

*Augmented Reality and Metaverse in Aesthetic Education Discourse
in Indonesia for Future*

Joni Agung Sudarmanto, Universitas Negeri Malang, Indonesia
Adzrool Idzwan Bin Ismail, Universiti Utara Malaysia, Malaysia

The Southeast Asian Conference on Education 2023
Official Conference Proceedings

Abstract

This study aims to conduct a systematic literature review on the concept of Augmented Reality (AR), which adds virtual objects into the real world and affects the computer vision field, which is the starting point for the metaverse concept of aesthetic education in Indonesia. This content analysis study systematically analyzes how AR impacts aesthetic education and how the metaverse concept has discoursed in education in the future. The search was conducted on Springer Link, Science Directs, Taylor Francis, JSTOR, and Google Scholar databases, with the keywords "augmented reality", "aesthetics education", "arts education", and "metaverse" and their combinations. Based on the inclusion criteria established, 50 articles were collected to be analyzed. The study results show that human needs increasingly vary according to the level of achievement of their culture, including in the post-pandemic phenomenon that makes all entities in the phase of resilience the footing of a new era. Furthermore, the collaboration between art and technology becomes significant in the dynamics of this culture, especially in the design of digital and virtual-based products, including in the field of aesthetic education in Indonesia. In this regard, AR has become an interesting discussion, along with the concept of a parallel world in art education called "metaverse", which can support students' understanding beyond just reading texts. This is related to the condition of the low literacy level in Indonesia; while the trend of technological and information advancement in Indonesia is so rapid, the discourse on the application of AR and the metaverse of aesthetic education in Indonesia can be an effort to increase the intellectual power of students in Indonesia.

Keywords: Augmented Reality, Indonesian Aesthetics Education, Metaverse

iafor

The International Academic Forum
www.iafor.org

Introduction

Learning media is needed as an intermediary to deliver messages to minimize failures during the communication process in education. Furthermore, learning media is an essential aspect of the learning process. The learning process is the process of delivering messages or materials from the sender of the message (in this case, the teacher) to the recipient (students) (Paatela-Nieminen, 2012). In the process of delivering the message or material, sometimes it succeeds, and sometimes it doesn't, where failure in the communication process is called noise or barrier. The process of converting messages or materials into verbal and nonverbal communication symbols is called encoding, and the interpretation of communication symbols by students is called decoding (Dekker, 2015; Priyaadharshini et al., 2020).

Learning media is needed by teachers to help deliver material in a learning process. A good learning process must contain interactive, fun, challenging, and motivating aspects and provide more space for students to develop creativity and independence according to students talents and interests (King et al., 2019). Although the teacher is only a facilitator in a lesson, and students are required to be more active, the teacher must be able to create a pleasant learning atmosphere to stimulate students to be more active in learning. Fun learning activities are strongly influenced by various factors, one of which is the selection of learning media used must be attractive for students to learn, interactive when used, but does not reduce the essence of the material presented (Sampurno & Camelia, 2020).

The development of increasingly advanced technology, of course, affects various sectors of human life. This development also plays a role in the development of learning media. Learning media is becoming more exciting and concise even though it does not reduce the essence of the material. One of the developments of learning media that are currently still new is learning media using Augmented Reality (AR). AR is an application of merging the real world with the virtual world in the form of two-dimensional and three-dimensional projection in a natural environment simultaneously (Lu & Liu, 2015; Pianfetti, 2001). AR is often also referred to as tethered reality. This application is often applied in a game. Xbox Development from Microsoft not only presents games in the form of Virtual Reality (VR) but also presents games in the form of AR.

The use of AR in Indonesia is not too big (Andriana et al., 2022; Kasiyan, 2019; Kidi et al., 2017), which is still relatively new, has little use in Indonesia. The lack of public knowledge about this technology is one of the causes. Using AR as an alternative learning media, it is hoped that a learning activity can be more interesting for students. Another benefit is a more advanced learning media utilizing current technological developments. Through AR, it can be a solution to overcome expensive modules or trainers that schools cannot buy. Students can still do practicum by seeing the goods as they are in the original but virtual form (Huang et al., 2016; Hurrell & Baker, 2020).

In connection with the above, the emergence of AR is also "supported" by the development of society, where there is a post-pandemic trend that makes life today prioritizes technology. Another exciting thing is that one of the tech moguls, Mark Zuckerberg, announced on October 29, 2021, that Facebook would change its name to Meta and also made significant investments in developing the Metaverse technology (Rahaman, 2022). The synergy between AR, VR, and Metaverse technology provides a perspective on how aesthetic education can be synergized with technology. The problem focuses on the role of technology intertwined in aesthetic education that puts forward the question of taste. However, when it is felt that

similar research has not been widely carried out, this study aims to determine whether the use of metaverse is appropriate for feeling-centered aesthetic learning, especially in the post-pandemic era, and to provide broader insight into the concept of a metaverse in aesthetic education in Indonesia.

Methods

This research approach uses multi-site qualitative methods, combining content analysis and literature concepts (Denzin & Lincoln, 2013; Leavy, 2017; Shkedi, 2019; Tashakkori & Creswell, 2008). This approach is used to deepen the theoretical context of the research about digital technology in education and its complexity with modern education perspectives. Furthermore, the data were analyzed with technology education, contextualized to how digital technology, modern technology, and contemporary technology that explores Internet of Thing (IoT) turned into augmented reality to metaverse aesthetics education (Dubowsky, 2016; Grossman, 2017; Keifer-Boyd, 2018; Kress, 2010; Kress & Leeuwen, 2012; Moerdisuroso, 2014; Svasek, 2012).

