

## **Bibliometric Analysis: Augmented Reality Research Trends in Indonesia in Physics Learning**

**Islamianti<sup>1</sup>, Fatni Mufit<sup>2</sup>, Ratnawulan<sup>3</sup>, Silvi Yulia Sari<sup>4</sup>**

<sup>1,2,3,4</sup> Universitas Negeri Padang  
e-mail: [islamiantimia02@gmail.com](mailto:islamiantimia02@gmail.com)

### **Abstract**

This study aims to conduct a Bibliometric Analysis of Augmented Reality (AR) research trends in the context of Physics learning in Indonesia. With the background of the researcher's desire to understand and summarize the development of research related to the use of AR, the research focus is focused on bibliometric analysis. The main objective of this research is to improve understanding of the development, implementation and effectiveness of AR in Physics learning in Indonesia. Using data from various research sources, this analysis reveals the dynamics of AR development in Physics learning, exposes shifting trends, and provides insights into the extent to which AR has been adopted in educational contexts. The results of this study can provide an in-depth view of the contribution of AR to Physics learning in Indonesia, as well as provide valuable information about the education levels and Physics materials that benefit most from AR integration. In addition, this analysis identifies the types of AR that are widely used, providing a foundation for further development in the application of this technology in Physics learning contexts in the future.

**Keywords:** *Bibliometric Analysis; Augmented Reality; Physics Learning*

### **INTRODUCTION**

Education in the 21st century era requires a paradigm shift in learning methods in order to prepare the younger generation to face the challenges of an increasingly complex and rapidly changing world. The focus of learning in this era lies on developing critical, creativity, collaboration and communication skills, known as "4C Skills". One of the main factors that are important in 21st century education is the integration of technology in the learning process, which opens up new opportunities to create learning experiences that are more interactive and adaptable to individual needs (Fatni Mufit, Yeka Hendriyani, M. Dhanil 2023). Interactive learning should have the ability to utilize technology as a tool in enhancing the learning experience. One interesting aspect of integrating technology is the use of Augmented Reality (AR).

Augmented Reality (AR) is a technology that enables the addition of virtual elements into the real world, creating an experience that combines both worlds (Mustaqim 2016). Augmented Reality (AR) can be an invaluable tool in learning, including Physics learning. AR refers to the projection of digital information or images onto real-world objects, aiding visualization and understanding of complex concepts. In Physics learning, AR can assist students in visualizing abstract physical phenomena and engaging with complex ideas in a tangible way. For example, AR can allow students to interact with three-dimensional models of Atoms, Particles, Forces, or Electromagnetic Waves. The use of AR can provide an immersive learning experience and allow students to "experience" abstract concepts first-hand. The use of AR is a rapidly evolving technology that can potentially revolutionize the learning experience and provide students with new and exciting opportunities to grow and develop (Dhar et al. 2021).

However, the lack of utilization of smartphones on students in learning Physics with Augmented Reality (AR) based technology is also one of the obstacles for students to grow and develop with the revolution of learning experiences that exist at this time. There are several factors that influence one of them is the limited accessibility of technology. Although most students own smartphones, not all of them own AR-enabled devices or have adequate access to the internet. This can be a major obstacle as AR applications usually require certain device specifications and considerable internet bandwidth. Secondly, there is a lack of understanding of the learning potential that AR technology has (Shafeey, Modi, and Lakulu 2021). Students and even teachers may not be fully aware of how AR can enhance the learning experience in the context of Physics. Lack of training or information on how to integrate AR into Physics learning can also be a hindrance. In addition, school policies that restrict the use of smartphones in the classroom could also be a factor.

Some schools may have strict policies regarding the use of gadgets during class hours, and this may hinder the potential utilization of smartphones as effective learning tools. Teachers' inability or unpreparedness in integrating AR technology can also be a cause of underutilization. If teachers do not have enough knowledge or support, they may be reluctant or unconfident in trying new technologies. Support from the school, specialized training, and adequate resources can help overcome this barrier. Finally, economic factors can also play a role. Although students have smartphones, they may not be able or allowed to download paid apps or subscribe to AR services that can enhance their learning experience. In addressing these issues, it is necessary to make a concerted effort between the school, teachers, and students to raise awareness, provide training, and create policies that support the utilization of smartphones and AR technology in Physics learning (Volioti 2022).

