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Bibliometric Analysis of Research Trends in Digital Learning Media for Technical and Vocational Education and Training (TVET)

Roni Arya Gunawan^{1*}, Agung Rorhi Prayudha², Purwandari Nur Tristianigsih³
^{1*,3}Program Studi Pendidikan Teknik Mesin, Fakultas Teknik, Universitas Negeri Medan
²Departemen Pendidikan Kesejahteraan Keluarga FKIP Universitas Syiah Kuala
Email: roniagunawan@unimed.ac.id,
agungrorhiprayudha@usk.ac.id, purwandari@unimed.ac.id

ABSTRACT

This study aims to map the trends, research focus, and developmental dynamics of studies on digital learning media in technical and vocational education during the period 2016–2026. The study employed a bibliometric analysis approach conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, with data mining carried out using the Dimensions database. The analysis was performed using VOSviewer software to identify research trends, keyword relationships, and patterns of author collaboration. The results indicate that the number of publications fluctuated but showed an overall upward trend, with a significant increase after 2021 and reaching a peak in 2025. Based on network visualization and overlay visualization results, research on digital learning media in technical and vocational education demonstrates an interconnected thematic structure that evolves dynamically. The keyword “vocational education and training” serves as a central node integrating various topics, such as learning and learning outcomes, the use of multimedia and technology, the development of media based on the ADDIE model, the utilization of virtual laboratories, and the implementation of immersive technologies such as augmented reality. Over time, the research focus has shifted from online learning and conventional multimedia toward more advanced digital technologies grounded in cognitive theory, such as cognitive load theory, android-based courseware, and the strengthening of 21st-century skills relevant to industry needs. Overall, the findings indicate substantial research opportunities related to the integration of artificial intelligence (AI) in digital learning media within the field of technical and vocational education, and this topic is recommended as a direction for future research.

Keywords: *bibliometrics, digital learning media, technical and vocational education*

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INTRODUCTION

The rapid advancement of digital technology has brought about fundamental changes in education, particularly within the context of technical and vocational education. The

digitalization of learning has encouraged the adoption of various forms of digital learning media, including interactive multimedia, online learning platforms, virtual laboratories, and immersive technologies such as virtual reality (VR) and augmented reality (AR). Digital learning media not only serve as tools for delivering instructional content but also play a crucial role in supporting competency-based

learning, enhancing practical skills, and preparing graduates to meet the increasingly dynamic demands of the workforce (Muktiarni, Rahayu, dan Wardani 2023).

Digital learning media refer to instructional tools that utilize digital technologies, electronic devices, and computer- or internet-based platforms to support, facilitate, and enhance the teaching and learning process in an interactive, flexible, and effective manner. These media encompass a wide range of formats, including web-based media, computer software, mobile applications, interactive multimedia, and e-learning systems, all of which are designed to deliver instructional content, increase learner engagement, and promote the achievement of optimal learning outcomes (Gubbins, Garavan, dan Bennett 2023; Kodrle dan Savchenko 2021).

With the increasing adoption of digital technologies in technical and vocational education, research on digital learning media has also experienced substantial growth. Numerous studies have demonstrated that the integration of digital technologies, including virtual reality (VR) and augmented reality (AR), has a positive impact on learning effectiveness, conceptual understanding, and the practical performance of vocational learners (Muskhir et al. 2024; Subekti et al. 2025; Yang, Rasul, dan Jie 2025). Furthermore, the digital transformation of technical and vocational education has gained increasing global attention, as reflected in the growing number of scientific publications and the expanding scope of research on digital learning innovations, virtual laboratories, and the integration of adaptive learning technologies

(Muktiarni et al. 2023; Othman, Omar, dan Rasul 2026).

Nevertheless, the rapid growth of scientific publications presents significant challenges in understanding the direction of research development, dominant research themes, and patterns of scientific collaboration in the field of digital learning media within technical and vocational education. Previous studies have primarily focused on evaluating the effectiveness of specific learning media or conducting empirical investigations within particular institutional and disciplinary contexts. Consequently, they have not provided a comprehensive understanding of the global intellectual structure and research dynamics of this field (Manjit Sidhu 2008).