This content analysis study systematically analyzes how AR impacts aesthetic education and how the metaverse concept has discoursed in education in the future. The search was conducted on Springer Link, Science Directs, Taylor Francis, JSTOR, and Google Scholar databases, with the keywords "augmented reality", "aesthetics education", "arts education", and "metaverse" and their combinations. Based on the inclusion criteria established, 50 articles were collected to be analyzed (Figure 1).

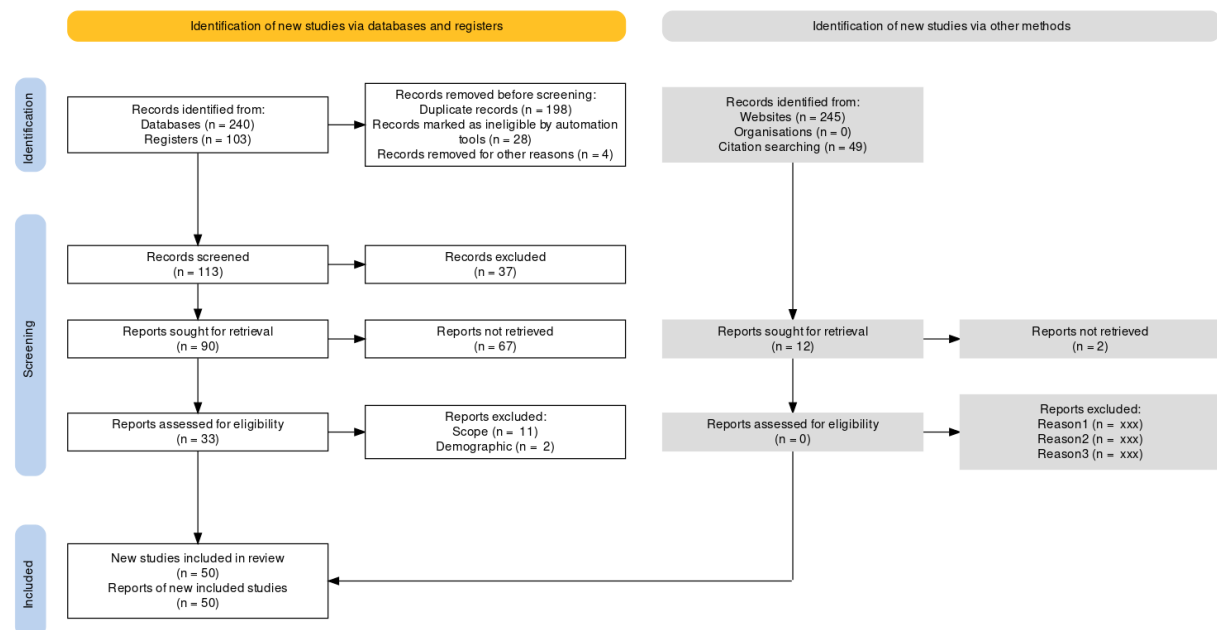


Figure 1. PRISMA Flow Diagrams

This approach begins its critical review from the introduction of the presence of digital art which is characterized by three things, namely; the presence of Virtual Reality (VR)-based art treasures, the principles of digital art for everyone, and a future that will be marked by technological-enabled artistic creativity. All three will be discussed cross-sectionally in order to achieve a more generic, multidimensional understanding, because this paper is not intended to lead us to a specific understanding of digital-based aesthetic education. Digital-based aesthetic education is certainly related to Artificial Intelligence (AI) or intelligence

engineering. So, this study is basically to observe the interconnectedness which explains that every aspect of learning or a particular intelligence in principle can be described precisely so that a machine, technology, or cyber things can be made to simulate it. In short, technological disruption (technological disruption) in the world of aesthetic education has occurred since the development of the world of ICT (Information Communication Technology).

Educational Need for AR and VR

Increasing students' interest in learning by reconstructing abstract concepts into visual forms will help educators deliver the material. During the past Covid-19 pandemic, technology became an educational medium to help increase student interest in learning. Unlike Virtual Reality (VR), which adds natural objects to virtual objects, Augmented Reality (AR) adds virtual objects to natural objects at the same time (Almonacid-Fierro, 2021; AlNajdi et al., 2020; Hash, 2021; Marsudi et al., 2020; Sampurno et al., 2020; Turan & Atila, 2021). AR was first used in 1957-1962 by a cinematographer named Norton Heilig named Sensorama (Koutromanos et al., 2015). Sensorama is a simulator that can simulate visuals, vibrations, and smells. In 1966, Sutherland claimed to have invented the head-mounted display, often shortened to HMD (Koutromanos et al., 2015). HMD became the forerunner to AR, which uses hardware and is installed in the user's head. An example of using HMD at this time is Google Glass. In the 2000s, to be exact, in 2009, Sqoosha introduced FLARToolkit, which was the result of the development of ARToolkit (Hwang et al., 2020; Samson & Karthiga, 2020). FLARToolkit can be used to add AR to websites because the output produced by the FLART toolkit is in the form of Flash. In 2010, Acrossair immersed AR technology in the iPhone 3GS (Payne, 2017). AR can be used in various activities, such as presentations, estimating an object, performance stimulant equipment, simulating a tool's performance, and others (Cai et al., 2020; Suparjoh et al., 2020).