In today's information age, the use of bibliometric analysis has become an important tool in understanding research trends and scientific developments in various disciplines. It helps identify specific research contributions, identify influential journals and researchers, and understand the development of research topics over time. In the

context of this study, researchers will focus on bibliometric analysis to understand Augmented Reality (AR) research trends in Indonesia in the context of Physics learning. An understanding of AR research trends in Physics learning in Indonesia can help evaluate the contribution of this technology to the country's education system. This is important to identify successes and potential improvements.

Through bibliometric analysis, it can help researchers identify research opportunities and provide recommendations for future studies in the field of technology-based learning media (Tupan et al. 2018). And this will help this study to update the literature base and explore the latest developments in the use of AR in Physics learning. If research trends show that AR has not been fully utilized in Physics learning in Indonesia, then this study can provide encouragement for educational institutions and researchers to further integrate this technology into learning. A lot of research has been done in the development of the use of AR in Physics learning, but it has not been comprehensively summarized into a new information. Although the number of publications on this material is still small, the interest in using AR in Physics learning in Indonesia is increasing (Septiany Maulani Soraya, Kurjono 2023).

The purpose of this study is to visualize research trends related to the application of new technologies, such as Augmented Reality (AR), in Physics learning through bibliometric analysis. AR has the potential to help students understand abstract Physics concepts more visually and interactively in the context of Physics learning. However, there has been no recent update on bibliometric analysis specifically on AR research trends in Physics learning in Indonesia. Therefore, conducting a bibliometric analysis of AR research trends in Physics learning in Indonesia can provide valuable insights for educational researchers and practitioners in shaping and implementing more effective and innovative learning methods.

Bibliometric analysis is an appropriate and potential approach for researchers to choose. By conducting bibliometric analysis, researchers can explore more in-depth knowledge about the field under study, as well as analyze and classify the scientific data that has been collected. Bibliometric analysis is used to evaluate the development of certain research over time. Utilizing software such as VosViewer, this analysis can simplify the research mapping process, facilitating easier and more efficient analysis. VosViewer software is used to identify everything related to the keywords searched such as researchers, countries, institutions, and relationships between keywords (Arjoni et al. 2023) to find out the results of related research that has been carried out.

Based on the background of the problem, the researcher wishes to understand and summarize the development of research related to the use of Augmented Reality (AR) technology in learning Physics in Indonesia, with a focus on bibliometric analysis. The results of this study also have the potential to be a valuable reference for further research on the use of AR technology in Physics learning. Therefore, researchers are interested in conducting research with the research title, namely: Bibliometric Analysis: Augmented Reality Research Trends in Indonesia in Physics Learning.

## **METHOD**

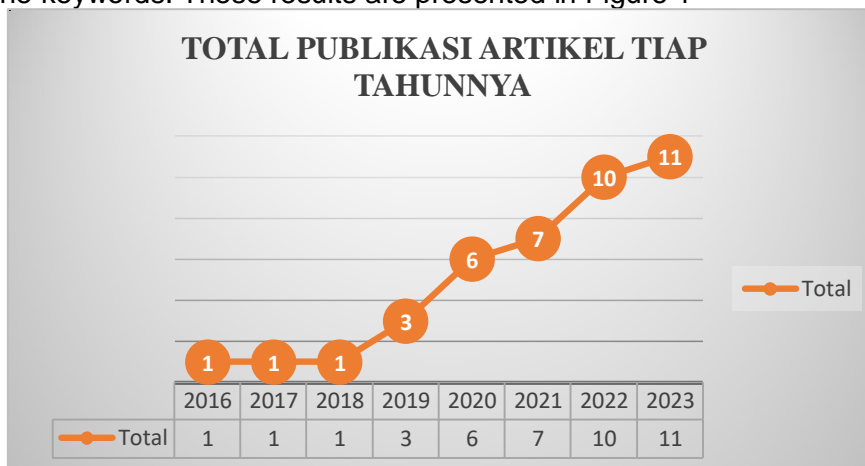
The research conducted used a descriptive type of research with visualization methods and bibliometric analysis. As a quantitative method, bibliometric analysis uses evaluative and descriptive approaches to present research trends and characteristics of a series of publications. The bibliometric visualization method is used to display an overview of the structure of a particular research condition. This research aims to identify publications related to ar in physics learning in Indonesia and then present them in a visual form. This research adopts a descriptive quantitative research method. The descriptive method used in this research is to describe the direction or process of research development according to the appearance of the research object used. The selected publications are publications published in the last 7 years (2016-2023) using publish or perish and vosviewer software.

