

Bibliometric Analysis of Augmented Reality Research Productivity in Early Childhood Education: A Comparison of Global and ASEAN Regional Trends

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ARTICLE INFO	ABSTRACT
Article history Received May 11, 2026 Revised June 08, 2026 Accepted June 29, 2026	This study aims to analyze trends and characteristics of research productivity on Augmented Reality (AR) in Early Childhood Education (ECE) globally and regionally in the ASEAN region. The study uses a quantitative approach with bibliometric analysis methods. The research subjects are scientific articles indexed in the Scopus database from 2015 to 2025. The research instruments included Scopus analysis features and VOSviewer software version 1.6.20 for mapping and visualizing bibliometric data. Data were collected through systematic searches using keywords related to AR and ECE, then filtered using PRISMA-based inclusion and exclusion criteria. Data analysis included annual publication trends, country productivity, institutions, most influential authors, and citation patterns. The results showed a significant increase in AR for ECCE publications globally since the mid-2010s, with European and East Asian countries dominating. In the ASEAN region, research productivity is still limited and concentrated in Malaysia and Indonesia, with a focus on storytelling, early literacy, and culture-based learning media. These findings confirm the existence of regional gaps in research capacity while also indicating opportunities for strengthening collaboration and developing AR for ECCE research in the ASEAN region. This is an open access article under the CC-BY license. 
Keywords Augmented Reality Early Childhood Education ASEAN Bibliometrics Learning Media	

I. Introduction

The use of Augmented Reality (AR) in early childhood education (ECE) is growing in popularity to bridge the gap between the real and virtual worlds. AR to enrich real-world experiences for young learners by placing virtual objects in the real world. Research indicates that AR has a positive impact on children's learning outcomes across a variety of domains, including foreign language learning, early literacy, letter recognition, color identification, and reading (Pan et al., 2021; Redondo et al., 2020; Yang et al., 2022). Additionally, AR facilitates SEL by fostering social-emotional development through interactive stories and hands-on learning opportunities, such as sharing, empathy, and self-regulation (Herman et al., 2025).

AR is a highly culturally sensitive field of research in the ASEAN region. Studies in Indonesia and Malaysia highlight the need to embed moral, religious, and cultural values in AR learning materials, for instance, the application of 'Do'a 4D' as religious education materials and the use of local folklore in AR teaching. The study found that children taught with AR improved their social

skills more than those taught with the conventional method (Murhayati et al., 2019; Zhu & Rosli, 2025). The focus is unusual in that this implies that using AR in the region is not just for its usefulness and relevance, but to ensure its local values are maintained (Herman et al., 2025).

Although augmented reality (AR) has been gradually integrated into the field of education, the previous bibliometric studies were mostly centered on tracing the overall publications and research properties. Bibliometric analyses of the last few years indicated that publications related to AR have significantly increased from 2012 to 2023, the United States, China and Spain being the leaders in the field of AR (Anesti & Irwanto, 2025; Asitah et al., 2024; Wibowo et al., 2026). The most common research areas found in these studies were education, virtual environments and critical thinking, suggesting the growing use of AR in education (Roy & Kumar, 2025; Zhen & Liu, 2025). But these bibliometric studies were largely about the patterns of publication and thematic trend in the world literature, rather than going into detail analysis of comparative study between the world and the ASEAN

research. Moreover, there has been little research on the comparative productivity, cooperation networks, thematic changes and citation impact of institutions by region. This divide hinders awareness of ASEAN's role in the international AR research landscape and helps to narrow the evidence gap for the development of an evidence-based ASEAN research agenda. As such, comparative bibliometric analysis is required with focus on publications from the globe and ASEAN countries to show the characteristics of research, collaboration and emerging trends which have not been sufficiently covered by previous research.

This study contributes to the field of bibliometric research of AR in ECE in the following four ways. First, it offers a comparative analysis of the features of the global and ASEAN AR-ECE research, which has not been done before. Secondly, it captures and reflects on the evolution of themes for research in both settings. Thirdly, it looks at the productivity level in the institution and the country to identify the key actors in the field. Finally, it suggests future research directions for ASEAN by proposing to use local cultural values as an enabler to inform the AR learning design. The contributions are meant to provide an evidence-based science to support policy for education in the region.