AR is an application that can display small, large, fast, and slow objects seen with the naked eye clearly without assistance (Capuano et al., 2016; Huang et al., 2016). In the context of education, AR has a feature to convert information into visual form. So that by utilizing this technology, students will receive learning in a visual form that is easy to understand. Like research on AR, which represents objects of tradition and cultural heritage, this technology can display museum objects from small to large by reconstructing museum objects into 3-Dimensional objects (Capuano et al., 2016; Harkema & Rosendaal, 2020). This technology allows visitors to study history, see the museum's contents virtually, and interact with the object.

Likewise, the AR Molymod application of hydrocarbon compounds is a learning medium for Chemistry subjects (Kelly et al., 2018; Udeozor et al., 2021). This application contains alkane derivative compounds such as alkyl, alcohol, and alkanol. Some 206 objects and 30 addition reactions are displayed clearly and in detail in this application so that students do not misunderstand differentiating the existing compounds. Next, is the AR application applied to Biology learning, namely the digestive system AR application (Christopoulos et al., 2022). This application can visualize the human digestive organs into 3-Dimensional objects. With these advantages, of course, to study the digestive organs of teaching staff and students, they do not have to practice it directly, just by depicting it virtually with AR applications (Farrell et al., 2022).

AR technology can be defined as a platform combining virtual objects into the real world as these two objects seem to blend. AR is not the same as Virtual Reality (VR) because, by

definition, VR is a virtual world that is made to resemble the real world. AR has several advantages when compared to VR. AR manipulates the real world on the device screen using a smartphone's camera or other image capture device. In contrast, VR makes use of sensors and other peripherals and makes the user feel in another world that is depicted virtually (Maas & Hughes, 2020; Mehrfard et al., 2021). On the one hand, AR was more popular at the beginning than VR. Moreover, AR is now ready to use, and VR is still being developed with improvements in programs and various hardware. They both have in common that AR and VR produce virtual content that users can interact with in various ways and features. Both have the same development area, namely for the development of the world of education and education.

In the context of aesthetic education in Indonesia, the discourse on AR shows that it can provide a live picture between the natural and virtual worlds. AR can also display a detailed visualization of an art object that should not be seen with the eye but ultimately can be seen by the components or particles that make it because of AR. AR has the advantage of being an aesthetic education medium coupled with a positive response that this technology has a considerable influence where students who study art objects will more easily understand using this technology than not using AR technology which can be seen from the results of comparison and analysis of learning (Baía Reis & Ashmore, 2022; Kumar, 2022; Szymański, 2019; Thomas et al., 2010). AR is considered feasible if it is implemented in art learning media which, from the highest total score of 100, got a score of 87 so that it can be classified as adequate to be implemented as a learning medium (Patton et al., 2020).

Judging from the advantages of AR above, of course, this platform is very useful in increasing student interest in aesthetic learning. Starting from illustrating invisible objects, which in the art world, will undoubtedly lead to different conceptions of each student because each person must have a different interpretation. Although face-to-face learning can indeed be helped a little by 2-dimensional drawing examples on the blackboard, this will still make it difficult for students because the level of teachers in representing an image is not always the same, even for representing 3-dimensional objects on a 2-dimensional board. AR can be the best solution in solving this problem. It can also be studied at school and home, especially in post-pandemic conditions.

AR can also be a learning solution in art design, which is very difficult to imagine. For example, in sculpture material or 3-dimensional primary forms, where AR can be a solution and can realize all of these things in the form of 3D animation that will describe it in an interactive educational media container that can be interacted with by zooming in on objects, rotating and play animations (Harkema & Rosendaal, 2020). The advantages of AR are directly proportional to the needs of learning media, making it easier for students to learn various things from 3D visualization. The estuary of the advantages of AR as an educational medium is to encourage students to think more creatively and critically to increase the experience and insight of the students themselves so that there is an embodiment of learning materials.

Metaverse Concepts and A New Chapter of Aesthetic Education

AR has produced educational products with the appropriate methods for the reconstructed field of science. This technology can attract the interest of potential users, which has been strengthened in recent studies. The application of AR into the world of education will be a solution for educators to help them impart knowledge to students (Kyza & Georgiou, 2019;

O'Banion et al., 2022). AR products made for a specific field of science can be implemented to be included in the Indonesian aesthetic education curriculum starting from elementary schools, junior high schools, high schools, and universities (Özyalçın & Avcı, 2022; Turan & Atila, 2021). Aesthetic learning mechanisms that can be used for AR learning can be divided into two: independent aesthetic learning at home and collective aesthetic learning in the classroom.

There are essential things to consider in developing AR into learning in aesthetic education. The issue of heterogeneity of education in Indonesia is the main starting point (Marsudi et al., 2020; Sampurno et al., 2020). This is related to the government's role in the collaborative development of digitalization in the world of aesthetic education, especially for the application of learning using AR technology. The country of Indonesia, which is quite large, certainly requires special attention, especially for areas that have not been touched by digital technology supporting infrastructure as a medium that supports the use of AR technology.

Because AR, many people see "metaverse" as a new term. Nevertheless, the concept of Metaverse is not a new term. The Metaverse first appeared in 1992 in the speculative fiction *Snow Crash* by Neal Stephenson (Rahaman, 2022). In this novel, the Metaverse is a large virtual environment. On the other hand, the Metaverse was also introduced in the novel and film *Ready Player One*, which ultimately led to the concept of Metaverse as a virtual environment, also known as MUVE (Multi-User Virtual Environments), which has a format derived from MMORPG (Massive Multiplayer Online Role-playing) (Baía Reis & Ashmore, 2022; Dichev & Dicheva, 2017; S. Kim et al., 2018; Rahaman, 2022; Rospigliosi, 2022a). Playing games, which allows everyone to meet avatars in 3D video games by combining virtual reality, augmented reality (AR), virtual reality (VR), and the internet (P. W. Kim et al., 2017). So, the Metaverse and its supporting technology devices allow users to feel the sensation of being in an authentic virtual environment.