Several previous studies have investigated digital learning media in the context of technical and vocational education using diverse research approaches. One such study was conducted by (Silaban et al. 2026), who employed a systematic literature review approach to examine a body of published articles. Their findings indicated that the use of digital learning media, such as interactive videos, Learning Management Systems (LMS), and virtual simulations, contributed positively to improving students' learning outcomes, motivation, and critical thinking skills. While the study provides a strong conceptual foundation regarding the effectiveness of digital learning media, it is primarily limited to evaluating their implementation and does not explore the broader research trends, intellectual structure, and evolving dynamics of the field of technical and vocational education.

This limitation is also evident in the study conducted by (Fauzan, Ardiansyah, dan Setiawan Fauzan 2025), which focused on the implementation of digital learning media in the instructional process, particularly to enhance students' engagement and conceptual understanding through the use of digital platforms such as Wordwall. The study adopted an empirical and context-specific approach, making its contribution primarily relevant to instructional practice rather than to understanding the broader development of knowledge and research trends in the field.

A similar tendency can also be observed in the studies conducted (Ahda Sabila et al. 2025; Eka Purnama Sari dan Ahmad Fuad 2022; Setuju; Astuti Wijayanti; dan Ratnawati 2017) which examined digital learning media in technical and vocational education from various perspectives. Although these studies have made significant contributions to understanding the implementation and effectiveness of digital learning media, they have not provided a comprehensive overview of publication trends, research collaboration networks, thematic structures, or the evolution of research keywords in the field of digital learning media within technical and vocational education. This gap highlights the need for an approach capable of systematically and comprehensively mapping the research landscape.

In this context, bibliometric analysis represents a relevant and strategic approach for understanding the development of research on digital learning media in technical and vocational education. Bibliometric analysis enables the identification of research trends,

research hotspots, and collaboration networks among authors, institutions, and countries contributing to the field of Technical and Vocational Education and Training (TVET) (Othman et al. 2026; Peter, Peter, dan Peter 2025). Through keyword co-occurrence analysis, citation analysis, and collaboration network mapping, this approach can reveal the intellectual structure and thematic evolution of the field, including the growing emphasis on immersive technologies, project-based learning, and the integration of emerging technologies such as artificial intelligence (AI) and the metaverse into Technical and Vocational Education and Training (TVET) (Ariawan et al. 2025; Saphira et al. 2024; Yang et al. 2025).

Beyond its academic contributions, bibliometric analysis also has important implications for educational policy and practice. Bibliometric findings can serve as an evidence-based foundation for formulating strategies to advance digital learning media, reduce the digital divide, and enhance the digital competencies of vocational educators through continuous professional development (Katherine Ortiz García et al. 2025; Nurtanto et al. 2025)(Katherine Ortiz García et al. 2025; Nurtanto et al. 2025). Consequently, bibliometric analysis functions not only as a scientific mapping tool but also as a strategic instrument for supporting the transformation and modernization of Technical and Vocational Education and Training (TVET).

Based on the foregoing discussion, this study aims to present a bibliometric analysis of digital learning media in Technical and Vocational Education and Training (TVET) to

map global research trends, collaboration patterns, and the overall trajectory of research in this field. The findings are expected to contribute to the literature by providing a comprehensive overview of the intellectual landscape and to serve as a valuable reference for researchers, educators, and policymakers in advancing technology-enhanced technical and vocational education .

RESEARCH METHODS

This study employed a bibliometric analysis approach conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Data retrieval from the Dimensions database was performed on 11 January 2026 through a series of stages, including data collection, data cleaning, data processing, and pattern analysis, to generate relevant information aligned with the objectives of the study. The retrieved records were subsequently managed using Mendeley Desktop for reference organization and duplicate removal. The article selection process involved screening and eligibility assessment based on predefined inclusion criteria. The selected articles were then analyzed to examine the application, advantages, and challenges of digital learning media in Technical and Vocational Education and Training (TVET). Bibliometric analysis was conducted using VOSviewer to map research trends, keyword co-occurrence networks, and author collaboration patterns.