The comparative bibliometric approach was used in this study to examine the production characteristics, trends and thematic focus of AR produced in ECE in the global as well as ASEAN context. Specifically, it will be able to: (1) monitor the trends of the publications over the years; (2) identify the most productive countries, institutions and journals; (3) analyse thematic cluster and (4) identify research gaps that are relevant to the ASEAN region. The intent is to situate ASEAN scholarship in the broader international academic landscape and propose some viable research and policy options. This study enhances bibliometric research on AR in ECE in four keyways. First, it provides a comparative analysis of the features of the global and ASEAN AR-ECE research, which has not been done previously. Secondly, it reflects and discusses the evolution of research themes in both contexts. Third, it examines productivity within the institution and the country to pinpoint the key players in the field. Secondly, it proposes future research directions for ASEAN by suggesting the use of local cultural values to inform AR learning design. These contributions aim to give actionable scientific evidence for educational policy in the region.

II. Method

The method of this study is quantitative, combining comparative bibliometric analysis and a Systematic Literature Review (SLR) to analyze the intellectual structure, collaboration, and emerging themes in AR research in ECE across Southeast Asian Association of Nations (ASEAN) countries. The literature search was

undertaken in 2025, mainly using the Scopus database, which is comprehensive and covers a wide range of internationally indexed scholarly publications. The identification and selection followed the guidelines of the PRISMA with the following inclusion criteria: (1) article published in English, (2) article published before December 17, 2025, and (3) studies focused on AR in early childhood education.

The literature search was carried out in the Scopus database on 17 December 2025. The first search used the Boolean query TITLE-ABS-KEY "augmented reality" AND "early childhood" to get 58,390 records. The inclusion criteria were then applied to the dataset to make it relevant and of high quality, such as publication type (journal articles), publication language (English), publication year (2015-2025) and relevance to early childhood education. When these database criteria were applied, 186 records still had to be screened.

Titles and abstracts of these 186 records were then sifted to find studies that were directly related to the use of augmented reality in early childhood education. The articles were excluded from the research if they failed to address the research objectives, were duplicative, dealing with conferences, reviews, book chapters, editorials or studies falling outside the scope of early childhood education. After this, full-text eligibility was done with the following inclusion criteria (Table 1). Therefore, 76 articles were kept for the final bibliometric analysis.

Table 1. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Type of literature	Indexed journal articles	Non-indexed journals, proceedings, conference papers, and book series
Publication language	English	Publications in languages other than English
Research scope	Studies focusing on Early Childhood Education (ECE)	Studies targeting educational levels or contexts other than ECE

The publication data were analyzed using selected bibliometric indicators in VOSviewer for the study's purposes. The five descriptive indicators, including publication count, total citations, average citations per article, and h-index, were used to measure overall research productivity and scholarly impact. Co-authorship analysis was used to map collaborations among countries and authors, identify the most influential researchers, and characterize the patterns of collaboration that emerged in this area (Donthu et al., 2021). To address the study's thematic trends, thematic clusters were identified through keyword co-occurrence analysis, and the evolution of research themes over time was tracked. Bibliographic coupling clustered articles based on the presence of common references, thereby establishing the intellectual structure and proximity of the publications in the analysed

corpus. These three types of network analysis gave a holistic approach to addressing research questions regarding collaboration, thematic focus, and intellectual

structure. The methodological guidelines were followed by using VOSviewer, Google Scholar, and Microsoft Excel for descriptive statistical analysis.