At first, even though it was just speculation, scholars did an in-depth study. Society enters the stage of true post-humanism life where there will be many cyborgs, and society will ultimately depend on machines. This trend shows that the community's collective memory immediately turned back to the existence of "cyborgs." Cyborg is short for Cybernetic Organism, namely cybernetic creatures (human machines) that have a system of self-regulating abilities (Houston, 2004). So the effect is a kind of human-machine where machine parts can be replaced, integrated, or functioned as additional body parts to increase the body's strength potential. Aesthetic education in the future also considers cyborgs living in a complete dimension with no boundaries between inner and outer space (Baía Reis & Ashmore, 2022; Rospigliosi, 2022b; Taylor & Carpenter, 2016).

Space for movement or alternative space in aesthetic education is called cyberspace (cybernetic space). Cyberspace is an alternative space for aesthetic education where data is depicted in such a way as to give the operator the illusion of control over movement and access to information (Baía Reis & Ashmore, 2022; Garrido-Iñigo & Rodríguez-Moreno, 2015; Rospigliosi, 2022b; Tasa & Görgülü, 2010). In this case, the cyborg is connected to various shadow-like simulations. For aesthetic education, such technologies are familiar to the public (3D, and 4D games, for example). Some are still being developed ('real time' presentations, for example), and some are still fictional, all of which have the capability of simulating the space in which we interact.

Synergy is seen when cyberspace is usually equipped with virtual reality (AR or VR), namely the expansion of the cyberspace process in order to provide a 'pure' information space through data construction that gives the effect of immersion into cybernetic space. AR is usually 3D/4D multimedia. So reality can provide artificial senses to our bodies in light, sound, and touch that are not limited to space and time (2D) and provide an exciting experience impact for aesthetic education.

Moreover, if in the 'normal' dimension, we cannot share space with other people precisely at the same time, in alternative space, we can not only share but also from entirely different places; we can share the same space with others. Moreover, because the 'movement' in cyberspace is entirely different from 'normal' space conditions, we can fly and enter the wall because the wall is not made of natural sand, brick, and cement but only visual manipulation (manipulate imagery) (Fook et al., 2021; Lungu et al., 2021; Sample et al., 2018; Waters, 2016).

In the context of community culture for aesthetic education in the context of the Metaverse, it is closely related to the community's readiness to face a new era. A small part of the community, especially users, can explore this Metaverse by carrying out various digital activities like in the real world. These people are usually already members of cyber and virtual 3D communities that support each other from various parts of the world. They go to school, work, and other activities in the virtual world (Blankenship, 2011; Weninger, 2017). Of course, there must be knowledge or skills that must be prepared for the younger generation, especially to prepare everything so that this metaverse era can later be helpful for the progress of the Indonesian nation.

The education system in Indonesia often changes. One of them is curriculum changes from year to year. The transformation of learning from time to time continues to occur. Facing the metaverse era, which is currently being discussed, the government needs to facilitate all needs in the field of technology-based education. The curriculum of the metaverse era must be different from the previous curriculum to welcome changes that will occur in the future. Even though it looks fun and exciting if society can do virtual activities like in the real world, but still this metaverse era has several challenges that need to be considered, including users will be busy with all activities that occur in the virtual world, so that users become addicted and choose to be engrossed in activities in the virtual world than in the real world (Ardoin et al., 2020; Sudarsana et al., 2019). The more sophisticated technology that develops, of course, has an impact that can affect its users. In addition, the field of education certainly experiences various challenges and obstacles because they have to make changes to the curriculum according to technological developments. The presence of the metaverse era is not only a challenge in education but also a challenge for society, especially in the economic field. The two fields are closely related because the fulfillment of economic needs accompanies the process of continuing education to facilitate education. For example, if learning is done virtually, it will cost money to finance these digital activities. Electronic devices such as gadgets and quotas will become the primary needs of people entering this metaverse era (Behnamnia, Kamsin, & Ismail, 2020; Behnamnia, Kamsin, Ismail, et al., 2020).

Meanwhile, many Indonesians still find it challenging to meet their daily needs. If education in Indonesia is directed to enter this metaverse era, there will be new problems considering that the online learning process still leaves many obstacles. The teaching and learning process will reduce the interaction between teachers and students because they will spend more time

in the virtual world (Lehtomäki et al., 2016; Mercer et al., 2019). Even though we know that students not only need various kinds of knowledge and skills but also need character education and moral values to shape each student's personality. In addition, parental supervision must be stricter so that children do not fall into negative things in the virtual world. Another thing, of course, every parent would hope to send their children to the best educational institutions and have adequate facilities. In this case, the best category is undoubtedly very subjective. However, some things can be considered general agreement, such as the need for a clean, safe, and comfortable school environment.

Nowadays parents want their children to study in modern schools. The term modern school is meant not only in terms of the availability of learning facilities considered sophisticated, such as the presence of a computer laboratory, the internet, or using specific applications to support online learning. However, modern schools can offer, even implement, educational systems and teaching and learning methods that can help students become independent in learning, have academic knowledge, be innovative, brave, critical, and ready to apply their knowledge in various contexts (Cannon, 2018; Richardson, 2020; Zhu et al., 2018). The concept of the modern school has become a reasonable discourse. Talking about modern schools is undoubtedly related to educators or teachers. Educators or teachers must also be able to choose materials and learning media suitable for teaching in this metaverse era.

