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Educational Technology in Education Research in ASEAN: Trends, Patterns, and Future Directions

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ABSTRACT

Rapid technological developments have driven innovation in education in the ASEAN region. However, the use of technology between countries is uneven due to limited resources and a lack of systematic integration methodologies. To fill the empirical synthesis gap related to the ASEAN context, this study conducted a comprehensive bibliometric analysis based on the PRISMA framework of 97 relevant articles. The results show an increasing trend in publications, with Malaysia being the most productive country. Furthermore, digital literacy and virtual reality are two hot topics that are widely discussed by education researchers in the ASEAN region. The contributions of this study are (1) mapping trends and gaps in educational technology research specifically in ASEAN; (2) identifying priority topics for the research agenda; and (3) providing practical recommendations for policymakers and researchers, including priority investments in digital literacy, the development of technology integration methodologies, and cross-country collaboration to reduce the technology access gap in education.

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1. Introduction

Technology in the field of education plays a crucial role in fostering high-quality education. The utilization of technologies such as artificial intelligence (AI) and others enables the realization of interactive, engaging, and effective learning [1], [2]. Technology in the field of education plays a crucial role in fostering high-quality education. The utilization of technologies such as artificial intelligence (AI) and others enables the realization of interactive, engaging, and effective learning [3]. This is in line with the evaluation of technology utilization in education, which focuses on eight themes consisting of learning outcomes, affective factors, design behavior, technology components, pedagogy, attendance, and institutional environment [4]. Theoretically, the application of educational technology should consider various aspects such as learning outcomes, affective factors, instructional design, and institutional environment to have a holistic and sustainable impact [3], [5].

In practice, the application of technology in the education sector is increasing, but not yet evenly. Various studies show that access to and use of technology can have various positive effects on students and educators [2], [6], [7]. However, its application in the field often encounters technical obstacles, the capacity of teaching staff, and the quality of online learning design that is not optimal [8], [9]. One of them is in the realm of physical education or fields that rely on physical practice; the integration of

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technology is still fairly limited due to unprepared teachers, less mature approaches, and shifting priorities in teaching [10], [11].

Particularly in the ASEAN context, the reality of implementation and research becomes more complex due to the heterogeneity of its member states. The uniqueness of ASEAN lies in the variation in the level of development and digital infrastructure between countries, the plurality of languages and educational cultures, as well as the differences in national policy capacity, which cause the adoption of EdTech to be not homogeneous [12], [13]. In addition, the geography and demographics of a predominantly young population create simultaneous regional and local challenges and opportunities. [13]. The combination of these factors has led to the need for cross-country research-based analysis that can provide policy and practice recommendations that become more relevant and equitable.

Bibliometrics is becoming an effective approach to map publication patterns, collaborations, domain keywords, and emerging topics [14], [15] thus becoming an important tool to formulate regional research and policy agendas [16], [17], [18]. However, the available bibliographic studies tend to be individual studies and not generalized, so a comprehensive mapping that focuses on the topic of educational technology in the ASEAN region is still lacking [19], [20], [21], [22]. Thus, a significant gap is still present in bibliometric analysis. This study aims to address this gap by comprehensively analyzing trends, patterns, and future research directions in educational technology in the ASEAN region through Scopus data analysis.

This study utilizes a comprehensive bibliometric analysis to examine and quantify the existing literature, to identify strengths, emerging trends, and opportunities for collaboration in educational technology research in the ASEAN region. The findings from this analysis will provide researchers and policymakers with valuable insights into the opportunities and needs of educational technology research in the ASEAN region, facilitating the development of more effective and innovative research strategies. In addition, this bibliometric research also aims to align research directions with practical needs and educational policies to ensure that the results not only enhance theoretical understanding but also contribute meaningfully to improving the quality of educational technology research and its utilization in the education sector.

2. Method

2. 1. Database Selection

This research uses the Scopus database to collect articles that match the predetermined criteria. The selection of Scopus as a data source is based on its comprehensive coverage and has the latest citation analysis, making it easier for researchers to check collaboration networks and to export tabulated data that has been selected [23].

2.2. Inclusion Criteria

Search keywords are applied to obtain bibliometric data that match the research objectives. The keywords used in the document search were TITLE ("educational technology") AND TITLE-ABSTRACT-KEYWORD (school OR student OR learning OR university). These keywords have been carefully designed to target publications specifically focused on educational technology, ensuring the articles retrieved remain relevant to the research objectives. In addition, restrictions on ASEAN countries were also made so that the final articles obtained remained relevant. For the year limitation itself, the researcher does not provide a minimum publication year limit; this aims to provide more complete data on the development of research trends on educational technology research topics in the ASEAN region.

2.3. Selection Criteria and Quality Assurance

To ensure that the analysis remained in line with the research objectives, the data collected was limited to finalized articles and conference papers, which ensured the credibility and depth of the findings. In addition, first authors were limited to authors from ASEAN countries. Fig. 1 depicts the

selection flow following the PRISMA framework [24], which can clarify the systematic and rigorous nature of this research. This methodology aims to generate quality bibliometric data and strengthen the validity of the analytical insights generated.