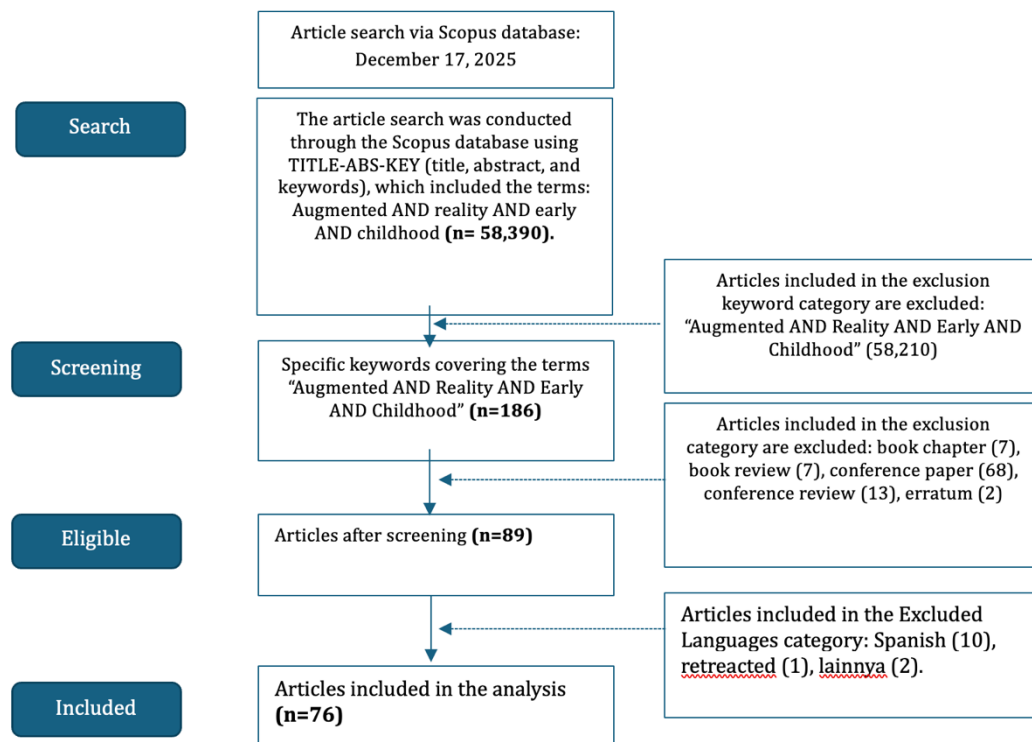


Fig. 1. Systematic Literature Review information flow using PRISMA

A total of 186 documents were initially found in the Scopus database when the search was performed using the title, abstract, and keywords "augmented reality" AND "early childhood," between 2015 and 2025, on 17 December 2025. During the first screening, documents were narrowed down to those that were not book chapters (7), book reviews (7), conference papers (68), conference reviews (13), and errata (2), and thus 89 documents were eligible for subsequent screening. Additionally, 10 publications in Spanish were excluded, and two that did not meet the inclusion criteria were excluded in a second screening. After completing all the screening stages, 76 journal articles met all the inclusion criteria and were included in the final bibliometric analysis as the global dataset. From this data, 19 publications relevant to ASEAN countries were selected for regional comparative analysis. These two datasets were subsequently analysed with VOSviewer, yielding two separate bibliometric network maps for each context.

III. Results and Discussion

This study's findings are based on 76 journal articles retrieved from the Scopus database for global data and 19 articles for ASEAN region data, both from 2015 to 2025. The analysis covers the number of publications per year, the journals in which the articles were published, and the main characteristics of AR-ECE research, such as authors, institutions, and countries involved. To address two

research questions, the study also explores the nature of collaboration, the dominant thematic clusters, and trends across the global and ASEAN contexts. The results are presented in four parts: global analysis, ASEAN analysis, comparative analysis, and discussion.

RQ1: What are the trends and characteristics of research productivity in Augmented Reality for Early Childhood Education around the world?

A search of the Scopus database over 10 years yielded 76 academic papers on AR in early childhood education. A bibliometric analysis of the Scopus database identified 76 academic papers published over the past 10 years on AR in early childhood education. This suggests that there is still relatively little research in this field (Figure 2). From around 2019, systematic research on AR in early childhood education started to grow. Delphi survey on the use of robot-projector-based augmented reality (AR) in dramatic activity for young children by Hyun et al. (2011) represented one of the earliest studies in this area. It was among the first to investigate AR in early childhood contexts systematically.

Since the last review, there has been an increasing amount of research on AR, with a wider variety of subjects included. Motor development, cognitive enhancement, language creativity, social skills development, and gamified learning methods are key areas of study (Herman et al., 2025; Lewis-Presser et al., 2025). Additionally,

several studies have investigated using AR to introduce geometric concepts, enhance literacy skills, teach the alphabet, enrich historical and cultural knowledge, and

integrate ethnoecology into early childhood education (Aslam et al., 2025; Özel et al., 2025; Soyupak & Soyupak, 2025; Yao et al., 2025).