The use of technology-based learning media can expedite the learning process. Of course, educators or teachers in this era must not be ignorant. They must be more proficient than their students because it is in the hands of these educators or teachers that the younger generation will be able to enter the metaverse era correctly so that they do not fall into a negative digital space. Even though we know the reality is that many teaching staff are still having trouble doing online learning for various reasons. The era of the Metaverse is in sight with all the changes that will occur there. Many preparations must be made, starting from the facilities and infrastructure, intellectual abilities, and legal umbrella from the government in regulating the metaverse era. Now the education system in Indonesia will face a metaverse era.

This is a big challenge because of the influence of metaverse technology on the world of education. The use of metaverse technology will change the world. The two-dimensional world we have known is starting to be replaced with a three-dimensional virtual world. Even now, this technology is reaching the more modern world of education. However, the Metaverse generally visualizes the internet in a three-dimensional media format. Metaverse technology must be used through mobile application tools, augmented reality glasses, virtual reality, and others. Some devices currently use metaverse technology. Soon there will be a significant change in schools and campuses' teaching and learning processes. In addition, learning technology tools will use a more sophisticated online system, and there are more interactive technology tools.

Conclusion

“The ‘earth’ without art is ‘eh’...this world without art people will only be ‘ehhh’.” Furthermore, when today's society says that art is on the side of the road, meaning that it is not the same as other knowledge, it turns out that after being reconstructed in neuroscience, art is very extraordinary. When the context of aesthetic education is put forward, there are two kinds of meaning. Aesthetic education, in the sense of schools, we call education for life and education for earning a living. The second is aesthetic science. Aesthetic education as the

estuary of art produces metacognitive thinking patterns expected by education's success in general.

The world of telepresence (virtual existence) is a cyber world because the primary entity (object) is transported and transfigured into the cyber world. As another layer of reality, cyberspace allows people to be present in other places and meet others even though their bodies are physically in other places. Aesthetic education through digital technology can enable even more extraordinary telepresence than that. Moreover, all of this is possible because of computers. Computers and aesthetic education are inseparable parts.

The concept of science in the conventional era shows that science develops partially and disconnectedly, including by their respective methods. The picture in the Aufklärung period provides an aesthetic deepening into dynamic and definite particles. Definite knowledge, very limited where to go. If it has become A, it is not possible to solve B. It is different from this metaverse era, where if art develops creativity, then technology develops for the benefit of humans. In other words, technology has developed with new technology, which increasingly shows that aesthetic education has the nature of developing creativity so that it penetrates the boundaries of the arts branch with fractal patterns and integrated, solid, and natural art. Therefore, aesthetic education is now integrated. Aesthetic education is undeniably integrated with other arts. Thus, aesthetic education in the metaverse concept includes three things; namely, it is presentational, non-representational, and deformative material at the same time. The discourse on AR and the metaverse in aesthetic education in Indonesia are fascinating, mainly when he collaborates with pure art, which has given rise to Non-Fungible Token (NFT) Art which certainly has more stable management than aesthetic education in the context of the metaverse. Thus, when collaboration and interdisciplinary, the context of Mixed-Reality (MR) can be discussed further.

References

- Almonacid-Fierro, A. (2021). Impact on teaching in times of Covid-19 pandemic: a qualitative study. *International Journal of Evaluation and Research in Education (IJERE)*, 10(2), 432–440. <https://doi.org/10.11591/ijere.v10i2.21129>
- AlNajdi, S. M., Alrashidi, M. Q., & Almohamadi, K. S. (2020). The effectiveness of using augmented reality (AR) on assembling and exploring educational mobile robot in pedagogical virtual machine (PVM). *Interactive Learning Environments*, 28(8), 964–990. <https://doi.org/10.1080/10494820.2018.1552873>
- Andriana, E., Kiling, I., & Evans, D. (2022). Inclusive education for indigenous students in the Indonesian context. *International Journal of Inclusive Education*, 1–15. <https://doi.org/10.1080/13603116.2022.2127494>
- Ardoin, N. M., Bowers, A. W., & Gaillard, E. (2020). Environmental education outcomes for conservation: A systematic review. *Biological Conservation*, 241(August 2019), 108224. <https://doi.org/10.1016/j.biocon.2019.108224>
- Baía Reis, A., & Ashmore, M. (2022). From video streaming to virtual reality worlds: an academic, reflective, and creative study on live theatre and performance in the metaverse. *International Journal of Performance Arts and Digital Media*, 18(1), 7–28. <https://doi.org/10.1080/14794713.2021.2024398>
- Behnamnia, N., Kamsin, A., & Ismail, M. A. B. (2020). The landscape of research on the use of digital game-based learning apps to nurture creativity among young children: A review. *Thinking Skills and Creativity*, 37(May), 100666. <https://doi.org/10.1016/j.tsc.2020.100666>
- Behnamnia, N., Kamsin, A., Ismail, M. A. B., & Hayati, A. (2020). The effective components of creativity in digital game-based learning among young children: A case study. *Children and Youth Services Review*, 116(March). <https://doi.org/10.1016/j.childyouth.2020.105227>
- Blankenship, M. (2011). How social media can and should impact higher education. *Education Digest*, 76(7), 39–42.
- Cai, S., Liu, E., Shen, Y., Liu, C., Li, S., & Shen, Y. (2020). Probability learning in mathematics using augmented reality: impact on student's learning gains and attitudes. *Interactive Learning Environments*, 28(5), 560–573. <https://doi.org/10.1080/10494820.2019.1696839>
- Cannon, M. (2018). *Digital Media in Education: Teaching, Learning and Literacy Practices with Young Learners*. The Palgrave Macmillan. <https://doi.org/10.1007/978-3-319-78304-8>
- Capuano, N., Gaeta, A., Guarino, G., Miranda, S., & Tomasiello, S. (2016). Enhancing augmented reality with cognitive and knowledge perspectives: a case study in museum exhibitions. *Behaviour & Information Technology*, 35(11), 968–979. <https://doi.org/10.1080/0144929X.2016.1208774>