The indicators used in this study are the number of publications, the number of citations, and the total link strength between objects displayed in data visualization. This research adopts a form of bibliometric analysis research. The bibliometric method in this research is used to map the development of research topics that are not yet clearly visible, because the bibliometric method can be used to determine the level of collaboration and research productivity. This research was conducted in the Google Scholar Crossref, and Scopus indexing databases since August 2023 based on the years 2016-2023. In this study, researchers chose to use secondary data. The data collection technique used in this study uses the help of Publish or Perish (PoP) software on the Google Scholar, Crossref and Scopus publication databases. with restrictions 2016-2023 based on the keywords "Augmented Reality, Physics Learning, Physics Learning". The data obtained is stored in RIS (Research Information System) format and then analyzed using VosViewer software.

## **RESULT AND DISCUSSION**

Augmented reality research in Indonesia in physics learning has been researched with good development from year to year. For 7 years, research with the keywords "augmented reality, physics learning and physics learning" there have been as many as 40 articles indexed in the google scholar, crossref and scopus databases. Research articles that are very relevant to the keywords "augmented reality, physics learning and physics learning" have been researched using several methods to overcome learning problems in physics, such as using technology-based media development methods in learning, applying the right learning model with the conditions of students and the environment, and by using the type of ar that can be used in accordance with the material in physics learning. And to find out the next research that is still relevant to the discussion of augmented reality research trends in Indonesia in physics learning, the researchers conducted research in the form of searching and analyzing research articles in the 2016-2023 time span with the keywords "augmented reality, physics learning and physics learning".

The results of publications, document sources, and languages used initially, there were 987 papers in the google scholar database, in the crossref database there were 1000 papers, and finally in the scopus database there were 85 papers related to ar in physics learning but not all of them displayed the results of publications originating from Indonesia and discussing physics learning. Furthermore, paper selection is carried out on publish or perish software in accordance with search keywords and 40 publication results are obtained publication results that match the keywords that match the keywords. These results are presented in Figure 1



**Figure 1. Total Article Publications Per Year**

Research articles related to the keywords Augmented Reality, Physics Learning and Physics Learning experienced quite good growth in 2020-2023, while at the beginning of the research year articles with these keywords experienced stagnant growth and occasionally rose then experienced a decline in the number of published articles again in the following year. Augmented Reality, Physics Learning keyword searches were conducted only on Scopus metadata.

The development of Augmented Reality (AR) technology from 2016 to 2023 has had a significant impact on Physics learning. A prominent peak in 2020 and a decline in 2016 to 2018. This occurs due to several external factors that affect the use of AR in Physics learning in Indonesia, such as changes in educational policies, technological developments, or adoption by certain educational institutions. Educational policy changes that support the use of AR technology in the curriculum or integrate this technology in lesson plans can have a big impact. If the Indonesian government prioritizes innovation in education, this may affect the development and application of AR in Physics learning (Purwoko Haryadi Santoso, Edi Istiyono 2022).

The worldwide trend of AR in education may also affect the use of AR in Indonesia. If education is increasingly focusing on the integration of technology in learning, this may motivate educational institutions in Indonesia to follow the trend and may experience an increase in the trend of AR research in Indonesia in Physics

Learning. The combination of these factors may impact the use of AR in Physics learning in Indonesia. The successful implementation of AR in the context of Physics learning will also depend on the collaborative efforts between the government, educational institutions, teachers, and other related parties in overcoming obstacles and taking advantage of existing opportunities.

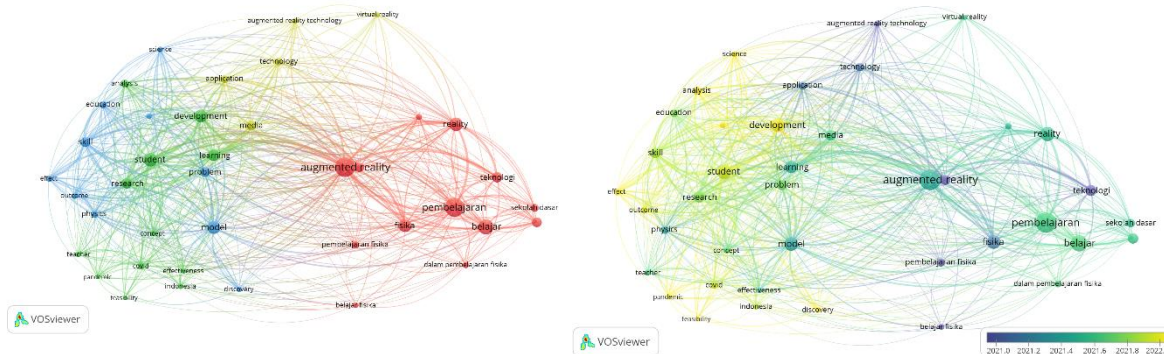
The decline in the number of research on Augmented Reality (AR) in 2016-2018 is due to a number of factors that affect the interest and focus of research in this technology. In 2016, AR had not yet reached a peak of interest in the research community, so this decline could reflect part of this natural cycle. In 2016, AR hardware may still be relatively expensive and less generally available, which could be a barrier to research and development (Muñoz-Saavedra, Miró-Amarante, and Domínguez-Morales 2020). Limitations in AR hardware and software can reduce interest in researching this technology. At the time, there were not many widely implemented AR applications in education. This could reduce research interest as researchers may lack seeing the real potential in the use of AR.