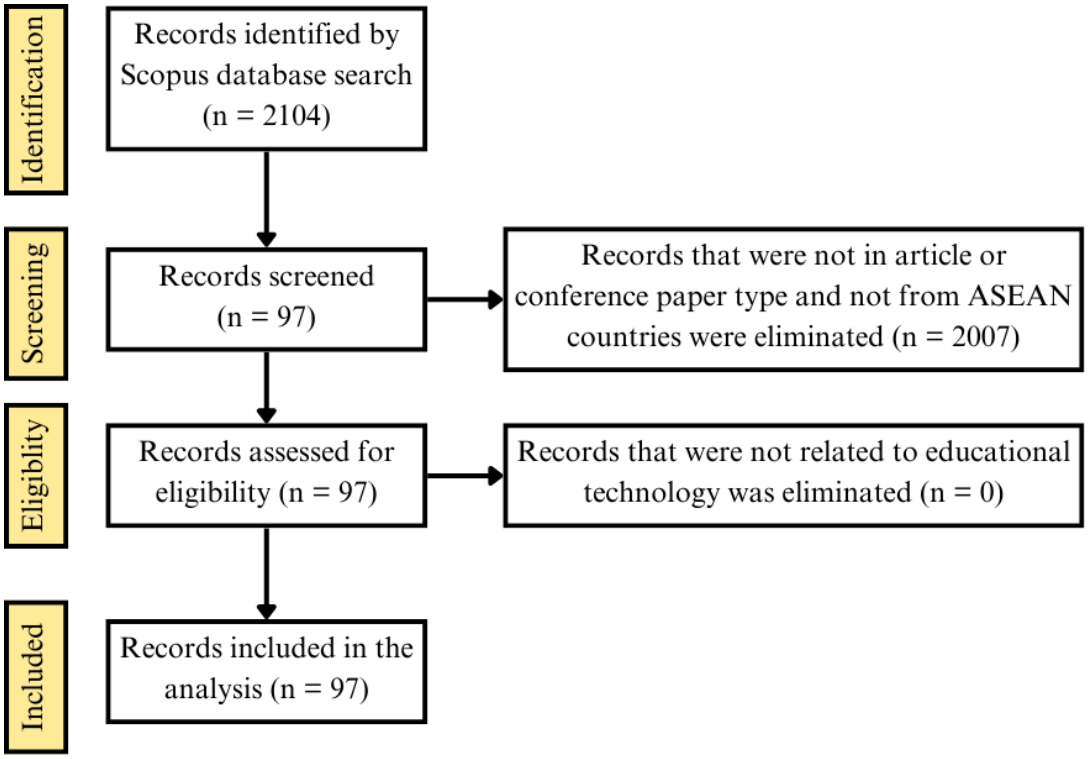


Fig. 1. Bibliometric analysis flowchart using PRISMA

2.4. Data Analysis Procedure

This research utilizes different bibliometric analysis methods, namely frequency analysis, co-authorship analysis, co-citation analysis, and co-word analysis, all of which follow the methodological framework established in bibliometric research [25]. The use of these four methods aims to provide a comprehensive insight into the patterns of scientific production and identify the five most influential sources on this topic. Through this approach, researchers were able to accurately calculate the frequency of publications across different time periods, shedding light on scientific trends from year to year. Through frequency analysis, the study identified relevant sources, thus highlighting journals with a substantial volume of publications dedicated to educational technology research.

Co-authorship analysis was used to explore the collaborative patterns that emerged among researchers in educational technology publications. Through this method, researchers were assisted in retrieving and analyzing data related to the country of origin of correspondence authors, top institutional affiliations, and leading authors in the field. The analysis also mapped international collaboration networks and institutional partnerships, providing comprehensive insights into the geographical and institutional distribution of research contributions. The analysis also further assisted researchers in uncovering the complex interconnections between researchers and institutions active in educational technology research in the ASEAN region.

The co-citation analysis method was used to systematically examine and map the citation relationships between publications and data sets. Through this approach, we were able to identify the countries with the most citations, providing quantitative insights into the countries that have made a significant academic impact on educational technology research in the ASEAN region. In addition, through this method, information is also obtained by analyzing the distribution of research contributions in different countries, the underlying factors contributing to variations in publication output, and the influence of citations among ASEAN countries.

Finally, co-word analysis was used to analyze the semantic structure and theme patterns present in the articles obtained. This analysis facilitated the mapping of key research themes and enabled the visualization of semantic networks formed by co-occurring terms and concepts. This analysis provides information regarding the current state of educational technology research in the ASEAN region and its potential for future development and collaboration between countries in ASEAN and other countries in the region.

2.5. Analytical Tools

The analysis was conducted using the biblioshiny package run through RStudio software. The analysis approach included analyzing publication growth, research trend patterns, and identifying influential contributors in the field. In addition, analysis was also conducted through the VOSViewer software to visualize the co-occurrence network between keywords. Mapping through VOSViewer also allows visualization of thematic clusters and quantification of relational closeness between keywords [15]. The use of two software tools in this bibliometric analysis provides a detailed and in-depth exploration of the bibliometric landscape, providing comprehensive information regarding the development of trends and their relevance in educational technology research in the ASEAN region.

3. Results and Discussion

3.1. Main Information

This study analyzed publications on the topic of educational technology in the ASEAN region from 1982 to 2026. The sample analyzed consisted of 97 articles published in 76 sources (journals and proceedings). Quantitatively, the main findings were as follows. The publication growth rate was recorded at 1.59% per year. The analyzed documents were also found to have an average age of 5.46 years. Then the total citations recorded were 5103 and resulted in an average of 52.61 citations per document. For the references themselves, the total number of references cited in the entire sample was 3449, or an average of 35.56 references per document.

In terms of keywords and author involvement, 284 keywords and 316 authors contributed to this corpus. A total of 14 documents (14.43% of all documents) were the work of a single author. The proportion of documents involving international collaboration was 22.68%, while the average number of co-authors per document was 3.45. Full details of the distribution of these metrics have been presented in Fig. 2.

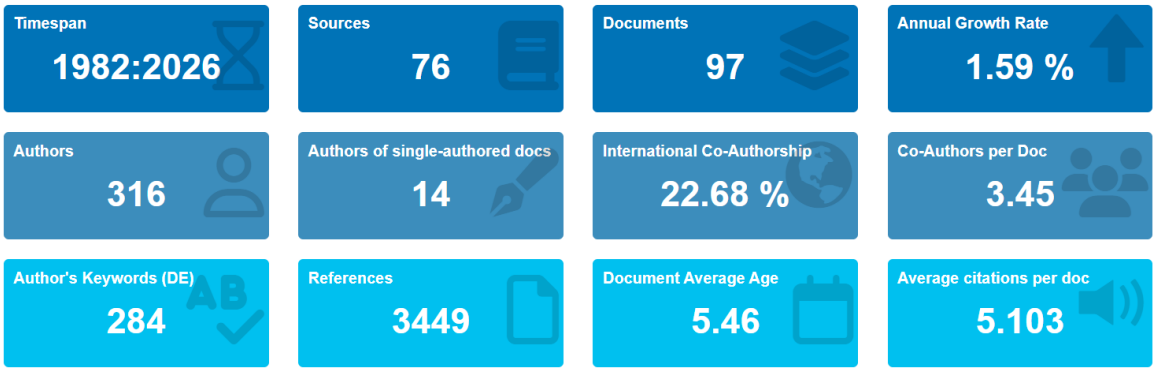


Fig. 2. Document source details

Although the average citation rate is relatively high, the aggregate pattern shows asymmetry. The high average citations could be due to a few highly impactful core articles; in other words, the visibility of the corpus appears to be concentrated on a select number of works rather than evenly distributed across publications. On the other hand, the low annual growth rate (1.59%) indicates that the increase in the quantity of publications in ASEAN has been slow and inconsistent throughout the study period.

The collaboration aspect displays a mixed character: the average co-author score (3.45) and the presence of about 22.7% of documents collaborating across countries indicate a real collaborative practice, but the proportion cannot be said to be dominant. This, combined with the concentration of citations on certain works, suggests that research activity in ASEAN may rely on certain groups/affiliations that are more prolific and internationally influential, while the contributions of most authors and other sources are relatively limited in terms of citation impact. In addition, the distribution of publications in medium to low-quality proceedings and journals implies that, despite scientific production, the visibility and academic staying power of ASEAN findings in the global discourse may fluctuate depending on the publication venue chosen.