- Christopoulos, A., Mystakidis, S., Cachafeiro, E., & Laakso, M.-J. (2022). Escaping the cell: virtual reality escape rooms in biology education. *Behaviour & Information Technology*, 1–18. <https://doi.org/10.1080/0144929X.2022.2079560>
- Dekker, J. J. H. (2015). Images as representations: visual sources on education and childhood in the past. *Paedagogica Historica*, 51(6), 702–715. <https://doi.org/10.1080/00309230.2015.1061565>
- Denzin, N. K., & Lincoln, Y. S. (Eds.). (2013). *Collecting and Interpreting Qualitative Materials* (4th ed.). SAGE Publications.
- Dichev, C., & Dicheva, D. (2017). Gamifying education: what is known, what is believed and what remains uncertain: a critical review. In *International Journal of Educational Technology in Higher Education* (Vol. 14, Issue 1). <https://doi.org/10.1186/s41239-017-0042-5>
- Dubowsky, J. C. (2016). *Intersecting Film, Music, and Queerness*. Palgrave Studies in Audio-Visual Culture Series. <https://doi.org/10.1057/9781137454218>
- Farrell, R., Cowan, P., Brown, M., Roulston, S., Taggart, S., Donlon, E., & Baldwin, M. (2022). Virtual Reality in Initial Teacher Education (VRITE): a reverse mentoring model of professional learning for learning leaders. *Irish Educational Studies*, 41(1), 245–256. <https://doi.org/10.1080/03323315.2021.2021102>
- Fook, C. Y., Narasuman, S., Aziz, N. A., Mustafa, S. M. S., & Han, C. T. (2021). Smartphone Usage among University Students. *Asian Journal of University Education*, 17(1), 283–291. <https://doi.org/10.24191/ajue.v17i1.12622>
- Garrido-Iñigo, P., & Rodríguez-Moreno, F. (2015). The reality of virtual worlds: pros and cons of their application to foreign language teaching. *Interactive Learning Environments*, 23(4), 453–470. <https://doi.org/10.1080/10494820.2013.788034>
- Grossman, J. (2017). Adaptation in Visual Culture. In *Adaptation in Visual Culture*. Palgrave Macmillan. <https://doi.org/10.1007/978-3-319-58580-2>
- Harkema, G. J., & Rosendaal, A. (2020). From cinematograph to 3D model: how can virtual reality support film education hands-on? *Early Popular Visual Culture*, 18(1), 70–81. <https://doi.org/10.1080/17460654.2020.1761598>
- Hash, P. M. (2021). Remote Learning in School Bands During the COVID-19 Shutdown. *Journal of Research in Music Education*, 68(4), 381–397. <https://doi.org/10.1177/0022429420967008>
- Houston, H. R. (2004). Other mothers: framing the cybernetic construction(s) of the postmodern family. *Consumption Markets & Culture*, 7(3), 191–209. <https://doi.org/10.1080/1025386042000271333>
- Huang, Y., Li, H., & Fong, R. (2016). Using Augmented Reality in early art education: a case study in Hong Kong kindergarten. *Early Child Development and Care*, 186(6), 879–894. <https://doi.org/10.1080/03004430.2015.1067888>

- Hurrell, C., & Baker, J. (2020). Immersive learning: Applications of virtual reality for undergraduate education. *College & Undergraduate Libraries*, 27(2–4), 197–209. <https://doi.org/10.1080/10691316.2020.1796879>
- Hwang, G.-J., Wu, P.-H., & Chen, C.-C. (2020). An online game approach for improving students' learning performance in web-based problem-solving activities. *Computers & Education*, 59(4), 1246–1256.
- Kasiyan. (2019). Art, art education, creative industry: Critique of commodification and fetishism of art aesthetics in Indonesia. *Cogent Arts and Humanities*, 6(1), 1–11. <https://doi.org/10.1080/23311983.2019.1586065>
- Keifer-Boyd, K. (2018). (re)Vision Visual Culture. *Studies in Art Education*, 59(2), 174–178. <https://doi.org/10.1080/00393541.2018.1440154>
- Kelly, D., Hoang, T. N., Reinoso, M., Joukhadar, Z., Clements, T., & Vetere, F. (2018). Augmented reality learning environment for physiotherapy education. *Physical Therapy Reviews*, 23(1), 21–28. <https://doi.org/10.1080/10833196.2018.1447256>
- Kidi, N., Kanigoro, B., Salman, A. G., Prasetyo, Y. L., Lokaadinugroho, I., & Sukmandhani, A. A. (2017). Android Based Indonesian Information Culture Education Game. *Procedia Computer Science*, 116, 99–106. <https://doi.org/10.1016/j.procs.2017.10.015>
- Kim, P. W., Shin, Y. S., Ha, B. H., & Anisetti, M. (2017). Effects of avatar character performances in virtual reality dramas used for teachers' education. *Behaviour & Information Technology*, 36(7), 699–712. <https://doi.org/10.1080/0144929X.2016.1275809>
- Kim, S., Song, K., Lockee, B., & Burton, J. (2018). *Gamification in Learning and Education Enjoy Learning Like Gaming*. Springer.
- King, A., Prior, H., & Waddington-Jones, C. (2019). Exploring teachers' and pupils' behaviour in online and face-to-face instrumental lessons. *Music Education Research*, 21(2), 197–209. <https://doi.org/10.1080/14613808.2019.1585791>
- Koutromanos, G., Sofos, A., & Avraamidou, L. (2015). The use of augmented reality games in education: a review of the literature. *Educational Media International*, 52(4), 253–271. <https://doi.org/10.1080/09523987.2015.1125988>
- Kress, G. (2010). *Multimodality*. Routledge. <https://doi.org/10.1177/1461445612446268b>
- Kress, G., & Leeuwen, T. van. (2012). *Reading Images: The Grammar of Visual Design*. Routledge.
- Kumar, A. (2022). Gamification in training with next generation AI- virtual reality, animation design and immersive technology. *Journal of Experimental & Theoretical Artificial Intelligence*, 1–14. <https://doi.org/10.1080/0952813X.2022.2125080>