The development of AR technology in 2016 has not reached a level mature enough to drive significant research interest. This could include limitations in visualization, object tracking, or device compatibility. While AR research may have declined in 2016, it's important to remember that AR technology has come a long way since then. In recent years, AR has experienced a significant surge in interest and adoption, especially in various industries such as education, and healthcare. This shows that interest in AR can fluctuate along with the trend of technological development. The most prominent year is 2020 because in 2020, the COVID-19 pandemic has changed the way many people learn and work. With schools and universities shifting to distance learning, AR is emerging as one of the solutions to make online learning more interactive and effective. AR can be used to create more engaging and immersive learning experiences, even remotely (Eldokhny and Drwish 2021).

Overall, the increase in research on AR in 2020 can be explained by these factors, including the challenges faced during the COVID-19 pandemic and the great potential offered by AR technology in various aspects of human life. AR research is expected to continue to grow as time goes by and the technology matures. The increase in research trends in Augmented Reality (AR) in 2023, especially in 21st century learning, could be due to a number of factors that illustrate why the integration of AR technology is key in 21st century learning. The concept of 21st-century learning emphasizes the importance of preparing students with the necessary skills to succeed in the digital age (Kamińska et al. 2023).

AR is one of the enabling technologies for learning experiences that suit 21st century education as it can enhance students' engagement, creativity, problem-solving and collaborative skills. AR devices becoming more affordable and widely available by 2023 may also influence the increased use of this technology in education. AR devices that are cheaper and compatible with existing devices can make them easier to adopt

in various educational environments. The COVID-19 pandemic has accelerated the adoption of technology in education, including AR. Schools are looking for ways to bring better learning experiences online or hybrid, and AR has become one of the attractive solutions (Guaya et al. 2023).



(a) (b)  
Figure 2. Visualization of AR research trends in Physics learning in Indonesia. Visualization based on network relationships: (a) Network Relationship in Physics Learning in Indonesia and (b) Amount of Research that has been done on AR in Physics Learning.

Based on 2072 journal articles with AR-based research publications in Physics learning in Indonesia, research trends were visualized using VosViewer software. This visualization helps to find novelty for future research related to AR in Physics learning. Figure 2(a) shows the network related to AR research in Physics learning. The visualization network of AR research in Indonesia consists of 3 main clusters visualized with colors (red, blue, and the second cluster visualized with colors (yellow, green)). The first cluster in red shows the use of AR applications in research related to Physics learning. The second cluster in blue shows the relationship between AR and Physics learning related to learning models, learning outcomes, and so on. The third cluster in yellow shows how AR applications are developed and applied in Physics learning. The fourth cluster, the green cluster, shows how AR technology is applied in Physics learning in various types of research, there is on development, effectiveness on Physics learning.

The number of studies that have been conducted regarding AR applications in Physics learning in Indonesia in 2016-2023 can be seen in the Overlay Visualization in VosViewer software. Figure 2(a) shows that visualization in light green is a lot of research that has been done, especially those that discuss learning Physics using AR. While visualization in light purple shows that there have been many studies that discuss the development of AR applications in learning Physics. It seems that the use of AR in learning Physics is a fairly large focus. The light green color that shows a lot of

research that has been done reflects a deep interest and understanding in combining AR with Physics teaching. While the light purple color, which highlights the development of AR applications, may indicate efforts to continuously improve technology in Physics learning.