Article Selection Process

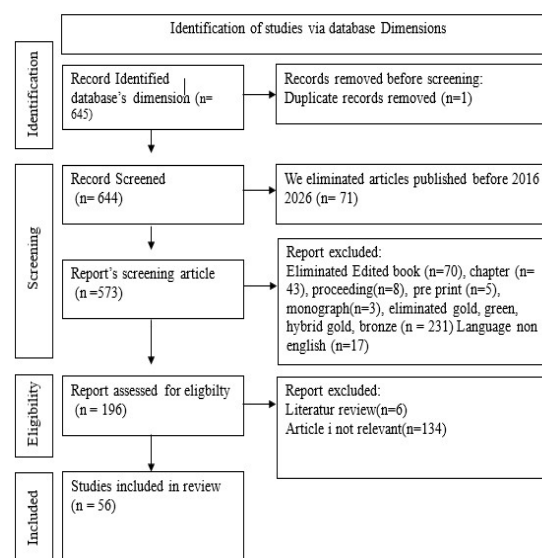


Figure 1. PRISMA Flow Diagram

Stage 1. Identification

During the identification stage, a literature search was conducted using the Dimensions database, resulting in a total of 645 records. An initial screening was performed to identify duplicate records, leading to the removal of one duplicate article. Consequently, 644 records were retained for the subsequent screening stage.

The literature search strategy was developed systematically to ensure the comprehensiveness and relevance of the retrieved publications. The primary search terms were "digital learning media" and "technical and vocational education", together with their relevant synonyms and abbreviations. The complete search query is presented in Table 1. The initial search yielded a total of 645 records.

Table 1. Database and Search Formula

<i>Database</i>	<i>Search Formula</i>
Dimensions	("technical and vocational education" OR "VET") AND ("digital learning media" OR "interactive learning media" OR "multimedia learning")

<i>Database</i>	<i>Search Formula</i>
	AND ("educational technology")

Stage 2: Screening

During the screening stage, all 644 records were screened based on the publication year criterion. A total of 71 records published before 2016 were excluded, leaving 573 records for further screening.

Subsequently, additional screening was conducted based on publication type, access status, and language. Records classified as edited books ($n = 70$), book chapters ($n = 43$), conference proceedings ($n = 8$), preprints ($n = 5$), and monographs ($n = 3$) were excluded. Furthermore, records categorized as Open Access Gold, Green, Hybrid Gold, or Bronze ($n = 231$), as well as records published in languages other than English ($n = 17$), were removed. After this screening stage, a total of 196 records remained for the subsequent eligibility assessment.

Stage 3: Eligibility Assessment

During the eligibility assessment stage, a total of 196 records were evaluated based on the relevance of their titles and abstracts to the research focus. The assessment identified 134 records as irrelevant to the study topic, while 6 review articles were excluded. Consequently, 56 articles met the eligibility criteria and were included for further analysis.

Stage 4: Included Studies

In the final stage, the 56 articles that met all predefined inclusion criteria were included in the systematic review. These studies were subsequently analyzed in depth to address the

research objectives and answer the research questions.

RESULTS OF RESEARCH AND DISCUSSION

Analysis of Annual Publication Trends

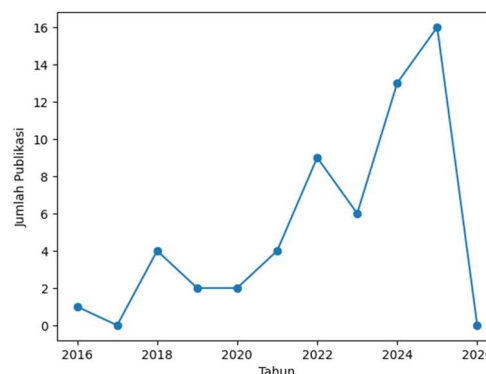


Figure 2. Research Trends from 2016 to 2026

As illustrated in Figure 2, the publication trend from 2016 to 2026 exhibits fluctuations with an overall upward trajectory. During the initial period (2016–2017), the number of publications remained relatively low. A gradual increase was observed in 2018, followed by a decline in 2019 and a stable trend in 2020. Since 2021, the annual number of publications has increased substantially, reaching a marked surge in 2022. Although a slight decline occurred in 2023, publication output increased sharply again in 2024 and reached its highest level in 2025, which recorded the largest number of publications during the study period. As of 2026, no publications had been indexed in the database.