3.2. Publication Trends

Based on Fig. 3, publication activity on the topic of educational technology in the ASEAN region shows contrasting phases of development in the period 1982 to 2026. In the period 1982 to 2005, the number of publications was almost non-existent, with only two initial publications recorded. The three articles illustrate the development of research focus from conceptual pedagogical to empirical. The first article that appeared in 1982 placed educational technology as a definitional and institutional problem, in which the author inventoried conceptual approaches and recommended changes in faculty structure to improve teaching quality [26]. Then the second article, published in 1985, shifted the research focus to the pedagogical dimension by emphasizing the humanistic approach in language teaching and introducing four paradigms for computer-assisted learning [27]. In brief, these two articles marked the first step of the educational technology scene from the fundamental need for definitional clarification and institutional reinforcement towards the development of an explicit pedagogical framework for the use of technology in the learning process. No further articles on the same topic were found until 2002. Publications began to increase gradually in 2007, with a more pronounced acceleration from 2019, and peaked in 2023 with a total of 14 publications.

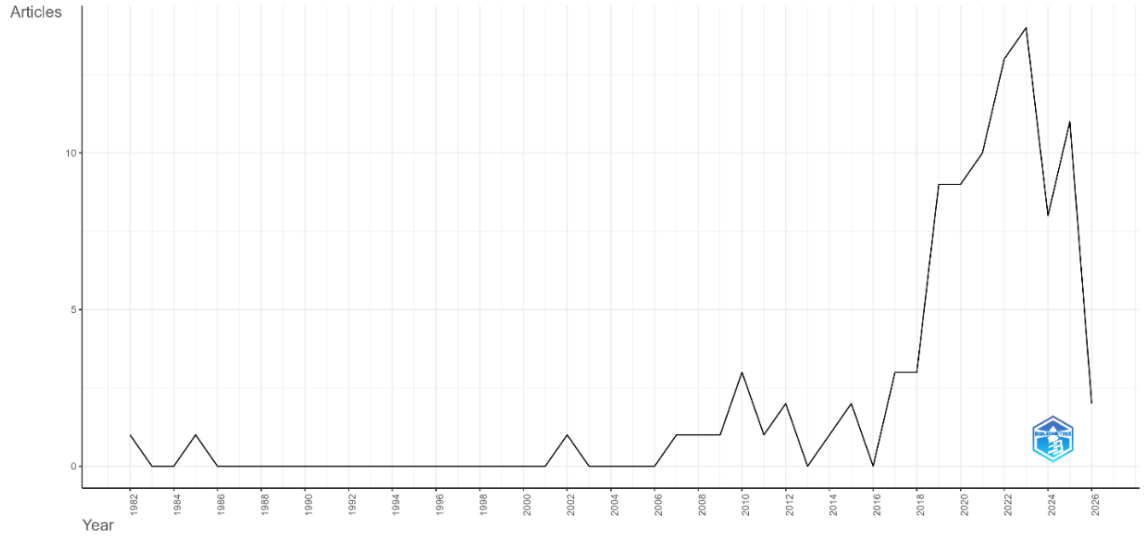


Fig. 3. Annual scientific production

In 2022, ASEAN published 13 articles on this topic, while the global publication count was 121. Therefore, it can be said that ASEAN's contribution is about 10.7% for that year (see Fig. 4). However, looking more broadly, the global trend over the last decade shows a sharper increase in the volume of publications on the topic of educational technology than in ASEAN; in other words, while ASEAN has experienced a post-2019 surge (in line with the response to the COVID-19 pandemic), the cumulative rate of ASEAN remains behind relative to the global trend. The post-2019 surge is consistent with the increased research focus on distance learning and technology solutions during the pandemic [28]. However, the low annual growth rate (1.59%) indicates that the surge is episodic, which increases volume in the short term but has not changed the long-term growth trend.

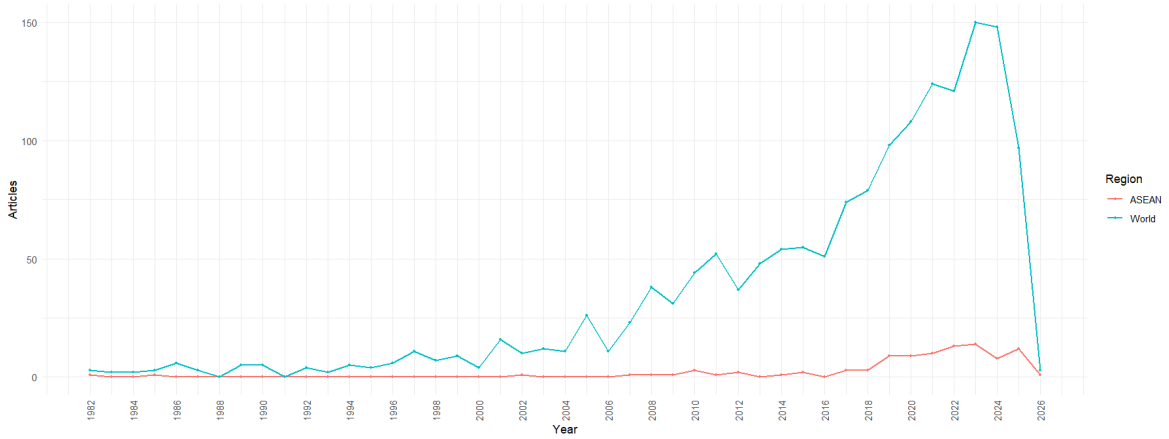


Fig. 4. Annual scientific production between ASEAN and the world

3.3. Most Productive and Collaborative Between Countries

Table 1 presents the number of affiliations that appear in the metadata, so the accumulated number of affiliations may exceed the number of unique articles (accumulated number = 103 in the table), as some articles have multiple affiliations across countries. Based on Table 1, Malaysia is the top contributor with 37 publications (35.92%), followed by Indonesia in the next place with 52 articles (29.38%). Thailand was the third country with 20 articles (11.30%) and 55 citations. The collaboration network analysis revealed three main research clusters. The first cluster (in blue) centers on Malaysia, which has established extensive collaborations with partners such as Singapore, China, Iran, Saudi Arabia, Jordan, Pakistan, Hong Kong, and Spain. These relatively strong linkages help explain Malaysia's dominance in terms of the number of affiliations. The second cluster (green color) includes Indonesia with links to Egypt, Australia, and Austria; these links are noticeably thinner than the Malaysian cluster. The third cluster (red color) consists of Thailand, which is networked with the UK and New Zealand, with the Thailand-UK linkage appearing more prominent than Thailand-New Zealand.

Table 1. The top five countries with the highest publications

Rank	Country	Total of Publications	%
1st	Malaysia	37	35.92
2nd	Indonesia	34	33.01
3rd	Thailand	13	12.62
4th	Philippines	8	7.77
5th	Singapore	7	6.80

Malaysia's superiority in terms of publications on educational technology topics compared to ASEAN countries such as Indonesia and Singapore is not a coincidence, but the result of a deliberate national strategy that has been in place for decades. This strategy systematically aligns top-down policy directives, such as the Malaysian Education Development Plan (PPPM) [29], with institutional-level performance metrics (MyRA) [30], as well as individual-level incentives (research grants, publication bonuses, and promotion criteria). In contrast, Singapore's policy prioritizes the pedagogical application of technology within its education system [31], [32], while Indonesia's focus remains on addressing fundamental challenges related to infrastructure and equity [33].

