrating visuals and text) enhances comprehension, something AR improves by allowing 3D manipulation.

Non-photography teachers, however, emphasize broader pedagogical shortcomings. The first, Limited student interaction: Traditional slideshows foster passive learning, whereas AR promotes exploratory engagement to Bruner's Discovery Learning Theory (Bruner,1961). The second, Rigid content structure: Unlike AR, which allows real-time customization, PowerPoint/Canva lack adaptability for dynamic subjects like motion graphics or typography. Nevertheless, while this study's participants viewed AR favorably, Bacca et al. (2014) found that poorly designed AR can overwhelm learners with excessive stimuli. This suggests that AR's efficacy depends on intentional scaffolding—a factor not deeply examined here but critical for future implementation.

AR's Applicability in Visual Communication Design Education

The unanimous agreement among participants that AR suits diverse subjects challenges the notion that AR is only viable for STEM fields (Radu, 2014). For instance, in Typography/Illustration, AR could overlay dynamic font pairings or animated critiques onto student work, addressing tactile learning gaps in Kolb's Experiential Learning (Kolb, 1984). In branding Design, AR simulations of packaging prototypes might bridge the "abstraction gap" in Paivio's Dual Coding Theory (Paivio, 1986), where students struggle to visualize 2D logos in 3D contexts.

Augmented reality can be used in the Visual Communication Design department. This can be seen from all participants' answers that Augmented Reality can be used in learning in the Visual Communication Design department. In addition, the application of Augmented Reality is believed to increase students' understanding of photography subjects, which follows the opinion expressed by Syamsinar (2022) that the use of new and 3D-based learning media can attract students' learning interest because students are very interested in using new learning media, especially if it is smartphone-based. From all the participants' answers, it was explained that Augmented Reality should not only be applied to basic photography subjects but to all subjects in schools.

The findings of this study align with Alyousify & Mustafa (2022) research, which determined that augmented reality is highly sought after in the educational field, particularly for teaching children. AR enhances the user's experience by superimposing

digital information onto the real world, visually illustrating data, concepts, and knowledge, and simplifying complex ideas. Trista & Rusli (2020) research also yielded similar results, demonstrating the vast potential of augmented reality technology in education. The study developed a historical learning application that used AR to improve the user's learning experience. Nurhasanah et al. (2019) discovered that AR significantly improved students' concept mastery. As a result, augmented reality is believed to positively impact education, notably in classroom learning activities.

Several theoretical frameworks support the broader applicability of AR in education. Embodied cognition theory, for instance, posits that physical interaction with learning materials can deepen cognitive engagement, a principle that AR naturally supports through its kinesthetic interfaces. Similarly, Rogers' Diffusion of Innovation theory helps explain the current adoption trends observed in the study, where early-adopter teachers are enthusiastic about AR. However, wider implementation may hinge on addressing the reservations of more hesitant educators. These reservations often stem from practical challenges, such as the technical complexity of AR tools or concerns about equitable access. Not all students may have the necessary devices to fully participate in AR-based activities, raising issues of digital exclusion that could exacerbate existing educational inequalities. Furthermore, the study does not examine the long-term sustainability of AR's benefits. Questions remain about whether the initial novelty of AR might wear off, diminishing its motivational impact over time, or how AR-assisted projects should be assessed compared to traditional work.

The study's findings suggest promising directions for future research and implementation. A longitudinal approach could assess whether the benefits of AR, such as increased student engagement and improved conceptual understanding, persist over time. Additionally, involving faculty and students in co-designing AR tools could ensure that these technologies are pedagogically sound and aligned with curricular goals. Professional development programs will also be essential to equip teachers with the skills to effectively integrate AR into their classrooms. By addressing these practical and theoretical considerations, educators can harness AR's potential to transform visual communication design education while mitigating its challenges. This balanced approach will ensure that AR moves beyond being a novel gadget and becomes a meaningful tool for enhancing learning outcomes.

D. CONCLUSIONS AND SUGGESTIONS

This study captures the teacher's perspective on augmented reality (AR) that significantly enhances vocational students' engagement and understanding in photography education compared to traditional tools like PowerPoint or Canva. By delivering interactive 3D content via smartphones, AR addresses key limitations of conventional media, particularly in visual clarity, student interaction, and real-world skill application. While teachers recognize AR's potential to revolutionize practical training, successful implementation requires targeted teacher training, infrastructure upgrades, and curriculum alignment. Future efforts should focus on developing affordable AR solutions tailored to vocational education and conducting long-term impact studies. When strategically adopted, AR can effectively bridge classroom learning with industry skill demands, transforming visual communication design education.

Vocational high school teachers acknowledge Augmented Reality (AR) as a valuable tool for enhancing practical skills training and student engagement, yet face challenges in adoption due to limited technical expertise, infrastructure gaps, and curriculum integration needs. Schools should prioritize teacher training programs, implement pilot projects in specific technical fields, and foster government-industry partnerships for resource support to maximize AR's potential. Future research should focus on longitudinal studies of AR's educational impact and the development of affordable, customizable AR solutions tailored to vocational training needs, ensuring this technology effectively bridges the gap between classroom learning and workplace skill requirements.

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