Analysis of the Most Cited Articles

The analysis identified the most highly cited articles within the dataset. The study by Hariyanto et al. (2020) ranked first with 56 citations, followed by Rabiman et al. (2021) and Jaedun et al. (2024) each receiving 27 citations.

The remaining highly cited articles received between 24 and 26 citations, indicating their substantial contributions to the advancement of technology-enhanced learning and Technical and Vocational Education and Training (TVET). Table 2. Most Cited Articles on Digital Learning Media in Technical and Vocational Education and Training (TVET).

Table 2. Most Cited Articles on Digital Learning Media in Technical and Vocational Education and Training (TVET)

Author	Title	Total Citations
(Hariyanto et al. 2020)	Usability evaluation of personalized adaptive e-learning system using USE questionnaire	56
(Rabiman et al. 2021)	Practical Learning Media in Subject Maintenance of Chassis and Power (MCP) Based Online: Simple Learning Using Videos on YouTube	27
(Jaedun et al. 2024)	<i>Perceptions of vocational school students and teachers on the development of interpersonal skills towards Industry 5.0</i>	27
(Tiwari, Bhagat, dan Lampropoulos 2024)	<i>Designing and evaluating an augmented reality system for an engineering drawing course</i>	26
(Ismail et al. 2018)	Development of massive open online course (MOOC) based on addie model	24

Author	Title	Total Citations
	for catering courses	
(Prasetya et al. 2023)	Effectiveness of Distance Learning Computer Numerical Control Based on Virtual Laboratory Using a Metaverse Platform to Improve Students' Cognitive Ability and Practice Skills	24

Network Visualization of Keyword Co-occurrence

The bibliometric analysis conducted using VOSviewer revealed that the keyword Technical and Vocational Education and Training (TVET) emerged as the most dominant node and occupied a central position within the keyword co-occurrence network. This finding indicates that research on digital learning media is predominantly situated within the context of Technical and Vocational Education and Training (TVET), serving as a key linkage between pedagogical approaches, learning technologies, and the development of twenty-first-century skills.

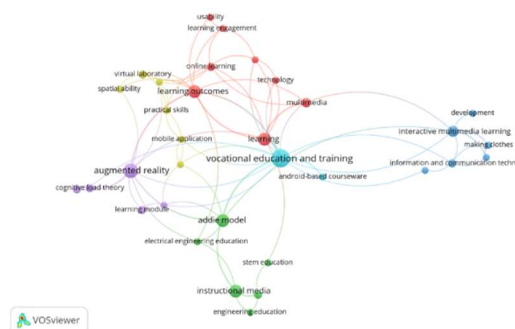


Figure 3. Network Visualization Tren Perkembangan Kata Kunci Penelitian

The network visualization analysis of keyword co-occurrence indicates that research on digital learning media in Technical and Vocational Education and Training (TVET) has evolved as an interconnected research ecosystem rather than as isolated lines of inquiry. The prominence of the keyword Technical and Vocational Education and Training (TVET) underscores that the development of digital learning media is primarily oriented toward enhancing the competencies of vocational learners in alignment with the evolving demands of the labor market. Furthermore, the strong connections among the keywords learning outcomes, practical skills, and technology suggest that improving learning effectiveness remains a central focus in the development and implementation of digital learning media.

Table 3. Keyword Cluster Analysis Results

Cluster	Keyword Focus and Network
Cluster 1 (8 Item)	Learning, learning engagement, learning outcomes, Learning strategy, multimedia online learning, technology, usability
Cluster 2 (6 Item)	addie model, electrical engineering education, engineering education, instructional media, mobile learning, stem education.
Cluster 3 (6 Item)	creative thinking skills, development, home science,

Cluster	Keyword Focus and Network
Cluster 1 (8 Item)	information and communication technology, interactive multimedia learning, making clothes.
Cluster 4 (6 Item)	ctering, cognitive ability, mobile application, practical skills, spatial ability, virtual laboratory.
Cluster 5 (5 Item)	augmented reality, cognitive load theory, learning module, learning style, virtual reality.
Cluster 6 (2 Item)	android based courseware, vocational education and training.