- Kyza, E. A., & Georgiou, Y. (2019). Scaffolding augmented reality inquiry learning: the design and investigation of the TraceReaders location-based, augmented reality platform. *Interactive Learning Environments*, 27(2), 211–225. <https://doi.org/10.1080/10494820.2018.1458039>
- Leavy, P. (2017). *Research Design: Quantitative, Qualitative, Mixed Methods, Arts-Based, and Community-Based Participatory Research Approaches*. The Guilford Press.
- Lehtomäki, E., Moate, J., & Posti-Ahokas, H. (2016). Global connectedness in higher education: student voices on the value of cross-cultural learning dialogue. *Studies in Higher Education*, 41(11), 2011–2027. <https://doi.org/10.1080/03075079.2015.1007943>
- Lu, S.-J., & Liu, Y.-C. (2015). Integrating augmented reality technology to enhance children's learning in marine education. *Environmental Education Research*, 21(4), 525–541. <https://doi.org/10.1080/13504622.2014.911247>
- Lungu, A. J., Swinkels, W., Claesen, L., Tu, P., Egger, J., & Chen, X. (2021). A review on the applications of virtual reality, augmented reality and mixed reality in surgical simulation: an extension to different kinds of surgery. *Expert Review of Medical Devices*, 18(1), 47–62. <https://doi.org/10.1080/17434440.2021.1860750>
- Maas, M. J., & Hughes, J. M. (2020). Virtual, augmented and mixed reality in K–12 education: a review of the literature. *Technology, Pedagogy and Education*, 29(2), 231–249. <https://doi.org/10.1080/1475939X.2020.1737210>
- Marsudi, M., Sampurno, M. B. T., Wiratmoko, C., & Ratyningrum, F. (2020). Kontribusi Desain Komunikasi Visual dalam Anti-Hoax System saat Pandemi Covid-19 di Indonesia. *SALAM: Jurnal Sosial Dan Budaya Syar-i; Vol 7, No 10 (2020): Special Issue Coronavirus Covid-19DO - 10.15408/Sjsbs.V7i10.15844*. <http://journal.uinjkt.ac.id/index.php/salam/article/view/15844>
- Mehrfard, A., Fotouhi, J., Taylor, G., Forster, T., Armand, M., Navab, N., & Fuerst, B. (2021). Virtual reality technologies for clinical education: evaluation metrics and comparative analysis. *Computer Methods in Biomechanics and Biomedical Engineering: Imaging & Visualization*, 9(3), 233–242. <https://doi.org/10.1080/21681163.2020.1835559>
- Mercer, N., Hennesy, S., & Warwick, P. (2019). Dialogue, thinking together and digital technology in the classroom: Some educational implications of a continuing line of inquiry. *International Journal of Educational Research*, 97(March), 187–199. <https://doi.org/10.1016/j.ijer.2017.08.007>
- Moerdisuroso, I. (2014). Social Semiotics and Visual Grammar: A Contemporary Approach to Visual Text Research. *International Journal of Creative and Arts Studies*, 1(1), 80091. <https://doi.org/10.24821/ijcas.v1i1.1574>

- O'Banion, M. S., Lewis, N. S., Boyce, M. W., Laughlin, J., & Majkowicz, D. C. (2022). Use of an augmented reality sand table for satellite remote sensing education. *Journal of Geography in Higher Education*, 1–12. <https://doi.org/10.1080/03098265.2022.2087215>
- Özyalçın, B., & Avcı, F. (2022). Let's get to learn the particulate structure of matter with augmented reality!: a jigsaw IV technique lesson plan. *Science Activities*, 59(2), 68–83. <https://doi.org/10.1080/00368121.2022.2056112>
- Paatela-Nieminen, M. (2012). Intercultural Design Education. *Procedia - Social and Behavioral Sciences*, 45, 84–94. <https://doi.org/10.1016/j.sbspro.2012.06.545>
- Patton, R., Sweeny, R. W., Shin, R., & Lu, L. (2020). Teaching Digital Game Design With Preservice Art Educators. *Studies in Art Education*, 61(2), 155–170. <https://doi.org/10.1080/00393541.2020.1738165>
- Payne, K. A. (2017). Democratic teacher education in elementary classrooms – Learning about, through, and for thick democracy. *Journal of Social Studies Research*, 41(2), 101–115. <https://doi.org/10.1016/j.jssr.2016.07.001>
- Pianfetti, E. S. (2001). Teachers and Technology: Digital Literacy through Professional Development. *Language Arts*, 78(255–262), 255–262.
- Priyaadharshini, M., NathaMayil, N., Dakshina, R., Sandhya, S., & Bettina Shirley, R. (2020). Learning analytics: Game-based Learning for Programming Course in Higher Education. *Procedia Computer Science*, 172(2019), 468–472. <https://doi.org/10.1016/j.procs.2020.05.143>
- Rahaman, T. (2022). Into the Metaverse – Perspectives on a New Reality. *Medical Reference Services Quarterly*, 41(3), 330–337. <https://doi.org/10.1080/02763869.2022.2096341>
- Richardson, C. (2020). Supporting collaborative creativity in education with The i5 Framework. *Educational Action Research*. <https://doi.org/10.1080/09650792.2020.1810731>
- Rospigliosi, P. 'asher.' (2022a). Metaverse or Simulacra? Roblox, Minecraft, Meta and the turn to virtual reality for education, socialisation and work. *Interactive Learning Environments*, 30(1), 1–3. <https://doi.org/10.1080/10494820.2022.2022899>
- Rospigliosi, P. 'asher.' (2022b). Adopting the metaverse for learning environments means more use of deep learning artificial intelligence: this presents challenges and problems. *Interactive Learning Environments*, 30(9), 1573–1576. <https://doi.org/10.1080/10494820.2022.2132034>
- Sample, C., McAlaney, J., Bakdash, J., & Thackray, H. (2018). A Cultural Exploration of Social Media Manipulators. *Journal of Information Warfare*, 17(4), 56–71. <https://doi.org/10.1017/CBO9781107415324.004>