In the collaboration network analysis, the country distribution pattern in Fig. 5 shows a concentration of research capabilities in certain countries that act as centers of scientific production on this topic in ASEAN. The strength of the Malaysian network increases access to collaborations, resources, and co-publications, which aids visibility; however, it also creates dependency within ASEAN on a few central nodes. In addition, the absence of publications from some ASEAN countries (Laos, Cambodia, Myanmar, Timor Leste) in Scopus extractions suggests a research gap in this topic.

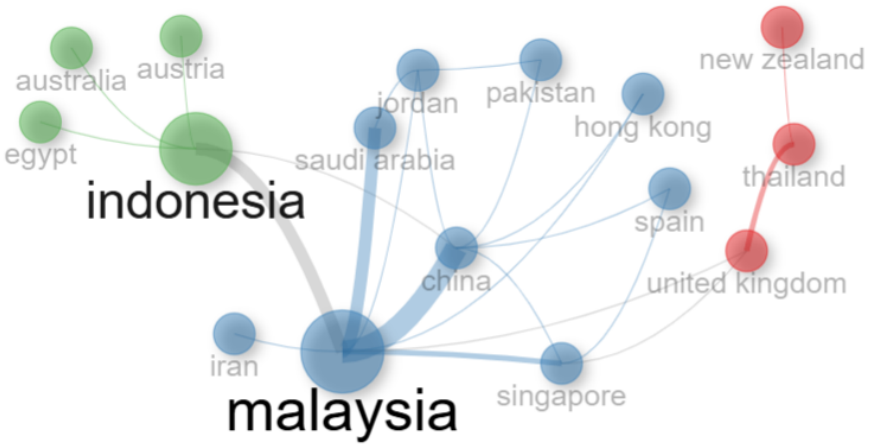


Fig. 5. Inter-country research collaboration network

3.4. The Most Productive Source

In Table 2, with 30 total citations and six publications, Journal of Physics: Conference Series from the UK is the journal with the highest citation and publication rate on this topic within the ASEAN region. The International Journal of Learning, Teaching, and Educational Research is in second place with 17 total citations and three publications. The journal has Q3 accreditation, making it the highest-accredited journal in the most productive journal group. Turkish Online Journal of Educational Technology and Advanced Science Letters are also included in this list, but unfortunately, both journals have been discontinued since 2017, according to Scimago data. Both were last recorded as Q4 accredited journals on Scimago.

Table 2. The top five journals with the highest publications

Rank	Journal	SQ[a]	Publishing	Country	TC[b]	NP[c]
1st	Journal of Physics: Conference Series	Q4	IOP Publishing Ltd.	UK	30	6
2nd	International Journal of Learning, Teaching, and Educational Research	Q3	Society for Research and Knowledge Management	Mauritius	17	3
3rd	Turkish Online Journal of Educational Technology	Q4*	Sakarya University	Turkey	14	3
4th	Advanced Science Letters	Q4*	American Scientific Publisher	USA	16	2
5th	AIP Conference Proceedings	-	American Institute of Physics	USA	1	2

a: Scopus Quartile, data accessed from 09 August 2025 at scimagojr.com
b: Total of Citation
c: Number of Publications
*: Discontinue in Scopus

The presence of proceedings and medium-low quality journals (Q3-Q4) in the productive list suggests that most of the region's output is published in journals that may have limited international visibility. While some articles achieve high citations, this distribution of journals indicates that an increase in volume is not necessarily followed by an increase in the proportion of publications in highly reputable journals. This factor may explain the fragmentation of ASEAN's scientific influence in the global sphere.

3.5. The Most Productive and Collaborative Affiliations

In the affiliation category with a topic focus on educational technology in the ASEAN region, as shown in Table 3, Malaysia is the dominating country with Universiti Teknologi Malaysia as the most productive institution with 16 publications (7.55%). The university leads in research contributions in this area. Only one affiliate from outside Malaysia, Universitas Negeri Padang, is in second place and comes from Indonesia with ten publications (4.72%).

Table 3. The top five affiliates with the highest publications

Rank	Affiliation	City	Country	TP*	%
1st	Universiti Teknologi Malaysia	Johor Baru	Malaysia	16	7.55
2nd	Univeritas Negeri Padang	Padang	Indonesia	10	4.72
3rd	Universiti Putra Malaysia	Seri Kembangan	Malaysia	7	3.3
4th	Universiti Tun Hussein Onn Malaysia	Parit Raja	Malaysia	7	3.3
5th	Universiti Teknologi Mara	Shah Alam	Malaysia	6	2.83

Furthermore, in Fig. 6, nine clusters illustrate the collaboration networks of various institutions in ASEAN and some institutions from other countries. These groups consist of 27 institutions and are grouped with different colours based on the research collaboration network formed. If examined further, the collaboration network between Nanyang Technological University (Singapore) and Universiti Putra Malaysia (Malaysia) is a collaboration network that can be considered strong. The thickness of the network formed evidences this.

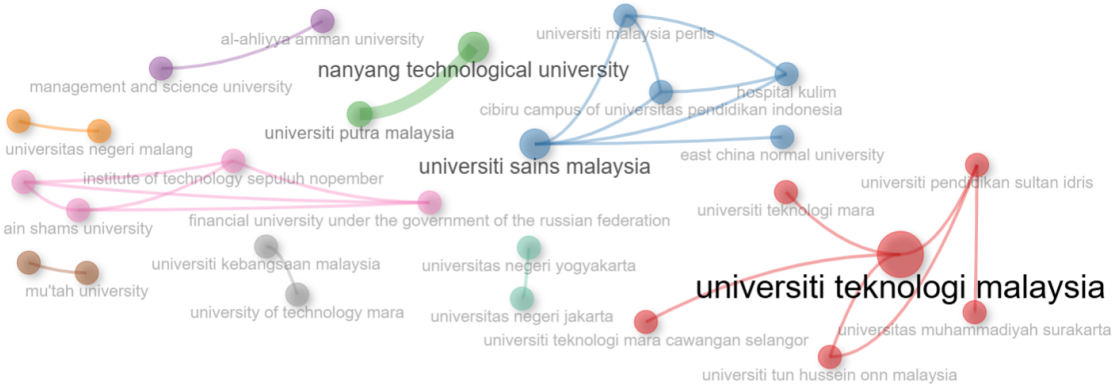


Fig. 6. Collaborative network between affiliates in the ASEAN region and the world

The concentration of publications in a few institutions—most notably Universiti Teknologi Malaysia—suggests the existence of institutional hubs that play a central role in knowledge production. Such hubs tend to facilitate cross-national collaboration and increase co-publication opportunities, thus increasing the chances of influential articles emerging. However, the reliance on certain institutional drivers also suggests that the expansion of other national/institutional capacities remains uneven, so the distribution of scientific contributions in ASEAN remains unequal.