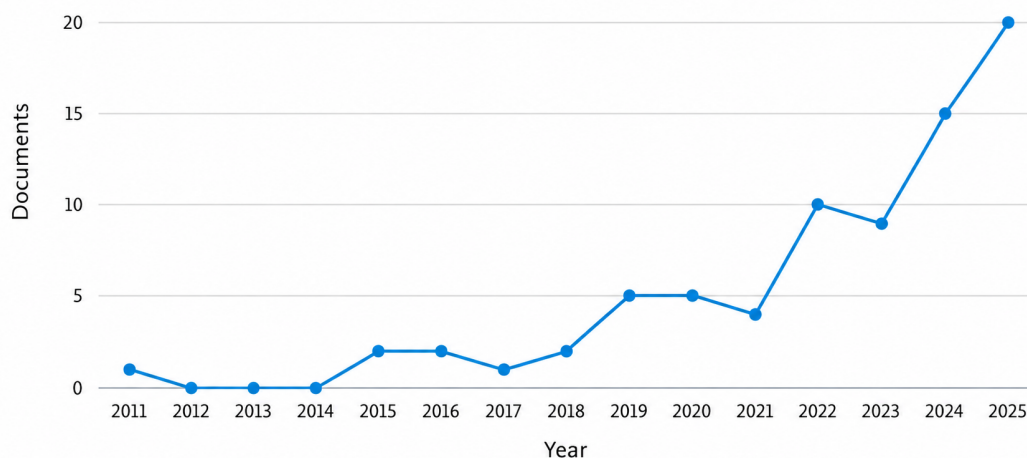


Fig. 2. Number of Augmented Reality Publications for Early Childhood

Looking at the annual publication records, there is a marked increase in publications on AR in early childhood education. The publications were still fewer than 5 from 2015 to 2021. Starting in 2022, interest in this topic increased, reaching 20 publications in 2025. This increase reflects the growing significance of AR in education research. It suggests potential applications to address research needs, particularly in teaching effectiveness and the practical application of immersive technologies.

Furthermore, the geographical distribution of AR research publications in early childhood education reveals a strong concentration in a limited number of countries. Figure 3 illustrates the ten most productive countries in terms of research output on AR for early childhood education.

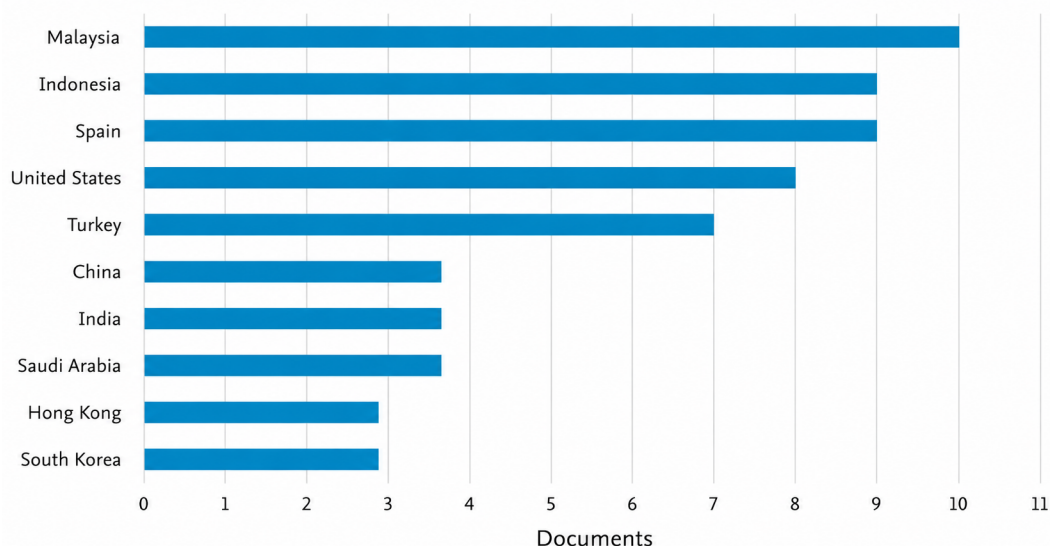


Fig. 3. Ranking of Countries Producing AR Research Publications in Early Childhood Education

There is a skewed regional distribution of publications. The 10 most productive countries in terms of AR research in early childhood education are presented in Figure 3. Malaysia is the top country in terms of articles (11.5%) in global publications. There were 10 articles from Indonesia, which is tied for second place with Spain. The United States ranks third with 9 articles (11.8%), and Turkey ranks fourth with 8 articles (10.5%).

In the meantime, China, India, and Saudi Arabia each published 4 articles (5.3%), and Hong Kong and South Korea each published 3 articles (3.9%). The disproportion of output between two ASEAN countries is due to various structural and systemic policies. Malaysia and Indonesia have matured digital infrastructure, a well-established national research environment, and policies that increasingly incorporate digital technology in early

childhood education. This has contributed to increased interest in researching the issues in this area. Other countries in the ASEAN region, however, have encountered a variety of technological problems, insufficient research funding, a lack of training in Educational Technology, and problems publishing papers in English-language international journals. This study documents a regional imbalance, which is explained by these issues (Hanauer & Englander, 2013; Salager-Meyer, 2008). These results indicate the need to promote the regional research ecosystem by improving collaboration among researchers, allocating more funding, and developing more effective publication strategies to make AR more visible and competitive in early childhood

education research in ASEAN (Garzón & Acevedo, 2019; Park & Leydesdorff, 2013).