- Sampurno, M. B. T., & Camelia, I. A. (2020). *Art and Fun Digital Learning for Children with Special Needs: A Case Study on Applying Art as a Learning Technology*. 380(SoSHEC), 175–180. <https://doi.org/10.2991/soshec-19.2019.38>
- Sampurno, M. B. T., Kusumandyoko, T. C., & Islam, M. A. (2020). Budaya Media Sosial, Edukasi Masyarakat, dan Pandemi COVID-19. *SALAM: Jurnal Sosial Dan Budaya Syar-I*, 7(5). <https://doi.org/https://doi.org/10.15408/sjsbs.v7i5.15210>
- Samson, S., & Karthiga, S. V. (2020). Gamification as a Tool in English Language Teaching. *International Journal of Early Childhood Special Education*, 12(2), 99–102. <https://doi.org/10.9756/INT-JECSE/V12I2.201061>
- Shkedi, A. (2019). *Introduction to Data Analysis in Qualitative Research*. Springer International Publishing.
- Sudarsana, I. K., Nakayanti, A. R., Sapta, A., Haimah, Satria, E., Saddhono, K., Achmad Daengs, G. S., Putut, E., Helda, T., & Mursalin, M. (2019). Technology Application in Education and Learning Process. *Journal of Physics: Conference Series*, 1363(1). <https://doi.org/10.1088/1742-6596/1363/1/012061>
- Suparjoh, S., Shahbodin, F., & Mohd, C. K. N. C. K. (2020). Technology-Assisted Intervention for Children with Autism Spectrum Disorder using Augmented Reality. *International Journal of Recent Technology and Engineering*, 8(5), 2156–2162. <https://doi.org/10.35940/ijrte.c6512.018520>
- Svasek, M. (Ed.). (2012). *Moving Subjects, Moving Objects: Transnationalism, Cultural Production and Emotions*. Berghahn Books. <https://doi.org/10.1017/CBO9781107415324.004>
- Szymański, M. (2019). Computer Games in Art History. Traditional architecture and painting presented in virtual reality. *E-Methodology*, 5(5), 84–99. <https://doi.org/10.15503/emet.v5i5.449>
- Tasa, U. B., & Görgülü, T. (2010). Meta-art: art of the 3-D user-created virtual worlds. *Digital Creativity*, 21(2), 100–111. <https://doi.org/10.1080/14626261003786251>
- Tashakkori, A., & Creswell, J. (2008). Mixed Methodology Across Disciplines. *Journal Of Mixed Methods Research*, 2(1), 1–5.
- Taylor, P. G., & Carpenter, B. S. (2016). Mediating Art Education : Digital Kids , Art , and Technology. *Visual Arts Research*, 33(2), 84–95.
- Thomas, R. G., William John, N., & Delieu, J. M. (2010). Augmented Reality for Anatomical Education. *Journal of Visual Communication in Medicine*, 33(1), 6–15. <https://doi.org/10.3109/17453050903557359>
- Turan, Z., & Atila, G. (2021). Augmented reality technology in science education for students with specific learning difficulties: its effect on students' learning and views. *Research in Science & Technological Education*, 39(4), 506–524. <https://doi.org/10.1080/02635143.2021.1901682>

- Udeozor, C., Toyoda, R., Russo Abegão, F., & Glassey, J. (2021). Perceptions of the use of virtual reality games for chemical engineering education and professional training. *Higher Education Pedagogies*, 6(1), 175–194. <https://doi.org/10.1080/23752696.2021.1951615>
- Waters, B. (2016). “A part to play”: the value of role-play simulation in undergraduate legal education. *The Law Teacher*, 50(2), 172–194. <https://doi.org/10.1080/03069400.2016.1162404>
- Weninger, C. (2017). The “vernacularization” of global education policy: media and digital literacy as twenty-first century skills in Singapore. *Asia Pacific Journal of Education*, 37(4), 500–516. <https://doi.org/10.1080/02188791.2017.1336429>
- Zhu, X., Sun, B., & Luo, Y. (2018). Interactive learning system “VisMis” for scientific visualization course. *Interactive Learning Environments*, 26(4), 553–565. <https://doi.org/10.1080/10494820.2017.1371197>