3.6. Document with the Highest Citations

Based on Table 4, the article with the highest citations is held by Machmud, Widiyan, and Ramadhani [34] with 41 citations that discuss ICT policy development to support educational technology by looking at four countries in ASEAN. The research examines the development and implementation of educational technology policies in ASEAN countries through a literature review. The contributions of each article on this topic are quite diverse. Not only is education policy, research related to technology adaptation in ESL [35] also busy. In addition, there is also a study related to the perspective of science teachers regarding the use of infographics for educational technology courses [36].

The concentration of citations on certain themes indicates that topics that offer cross-country perspectives, policy, or method synthesis tend to attract wider attention. This further confirms the pattern of unevenness: several strategic topics gain traction and high citations, while studies with a local focus or based on single cases tend to be less visible.

Table 4. Top five authors with the highest citations

Rank	Authors	Year	Title	TC
1st	Machmud, Widiyan, and Ramadhani	2021	The development and policies of ICT supporting educational technology in Singapore, Thailand, Indonesia, and Myanmar	41
2nd	Yew Kai Wen & Hua	2020	ESL Teacher's Intention in Adopting Online Educational Technologies during COVID-19 Pandemic	38
3rd	Jing, Wang, Chen, Wang, Yu, and Shadiev	2024	Bibliometric mapping techniques in educational technology research: A systematic literature review	38
4th	Fadzil	2018	Designing infographics for the educational technology course: Perspectives of preservice science teachers	29
5th	Sakat	2021	Educational Technology Media Method in Teaching and Learning Progress	23

3.7. Focus Research

The bibliometric analysis shows that educational technology is key and closely related to various research topics in education (Fig. 7). This can be seen from its connection with "quality of education", "artificial intelligence", "gamification", and "medical education". This network shows the development of research sub-topics among researchers to expand the topic of educational technology into broader, more inclusive, and timely education research topics. Other research focuses are centered on various issues, such as the usefulness of educational technology for learning, and its usefulness in other research fields, such as medical and engineering. This is illustrated in the connection between educational technology and keywords such as "medical education", "engineering education", and "industrial revolutions". This series of keyword networks indirectly shows that research in the ASEAN region on the topic of educational technology is starting to expand into various other relevant fields of study, especially in improving the quality of education through technology, as indicated by keywords such as "curricula" and "learning systems".

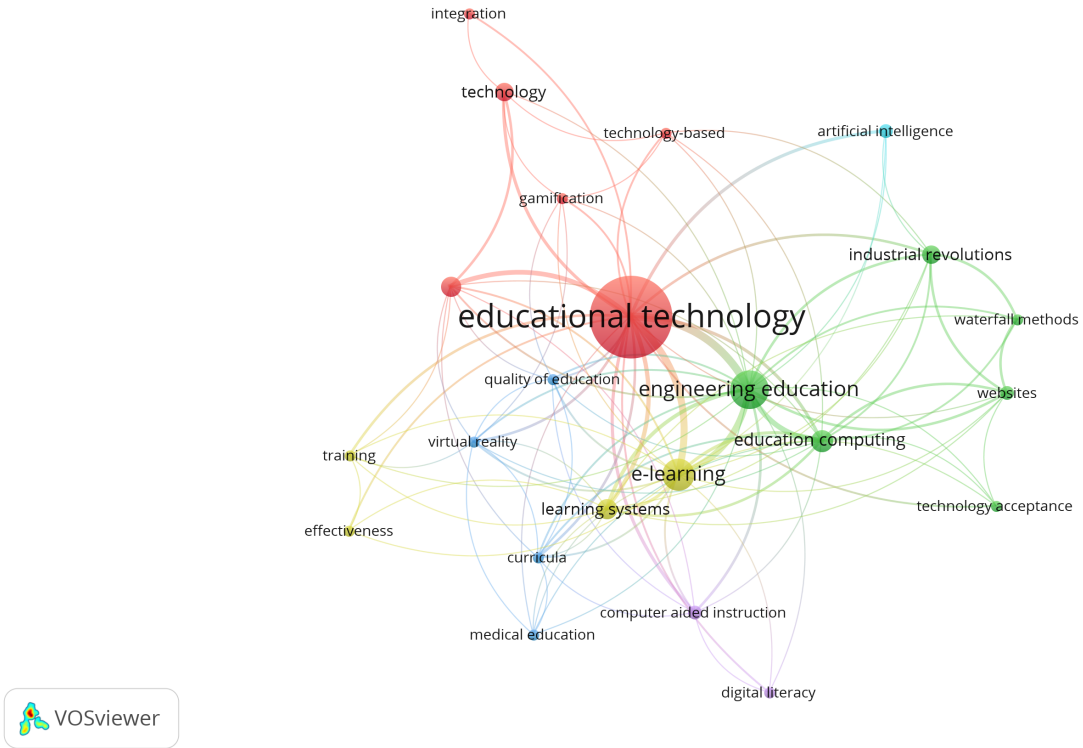


Fig. 7. Research focus network

3.8. Keyword Novelty

Next is the analysis of novelty through keywords. As illustrated in Fig. 8, the direction of research novelty in the field of educational technology in the ASEAN region is. Topics presented in bright colours, such as yellow, indicate that the topic is still quite new in the field of educational technology in the ASEAN region. Meanwhile, topics presented in a darker colour indicate that the topic has often been raised or discussed in various studies. Therefore, analysing the novelty of keywords is important to see the latest trends and novelty in the field of educational technology, especially in the ASEAN region.