Once the most productive countries were identified, the analysis focused on institutions or universities that had been shown to have a notable impact on Early Childhood Education research in AR. The results show that the three universities with the highest number of articles are Atatürk Üniversitesi (3), Universidad de Oviedo (3), and

Universidad de Sevilla (3). The following groups each include two articles: Universiti Sains Malaysia, The University of Hong Kong, Sungkyunkwan University, Education Development Center, Inc., and Universiti Malaya.

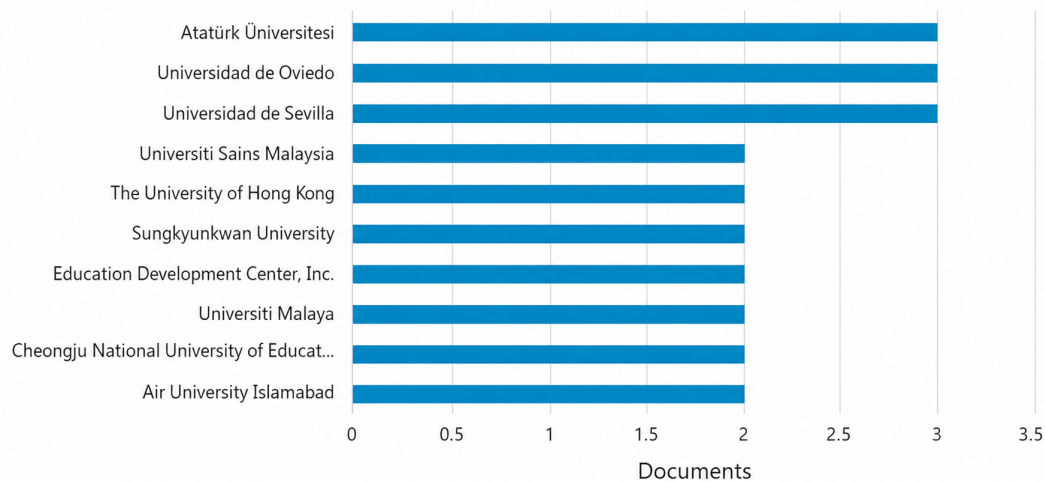


Fig. 4. Ranking of Universities Producing AR Research Publications in Early Childhood Education

From Figure 4, it can be observed that none of the institutions is leading the top. Atatürk Üniversitesi (Turkey) has the same score as Universidad de Oviedo and Universidad de Sevilla (Spain), both with three publications. This finding suggests that knowledge production in augmented reality for early childhood education is distributed across multiple institutions rather than a single institution. The presence of leading institutions from various regions reflects the progress of research on this topic worldwide, particularly between Europe and Asia, where there is increasing global interest in technological innovation in early childhood education. However, the number of publications per institution is relatively small, indicating that this field of research is not yet mature. Good inter-institutional and inter-regional cooperation can help strengthen, sustain, and amplify research outcomes.

Table 2 presents the top 10 most cited authors in the world in the field of Early Childhood Education, according to the number of citations found in 75 documents analysed.

Table 2. Most Influential Authors

No	Citation	Authors	Title
1	244	(Yilmaz, 2016)	Educational magic toys developed with augmented reality technology for early childhood education
2	113	(Redondo et al., 2020)	Integration of Augmented Reality in the Teaching of English as a Foreign Language in Early Childhood Education
3	105	(Chen & Chan, 2019)	Using Augmented Reality Flashcards to Learn Vocabulary in Early Childhood Education
4	104	(Han et al., 2015)	Examining young children's perception toward augmented reality-infused dramatic play
5	101	(Bai et al., 2015)	Using augmented reality to elicit pretend play for children with autism
6	93	(Huang et al., 2016)	Using Augmented Reality in early art education: a case study in Hong Kong kindergarten
7	57	(Tuli & Mantri, 2021)	Evaluating Usability of Mobile-Based Augmented

No	Citation	Authors	Title
8	53	(Pan et al., 2021)	Reality Learning Environments for Early Childhood
9	39	(Madanipour & Cohns, 2020)	Introducing augmented reality in early childhood literacy learning
10	37	(Dash et al., 2018)	Augmented reality as a form of digital technology in early childhood education
			Designing of marker-based augmented reality learning environment for kids using convolutional neural network architecture

Table 2 presents the top 10 most cited authors in the world in the field of Early Childhood Education, according to the number of citations found in 75 documents analysed. As shown in Table 2, Yilmaz (2016) has the highest number of citations (244) in AR in early childhood education. The teacher and the children had positive attitudes towards Educational Magic Toys (EMT) according to Yilmaz (2016). The teachers described it as easy to use, and children's engagement was high.