Looking at the amount of research that has been done on AR in Physics learning in Indonesia from 2016 to 2023, it seems to show significant interest and focus in incorporating this technology in an educational context. The light green color symbolizing the research that has been done indicates that many people have investigated and tried to apply AR in teaching Physics. The importance of developing AR applications, as indicated by the light purple color, also suggests that there is a drive to continuously improve and optimize the use of the technology. This could reflect the desire to bring innovative and interactive learning methods to Physics learners. However, looking only at the number of studies may not give the full picture. It is also important to understand the outcomes of these studies and the extent to which the use of AR can have a positive impact on students' understanding and engagement in learning Physics. AR is widely used at various levels of education, especially at the college and high school level as can be seen in figure 2 (b).

## CONCLUSION

This research concludes that the development of Augmented Reality (AR) in physics learning from 2016 to 2023 has made a positive contribution to students' learning experience. It was found that the integration of AR in physics learning can increase student engagement and facilitate the understanding of complex physics concepts through interactive visual experiences. Recommendations resulting from this research include the need for further development in AR content that can be adapted to the physics curriculum. In addition, further training is needed for teachers to maximize the potential of AR technology in the learning environment. It is also expected that there will be cooperation between researchers, technology developers, and educational practitioners to continue optimizing the use of AR in improving the quality of physics learning in the future.

## REFERENCES

- Arjoni, Diego Hernandez, Ivan de Souza Rehder, José Márcio Pereira Figueira, and Emilia Villani. 2023. "Augmented Reality for Training Formation Flights: An Analysis of Human Factors." *Heliyon* 9(3).
- Dhar, Poshmaal et al. 2021. *Augmented Reality in Medical Education: Students' Experiences and Learning Outcomes*.
- Eldokhny, Amany Ahmed, and Amr Mohammed Drwish. 2021. "Effectiveness of Augmented Reality in Online Distance Learning at the Time of the COVID-19 Pandemic." *International Journal of Emerging Technologies in Learning* 16(9): 198–218.
- Fatni Mufit, Yeka Hendriyani, Muhammad Dhanil. 2023. *Augmented Reality Dan Virtual*



- Reality Berbasis Konflik Kognitif Sebagai Media Pembelajaran Abad Ke-21*. Depok: Rajawali Pers.
- Guaya, Diana, Miguel Ángel Meneses, Ximena Jaramillo-Fierro, and Eduardo Valarezo. 2023. "Augmented Reality: An Emergent Technology for Students' Learning Motivation for Chemical Engineering Laboratories during the COVID-19 Pandemic." *Sustainability* 15(6): 5175.
- Kamińska, Dorota et al. 2023. "Augmented Reality: Current and New Trends in Education." *Electronics (Switzerland)* 12(16).
- Muñoz-Saavedra, Luis, Lourdes Miró-Amarante, and Manuel Domínguez-Morales. 2020. "Augmented and Virtual Reality Evolution and Future Tendency." *Applied Sciences (Switzerland)* 10(1).
- Mustaqim, I. 2016. "Pemanfaatan Augmented Reality Sebagai Media Pembelajaran." *Jurnal pendidikan teknologi dan kejuruan*. <https://ejournal.undiksha.ac.id/index.php/JPTK/article/view/8525>.
- Purwoko Haryadi Santoso, Edi Istiyono, Haryanto and Wahyu Hidayatulloh. 2022. "Literature Using Machine Learning."
- Septiany Maulani Soraya, Kurjono, Ilham Muhammad. 2023. "Analisis Bibliometrik: Penelitian Literasi Digital Dan Hasil Belajar Pada Database Scopus (2009-2023)." *Jurnal Pendidikan dan Pembelajaran* 4(1): 387–98.
- Shafeey, Ghailan A Al, Muhammad Modi, and Bin Lakulu. 2021. "Challenges Analysis for Using Augmented Reality in Education : A Review." *International Journal of Science and Research* 10(3): 466–71.
- Tupan, Tupan, Rochani Nani Rahayu, Rulina Rachmawati, and Endang Sri Rusmiyati Rahayu. 2018. "Analisis Bibliometrik Perkembangan Penelitian Bidang Ilmu Instrumentasi." *Baca: Jurnal Dokumentasi Dan Informasi* 39(2): 135.
- Volioti, C. 2022. "Using Augmented Reality in K-12 Education: An Indicative Platform for Teaching Physics." *Information (Switzerland)* 13(7). [https://api.elsevier.com/content/abstract/scopus\\_id/85136043198](https://api.elsevier.com/content/abstract/scopus_id/85136043198).