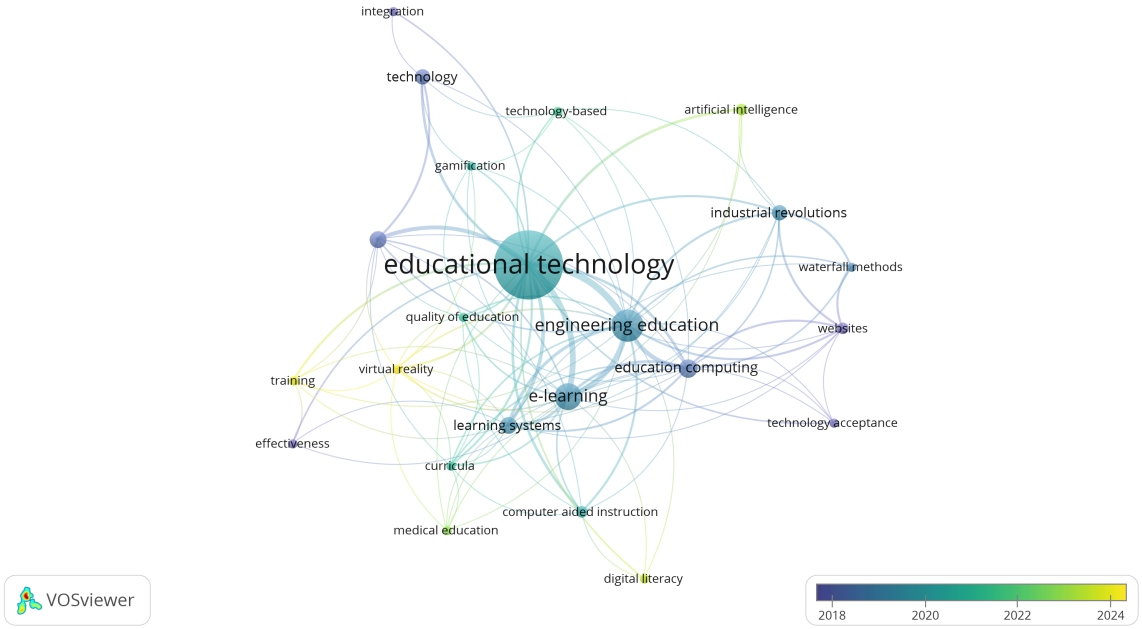


Fig. 8. Keyword novelty network

One of the brightly colored keywords is "virtual reality" and "digital literacy". The emergence of these two terms indicates a new research focus in ASEAN related to educational technology. In addition, the findings indicate a new effort for researchers to improve the effectiveness of learning. This can be proven by the existence of a network of "quality education" related to "virtual reality" in the field of educational technology in the ASEAN region. The same thing also happens to "digital literacy," which is present to improve the quality of education in various countries in the ASEAN region.

Why, then, have "digital literacy" and "virtual reality" emerged as new focal points in educational technology research in ASEAN? This trend is essentially not a random academic phenomenon, but a direct reflection of strategic priorities in ASEAN [37], [38]. There are key challenges that consistently drive the digital literacy research agenda. First is the widespread lack of ICT skills among ASEAN teachers [39], [40]. This is identified as a major obstacle to successful digital transformation. The second driver is the persistent digital divide, characterized by unequal access to connectivity and devices, especially in urban and rural areas [41]. Various studies highlight how this gap exacerbates learning inequalities, making it a critical focus area for researchers [42], [43], [44].

In contrast to the virtual reality (VR) buzzword, the research trend is driven by the convergence between the decreasing cost of the technology, its alignment with advanced pedagogical goals, and its adoption in government-supported pilot projects as a living laboratory for researchers [45], [46], [47]. These two research trends do not run parallel, but are deeply intertwined. Digital literacy is a prerequisite for the effective use of more advanced technologies such as VR. Students and teachers must be digitally competent to navigate virtual environments, solve technical problems, and engage with immersive content critically [48]. Conversely, VR can be a powerful platform for developing

high-level digital literacy skills [48]. Immersive environments can be used to teach complex digital citizenship concepts, simulate responses to misinformation, and foster collaborative problem-solving in digital spaces [49].

Starting from the above narrative, it can be said that research on the topic of educational technology in the ASEAN Region in the future will shift from merely identifying problems (digital literacy gap) and potentials (VR opportunities), towards designing solutions that integrate the two. The focus is no longer on two separate trends, but rather on how their synergy can be engineered. The main research opportunities lie in practical interventions, namely designing experiments to measure how effective VR can accelerate the mastery of digital citizenship skills, developing low-cost VR implementation models for schools in isolated areas to ensure inclusivity, and creating new teacher training modules that utilize immersive technology to improve their competencies. This also applies to other keywords, given that each keyword has its own relevance.

4. Conclusion

Research on educational technology in ASEAN across the last four decades (1982–2026) paints a paradoxical landscape: while a scholarly foundation has been established, its growth has been slow, uneven, and concentrated. Although a surge in publications post-2019 indicates the region's response to urgent catalysts like the COVID-19 pandemic, a low annual growth rate and a disparate distribution of contributions signify a development that is more episodic than sustainably transformative. The dominance of Malaysia, driven by strategic policies and structured research incentives, stands in stark contrast to other nations focusing on infrastructural challenges or pedagogical applications. This pattern, coupled with a concentration of citations within a handful of works and publication in mid-tier sources, confirms that ASEAN stands at a strategic crossroads: a choice between merely increasing publication volume and building a cohesive, sustainable scientific impact on the global stage.

These findings present urgent strategic implications for stakeholders. For policymakers, the challenge is to transition from national silos toward integrated regional collaboration. This effort must transcend collaborative rhetoric and manifest in concrete initiatives, such as establishing a joint ASEAN research fund targeting cross-border issues and harmonizing quality standards to incentivize publication in high-impact journals. For researchers, the era of descriptive studies must urgently conclude. The most promising opportunities lie at the intersection of pressing needs and technological innovation. Future research must prioritize validating technological efficacy through rigorous experimental and longitudinal studies; for instance, testing how VR can accelerate digital literacy acquisition or examining the long-term impacts of AI adoption in diverse learning environments. For educators, these findings call for a shift from passive consumers to pedagogical innovators. Effective adoption strategies do not merely await top-down directives but proactively form communities of practice (CoPs) across schools and nations to share best practices in integrating gamification, VR, or AI into existing curricula, transforming classrooms into living laboratories for innovation.

Ultimately, the landscape of educational technology research in ASEAN is at a strategic inflection point. The past increase in publication volume has successfully laid a foundation, but it is no longer adequate to address future challenges. ASEAN is now transitioning from quantity-driven research to quality-driven innovation, a shift that demands stronger cross-national collaboration and experimental validation. This pivot is the only pathway to ensure that research is not only academically relevant but also capable of generating tangible, inclusive, and transformative solutions for the entire region.

Declaration

Supplementary Materials: The supplementary materials of this study include the complete dataset retrieved from Scopus and the visualizations generated using R Program and VOSviewer.

Author Contribution: IKS: Conceptualization, Writing – Original Draft, Editing, and Visualization; ON: Formal analysis, methodology, and review; RN: Validation. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflict of interest.

References

[1] M. Escueta, A. J. Nickow, P. Oreopoulos, and V. Quan, "Upgrading Education with Technology: Insights from Experimental Research," 2020, *American Economic Association*, https://doi.org/10.1257/jel.20191507.

[2] I. K. Sudarsana *et al.*, "Technology Application in Education and Learning Process," *J Phys Conf Ser*, vol. 1363, no. 1, pp. 1–6, 2019, https://doi.org/10.1088/1742-6596/1363/1/012061.

[3] S. Joshi, "Technology in Education," *VIDYA - A Journal of Gujarat University*, vol. 2, no. 2, pp. 3–5, Jul. 2023, https://doi.org/10.47413/vidya.v2i2.197.

[4] J.-M. Liang, W.-C. Su, Y.-L. Chen, S.-L. Wu, and J.-J. Chen, "Smart Interactive Education System Based on Wearable Devices," *Sensors (Switzerland)*, vol. 19, no. 15, 2019, https://doi.org/10.3390/s19153260.

[5] J. W. M. Lai and M. Bower, "How is The Use of Technology in Education Evaluated? A Systematic Review," *Comput Educ*, vol. 133, pp. 27–42, 2019, https://doi.org/10.1016/j.compedu.2019.01.010.