However, the children's cognitive outcomes were limited to describing pictures in the AR-based media, without using imagination or conceptual thinking. It implies that technological interactivity does not necessarily entail deeper cognitive processing and that the need is for improved instructional design. Thus,

educational toys based on AR should include appropriate multimedia components, promote cooperation between teachers and children, and design activities that allow children to interact with the toys, ask questions, share their observations, and reflect on what they have learned, thereby enhancing children's engagement and learning.

RQ2: What are the trends and characteristics of research productivity on Augmented Reality in Early Childhood Education in the ASEAN region?

The ASEAN AR-ECE publications demonstrated a diverse trend with overall rising numbers from 2019 to 2025. From the first published paper by Murhayati et al. (2019) from Indonesia, publishing output was low until 2022, when it rose, then dropped in 2023-2024, and reached its highest point in 2025, with a total of six papers. This pattern suggests that there is not yet a solid research infrastructure in ASEAN on this field. However, the recent increase in publications indicates interest; perhaps digital technology has gained popularity during the pandemic. The results outlined above indicate the benefit of pursuing more regular and consistent research activities in the region.

The geographical distribution of publications was then analysed to identify publications from each ASEAN member country, with varying levels of technological development and research capability. As seen in fig. 6, the distribution of publications by country from 2019-2025 indicates that publications are very strongly concentrated in two ASEAN nations.

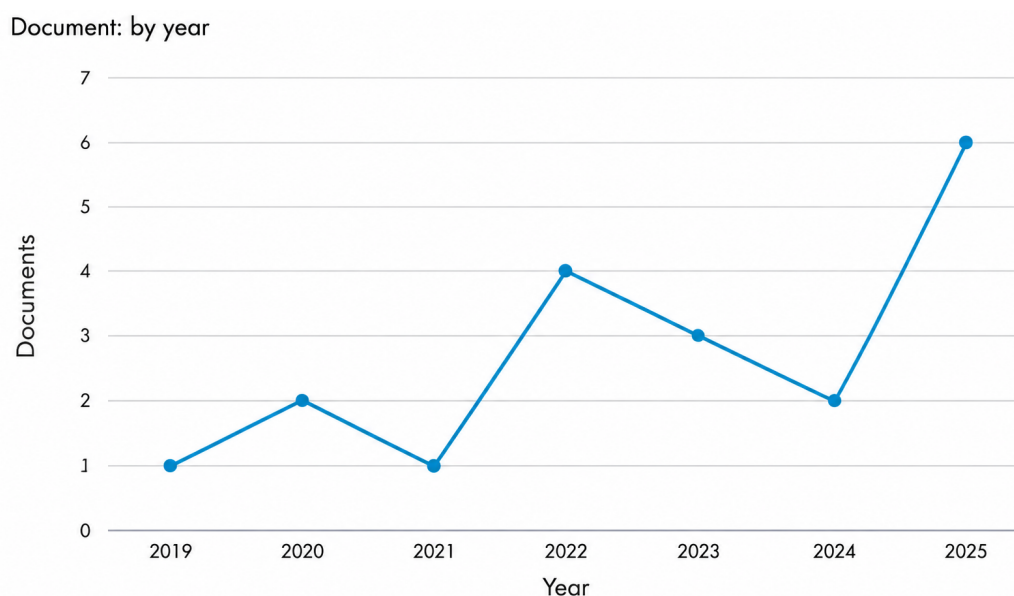


Fig. 5. Number of Augmented Reality Publications for Early Childhood Education in ASEAN

Based on Figure 6, Malaysia is the ASEAN leader in creative economy research productivity, with 11 publications (52.4%), followed closely by Indonesia with 10 publications (47.6%). No publications were found for the other eight ASEAN countries during this period. This is an output concentration of multiple factors relating to

structure and system. Malaysia and Indonesia have relatively well-developed digital infrastructure, strong national research environments, and universities with specialized education faculties that conduct ECE-related research. Contrastingly, countries in Southeast Asia, including Myanmar, Laos, Cambodia, and Timor-Leste,

face serious technological challenges and limited connectivity, making it difficult to conduct, publish, and share AR-based educational research on an international scale.

Further, in more productive countries, national policy-making processes have increasingly incorporated requirements for digital technology into early childhood education frameworks, thereby fostering research demand. The absence of such policies in many other ASEAN countries, coupled with limited amounts of funding for research, insufficient training of researchers in educational technology, and challenges to their ability to publish in English-language journals, also contribute to the large disparity in this study (Hanauer & Englander, 2013; Salager-Meyer, 2008). These findings confirm the importance of enhancing the regional research ecosystem by fostering more strategic publication patterns, increasing funding, and promoting greater collaboration between researchers within the region (Garzón & Acevedo, 2019; Park & Leydesdorff, 2013).

The subsequent analysis is based on the most influential authors by citation count, consistent with the publication concentration in Malaysia and Indonesia. To evaluate the contribution or impact of individual researchers in the field of Augmented Reality in early childhood education in the ASEAN region, it is better to use Citation Analysis.

Based on Figure 6, AR for ECE research productivity in ASEAN is led by Malaysia with 11 publications (52.4%), followed closely by Indonesia with 10 publications (47.6%), while the remaining eight ASEAN countries did not produce any Scopus-indexed publications during the 2019-2025 period. This concentration of output within only two ASEAN countries reflects a complex interplay of structural and systemic factors. Malaysia and Indonesia benefit from relatively more developed digital infrastructure among ASEAN nations, stronger national research ecosystems, and universities with dedicated faculties of education that

actively engage in ECE-related research. In contrast, countries such as Cambodia, Myanmar, Laos, and Timor-Leste continue to face significant constraints in

technological readiness and digital connectivity, which directly limits the capacity to conduct, publish, and disseminate AR-based educational research at an international level.

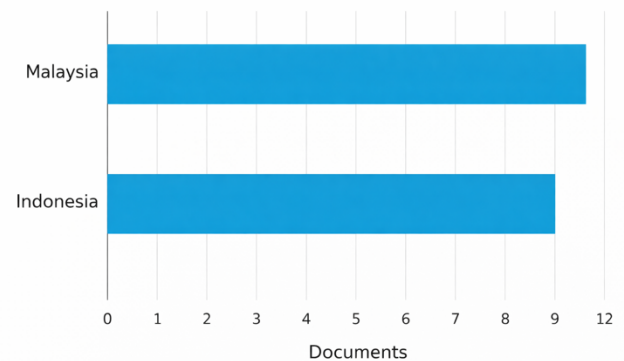


Fig. 6. Ranking of ASEAN Countries by AR for ECE Publications

Furthermore, national educational policies in the more productive countries have increasingly incorporated digital technology mandates into early childhood education frameworks, thereby stimulating demand for evidence-based research in this field. The absence of equivalent policy-driven incentives in many other ASEAN states, compounded by limited research funding, insufficient researcher training in educational technology, and barriers to publishing in English-language international journals, collectively explains the stark regional imbalance observed in this study (Hanauer & Englander, 2013; Salager-Meyer, 2008; Mertkan et al., 2021). These findings underscore the need to strengthen the regional research ecosystem through enhanced collaboration, increased research funding, and more strategic publication practices to improve the visibility and competitiveness of AR–ECE research in ASEAN (Garzón & Acevedo, 2019; Park & Leydesdorff, 2013).