[6] V. Tomar and Soni, "Impact of technology on education," *International Journal of Advanced Academic Studies*, vol. 6, no. 6S, pp. 127–130, Jun. 2024, https://doi.org/10.33545/27068919.2024.v6.i6b.1222.

[7] S. Rabani, A. Khairat, X. Guilin, and D. Jiao, "The Role of Technology In Indonesian Education At Present," *Journal of Computer Science Advancements*, vol. 1, no. 2, pp. 85–91, Aug. 2023, https://doi.org/10.55849/jsca.v1i1.403.

[8] A. A. Syaukani, N. Subekti, L. A. Khuddus, A. Zoki, and A. P. Bimantoro, "Challenge and Barriers: Teacher Reflection on Teaching Physical Education and Sports during COVID-19 pandemic," *Journal of Physical Education (Maringa)*, vol. 34, no. 1, 2023, https://doi.org/10.4025/jphyseduc.v34i1.3434.

[9] C. Fletcher, C. Iannucci, and D. Scanlon, "A Teacher's Self-Study of Digitally-Enabled Assessment Practices to Support Enhancements in Assessment Literacy in Primary Physical Education," *Curriculum Studies in Health and Physical Education*, pp. 1–19, Oct. 2023, https://doi.org/10.1080/25742981.2023.2265903.

[10] W. J. AlKasasbeh and A. T. Amawi, "Elevating Physical Education Teacher Through Technology Integration," *International Journal of Interactive Mobile Technologies*, vol. 18, no. 2, pp. 16–26, 2024, https://doi.org/10.3991/ijim.v18i02.43669.

[11] J. U. Nepangue and W. T. Ibañez, "Lived Experiences of Tertiary Physical Education Teachers in Quaranteaching," *Malaysian Journal of Learning and Instruction*, vol. 19, no. 2, pp. 251–279, 2022, https://doi.org/10.32890/mjli2022.19.2.9.

[12] UNESCO, *Languages Matter: Global Guidance on Multilingual Education*. Paris: UNESCO, 2025, https://doi.org/10.54675/MLIO7101.

[13] UNESCO, *Global Education Monitoring Report 2023, Southeast Asia: Technology in Education: A Tool on Whose Terms?* Paris: GEM Report UNESCO, 2023, https://doi.org/10.54676/RJNF1598.

[14] D. Oluwadele, Y. Singh, and T. T. Adeliyi, "Trends and Insights in E-Learning in Medical Education: A Bibliometric Analysis," *Review of Education*, vol. 11, no. 3, Dec. 2023, https://doi.org/10.1002/rev3.3431.

[15] S. Nurjanah *et al.*, "Assessment in Physics Education Research: Trends, Patterns, and Future Directions," *Review of Education*, vol. 13, no. 1, Apr. 2025, https://doi.org/10.1002/rev3.70043.

[16] C. Huang, C. Yang, S. Wang, W. Wu, J. Su, and C. Liang, "Evolution of Topics in Education Research: A Systematic Review Using Bibliometric Analysis," *Educ Rev (Birm)*, vol. 72, no. 3, pp. 281–297, May 2020, https://doi.org/10.1080/00131911.2019.1566212.

[17] J. Julia *et al.*, "Flipped Classroom Educational Model (2010-2019): A Bibliometric Study," *European Journal of Educational Research*, vol. volume-9-2020, no. volume-9-issue-4-october-2020, pp. 1377–1392, Oct. 2020, https://doi.org/10.12973/eu-jer.9.4.1377.

[18] C. Mejia, M. Wu, Y. Zhang, and Y. Kajikawa, "Exploring Topics in Bibliometric Research Through Citation Networks and Semantic Analysis," *Front Res Metr Anal*, vol. 6, Sep. 2021, https://doi.org/10.3389/frma.2021.742311.

[19] T.-V. Nguyen and V.-N. Tran, "Researching Creativity in Education from ASEAN Countries: Bibliometric Analysis," *International Journal of Evaluation and Research in Education (IJERE)*, vol. 14, no. 4, p. 2593, Aug. 2025, https://doi.org/10.11591/ijere.v14i4.33669.

[20] D. N. Al Husaeni, D. F. Al Husaeni, A. B. Dani Nandiyanto, and A. Sh. Mahdi Al-Obaidi, "Introducing ASEAN Journal of Science and Engineering Education: A Bibliometric Analysis Study for Understanding Internationalization," *Data and Metadata*, vol. 1, p. 82, Dec. 2022, https://doi.org/10.56294/dm202282.

[21] I. B. Masangcay, J. C. G. Tolentino, J. P. P. Miranda, M. A. N. Baltazar, E. B. Santos, and S. I. Custodio, "Current Research, Emerging Trends, Gaps, and Opportunities in Physical Education in the ASEAN Context," *Modern Perspectives and Current Trends in Asian Education, Psychology, and Sociology*, 2023, pp. 26–69, https://doi.org/10.4018/978-1-6684-7375-7.ch002.

[22] N. H. T. Chung and T. A. Cam, "Clarivate Research Fronts in the Digital Education: Perspectives from Asean Higher Education System," *Journal of Ecohumanism*, vol. 3, no. 8, Dec. 2024, https://doi.org/10.62754/joe.v3i8.5975.

[23] J. Baas, M. Schotten, A. Plume, G. Côté, and R. Karimi, "Scopus as A Curated, High-Quality Bibliometric Data Source for Academic Research in Quantitative Science Studies," *Quantitative Science Studies*, vol. 1, no. 1, pp. 377–386, Feb. 2020, https://doi.org/10.1162/qss_a_00019.

[24] M. J. Page *et al.*, "The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews," *BMJ*, p. n71, Mar. 2021, https://doi.org/10.1136/bmj.n71.

[25] S. Büyükkidik, "A Bibliometric Analysis: A Tutorial for the Bibliometrix Package in R Using IRT Literature," *Egit Psikol Olcme Deger Derg*, vol. 13, no. 3, pp. 164–193, Sep. 2022, https://doi.org/10.21031/epod.1069307.

[26] D. M. Tow and J. A. Phillips, "Educational Technology and the Social Sciences in the University of Malaya," *High Educ (Dordr)*, vol. 11, no. 6, pp. 657–668, Nov. 1982, https://doi.org/10.1007/BF00139782.

[27] T. J. Kral, "Educational Technology and Effective Growth in Second Language Classrooms," *CALICO Journal*, vol. 3, no. 4, pp. 11–13, Oct. 1985, https://doi.org/10.1558/cj.v3i4.11-13.

[28] S. Nurjanah, N. A. Martaputri, Z. Zamzami, I. K. Suardi, and H. K. Hulu, "Artificial Intelligence in Physics Education Research in Two Decades: A Bibliometric Study from Scopus Database," *Jurnal Pendidikan Fisika*, vol. 12, no. 2, Aug. 2024, https://doi.org/10.26618/jpf.v12i2.14745.