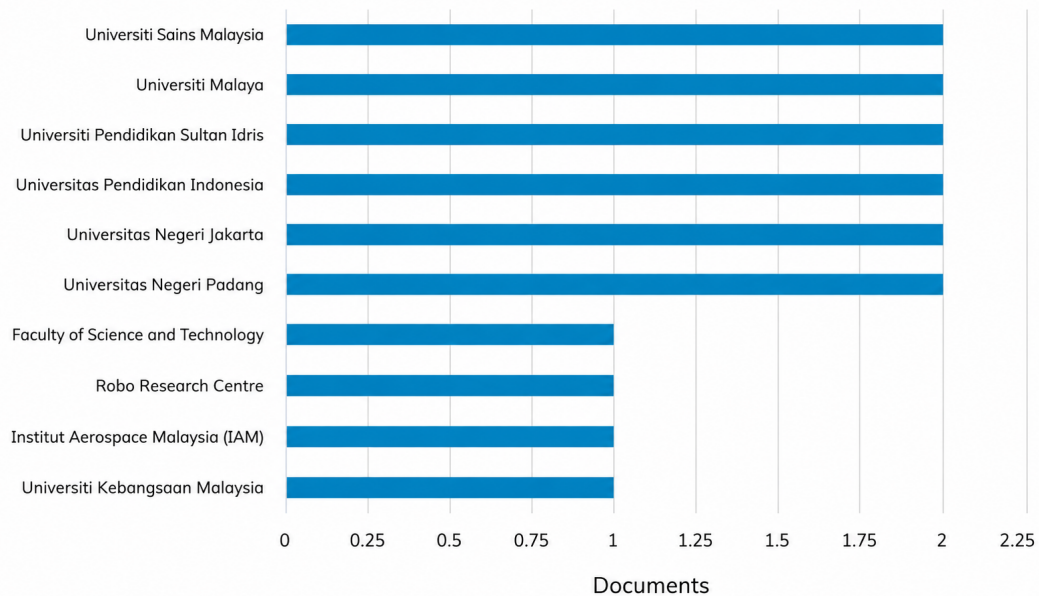


Fig. 7. Ranking of Universities Producing AR for ECE Publications in ASEAN

In line with the concentration of publication contributions in Malaysia and Indonesia, the subsequent analysis identifies the most influential authors based on citation counts. Citation analysis is employed as an indicator of scholarly impact to assess the extent to which individual researchers have shaped the direction and development of augmented reality research in early childhood education within the ASEAN region.

Table 3. Most Influential Authors in ASEAN

No	Citation	Authors	Title
1	17	(Novaliendry et al., 2022)	Development of Interactive Media Based on Augmented Reality for Early Childhood Learning Around the Home
2	11	(X. Wang et al., 2024)	The impacts of augmented reality technology integrated STEM preschooler module for teaching and learning activity on children in China
3	11	(Sari et al., 2022)	Developing a Financial Literacy Storybook for Early Childhood in an Augmented Reality Context
4	9	(Kisno et al., 2022)	Digital Storytelling for Early Childhood Creativity: Diffusion of Innovation "3-D Coloring Quiver Application Based on Augmented Reality Technology in Children's Creativity Development
5	6	(Khazali et al., 2023)	Smart pictorial dictionary via mobile augmented reality

No	Citation	Authors	Title
6	6	(Soon et al., 2022)	Reading Augmented Reality Story Book in Enhancing Learning Perceptions
7	4	(Ahmad Razi & Jamiat, 2023)	Childrens' Happiness, Enjoyment, Perceived Motivation And Achievement Towards Science Augmented Reality Picture Book
8	4	(Chit & Subaramaniam, 2020)	Understanding the requirement of a 3D aided augmented reality mobile app dictionary for children
9	3	(Ramli et al., 2023)	Augmented Reality Technology in Early Schools: A Literature Review
10	3	(Madi et al., 2020)	AR mobile application in learning Hajj for children in Malaysia

The most cited authors in this region have fewer citations than their global counterparts. The highest number of citations (17) goes to the article by Novaliendry et al. (2022), with Y. Wang & Gao (2025) and Sari et al. (2022) coming in with 11 and 10 citations, respectively. This trend indicates a considerable gap between this, and the average number of citations earned by the most-cited global authors in the AR-ECE field, ranging from dozens to hundreds. This may not always imply lower research quality, but rather relatively recent publication /or a more limited international citation network, and an emerging role within the international scholarly community. Therefore, the research contributions of ASEAN authors are still in an infancy stage compared to the world's research community.

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In general, the research on AR-ECE in ASEAN appears to be early-stage applied research, and there is a strong local base. Theoretical frameworks can be developed, methodological rigor can be enhanced, and opportunities for collaboration across regions exist.

Conclusion

According to this bibliometric study, research on AR-ECE has been ongoing worldwide, though productivity varies across regions. Although they have been expanded across many fields of AR-ECE research worldwide, in ASEAN, there are only a limited number of countries and institutions producing this type of research, mostly on media development and perceptions of learning. The following observations indicate that there are structural differences between global and regional research growth, shaped by technological capacity, policy directions, international publication visibility, and the robustness of collaboration networks. The comparative analysis illustrates that AR in early childhood education is highly context-specific, influenced by education systems, national policy, and digital infrastructure. This study is part of the bibliometric research on AR-ECE. It helps identify structural differences between the global and ASEAN research environments that have not been systematically discussed before. The results indicate that national educational policies, funding structures, and digital infrastructure, in addition to technological capacity, are determinants of research productivity, providing a more solid basis for understanding regional differences in educational technology research. The study practically helps policymakers and research institutions in ASEAN gain a better understanding of the structural challenges that limit the visibility of ASEAN's academic output, such as limited funding, poor digital connectivity, and issues with English-language publications. The comparative bibliometric context used here may also be applied in the future to the other regions of educational technology.

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