[29] Kementerian Pendidikan Malaysia, *Executive Summary Malaysia Education Blueprint 2015-2025: Higher Education*. Putrajaya: Kementerian Pendidikan Malaysia, 2015. Accessed: Sep. 21, 2025. [Online]. Available: https://www.um.edu.my/docs/um-magazine/4-executive-summary-pppm-2015-2025.pdf

[30] N. Z. Abidin, N. Z. Zaibidi, and K. N. Karim, "Strategic Planning for MyRA Performance: A Causal Loop Diagram Approach," *AIP Conference Proceedings*, 2017, p. 020151, https://doi.org/10.1063/1.5005484.

[31] Singapore Ministry of Education, "EdTech Masterplan 2030 | MOE," Government of Singapore. Accessed: Sep. 21, 2025. [Online]. Available: https://www.moe.gov.sg/education-in-sg/educational-technology-journey/edtech-masterplan

[32] Singapore Ministry of Education, "Educational Technology Journey | MOE," Government of Singapore. Accessed: Sep. 21, 2025. [Online]. Available: https://www.moe.gov.sg/education-in-sg/educational-technology-journey

[33] Q. Aini, A. Kurniawan, and T. Bina Sulistiyowati, "Digital Transformation: Best Practices of Educational Platform in Indonesia," *Jurnal Transformative*, vol. 10, no. 1, pp. 42–59, Mar. 2024, https://doi.org/10.21776/ub.transformative.2024.010.01.3.

[34] M. T. Machmud, A. P. Widiyan, and N. R. Ramadhani, "The Development and Policies of ICT Supporting Educational Technology in Singapore, Thailand, Indonesia, and Myanmar," *International Journal of Evaluation and Research in Education (IJERE)*, vol. 10, no. 1, p. 78, Mar. 2021, https://doi.org/10.11591/ijere.v10i1.20786.

[35] K. Yew Kai Wen and T. K. Hua, "ESL Teachers' Intention in Adopting Online Educational Technologies during COVID-19 Pandemic," *J Educ Elearn Res*, vol. 7, no. 4, pp. 387–394, 2020, https://doi.org/10.20448/journal.509.2020.74.387.394.

[36] H. M. Fadzil, "Designing Infographics for the Educational Technology Course: Perspectives of Preservice Science Teachers," *Journal of Baltic Science Education*, vol. 17, no. 1, pp. 8–18, Feb. 2018, https://doi.org/10.33225/jbse/18.17.08.

[37] ASEAN, "Declaration on the Digital Transformation of Education Systems in ASEAN," Phnom Penh, Nov. 2022. Accessed: Sep. 21, 2025. [Online]. Available: https://www.asean.org/wp-content/uploads/2022/11/35-Declaration-on-the-Digital-Transformation-of-Education-Systems-in-ASEAN.pdf

[38] ASEAN, "Joint Statement from the Conference on the Digital Transformation of Education Systems Throughout ASEAN," Ha Noi, 2020. Accessed: Sep. 21, 2025. [Online]. Available: https://asean.org/joint-statement-conference-on-the-digital-transformation-of-education-systems-throughout-asean/

[39] E. A. Pascua-Valenzuela, "Digital Literacy and Transformation in ASEAN: A Call for Education Policy Reforms ASEAN Socio-Cultural Community Policy Brief No. 19 (2025) ASCC Research and Development Platform on The Future of Education," ASCC Research and Development Platforms Programme, Manila, 2025.

[40] D. Mutiarin *et al.*, "Bridging the Digital Divide Through Digital Infrastructure," *Journal of Infrastructure, Policy and Development*, vol. 8, no. 8, p. 6817, Aug. 2024, https://doi.org/10.24294/jipd.v8i8.6817.

[41] A. Habbal, E. O. C. Mkpojiogu, L. Cottrell, B. White, S. Hassan, and F. Zulhumadi, "Socio-Economic Development Indices and Their Reflection on Internet Performance in ASEAN Countries," *ASEAN Engineering Journal*, vol. 14, no. 1, pp. 19–29, Feb. 2024, https://doi.org/10.11113/aej.v14.18666.

[42] P. Prajaknate, "Information Communication Technologies (ICT) for Education Projects in ASEAN: Can We Close the Digital Divide?," in *Sustainable Development Goals in the Asian Context*, 1st ed., J. Servaes, Ed., Springer Singapore, 2017, pp. 107–133, https://doi.org/10.1007/978-981-10-2815-1_6.

[43] D. McFarlane, Y. Mieruch, and N. L. Wann Si, "Closing the Digital Divide in Education: An Innovative Review of Demand and Supply Side Policies in Four ASEAN Member States," *International Journal of Evaluation and Research in Education (IJERE)*, vol. 13, no. 6, p. 3827, Dec. 2024, https://doi.org/10.11591/ijere.v13i6.28011.

[44] M.-T. Chong, C.-H. Puah, S. A. Mansor, and C.-S. Teh, "Digital Connectivity Bridging Digital ASEAN," *International Journal of Economics and Management*, vol. 17, no. 1, pp. 139–149, Apr. 2023, https://doi.org/10.47836/ijeam.17.1.10.

[45] J. Zhang, S. Chembumroong, and P. Sureephong, "The Implementation of Virtual Reality Technology in Education: the Perspective of Learning Environment," in *2021 Joint International Conference on Digital Arts, Media and Technology with ECTI Northern Section Conference on Electrical, Electronics, Computer and Telecommunication Engineering*, IEEE, Mar. 2021, pp. 327–331, https://doi.org/10.1109/ECTIDAMTNCON51128.2021.9425762.

[46] J. Martín-Gutiérrez, C. E. Mora, B. Añorbe-Díaz, and A. González-Marrero, "Virtual Technologies Trends in Education," *EURASIA Journal of Mathematics, Science and Technology Education*, vol. 13, no. 2, Jan. 2017, https://doi.org/10.12973/eurasia.2017.00626a.

[47] D. Hariyanto, A. A. Rafiq, T. S. Gunawan, and N. V. Quynh, "Exploring the Research Trends and Development of Augmented Reality and Virtual Reality in ASEAN Countries: a Bibliometric Study," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 14, no. 4, p. 4430, Aug. 2024, https://doi.org/10.11591/ijece.v14i4.pp4430-4444.

[48] D. T. K. Ng, R. C. W. Ng, and S. K. W. Chu, "Engaging Students in Virtual Tours to Learn Language and Digital literacy," *Journal of Computers in Education*, vol. 10, no. 3, pp. 575–602, Sep. 2023, https://doi.org/10.1007/s40692-023-00262-2.

[49] X. P. Lin, B. Bin Li, Z. N. Yao, Z. Yang, and M. Zhang, "The Impact of Virtual Reality on Student Engagement in the Classroom–A Critical Review of the Literature," *Front Psychol*, vol. 15, Apr. 2024, https://doi.org/10.3389/fpsyg.2024.1360574.