The keyword clustering analysis identified six major clusters, each representing a distinct research focus within the fields of technology-enhanced learning and Technical and Vocational Education and Training (TVET). Cluster 1 primarily focuses on technology-enhanced learning, learner engagement, learning outcomes, instructional strategies, the use of online multimedia, and usability aspects. Cluster 2 is characterized by research on instructional design models, particularly the ADDIE model, as well as the development of learning media in the contexts of technical education and STEM education, including mobile learning. Cluster 3 comprises studies emphasizing the development of creative thinking skills through the integration of information and communication technology (ICT) and interactive multimedia, particularly in skill-based learning environments. Cluster 4 encompasses research on the enhancement of cognitive abilities, practical skills, and spatial abilities through the use of mobile applications and virtual laboratories. Cluster 5 highlights the application of immersive technologies, such as augmented reality (AR) and virtual reality (VR), incorporating the principles of Cognitive Load Theory (CLT) and learning style adaptation.

Meanwhile, Cluster 6 specifically focuses on the development of Android-based courseware for Technical and Vocational Education and Training (TVET).

Overlay Visualization of Keyword Evolution

The overlay visualization generated using VOSviewer illustrates the temporal evolution of research topics, with different colors representing publication periods. Blue to green colors indicate topics that were predominant during the earlier stages of research, including online learning, multimedia, and learning outcomes. In contrast, light green to yellow colors represent more recent research topics, such as augmented reality (AR), Cognitive Load Theory (CLT), Android-based courseware, and the development of virtual laboratories. These findings suggest a shift in research focus toward the adoption of emerging digital technologies that are more adaptive and responsive to the evolving needs of Technical and Vocational Education and Training (TVET).

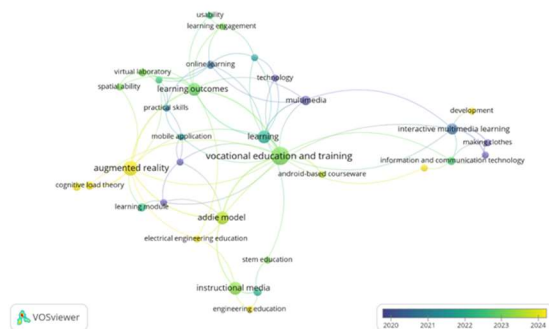


Figure 4. Overlay Visualization of Keyword Evolution by Publication Year

The thematic evolution revealed by the overlay visualization reflects a transition in learning approaches from conventional multimedia-based instruction toward more immersive technologies grounded in cognitive

learning theories. The emergence of augmented reality (AR) and virtual laboratories highlights ongoing efforts to bridge the gap between theoretical instruction and practical learning, particularly in Technical and Vocational Education and Training (TVET). Furthermore, the increasing adoption of Cognitive Load Theory (CLT) and the development of Android-based courseware indicate a growing emphasis on designing learning environments that are adaptive, efficient, and accessible. Overall, these findings demonstrate that current research is directed not only toward technological innovation but also toward meaningful pedagogical integration that supports the development of twenty-first-century skills and enhances the employability and work readiness of TVET graduates.

Analysis of the Co-Authorship Network

Co-authorship analysis was conducted to identify collaboration patterns among authors in the analyzed publications. Each node represents an author, whereas each link indicates a collaborative relationship between authors. Eliza, Fivia and Yanto, Doni Tri Putra exhibited the highest degree of collaboration, highlighting their roles as the most central authors within the co-authorship network. The VOSviewer co-authorship network analysis identified three major author clusters, representing distinct collaboration patterns among the analyzed publications. These clusters are distinguished by different colors—red, green, and blue—reflecting varying levels and characteristics of scientific collaboration. The co-authorship network is presented in Figure 5.

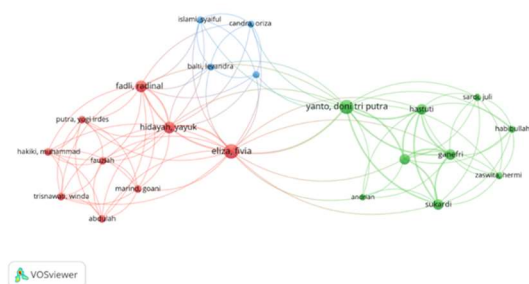


Figure 5. Co-Authorship Network Analysis

CONCLUSIONS AND SUGGESTIONS

Conclusion

Based on the findings and discussion, it can be concluded that research on the use of digital learning media in Technical and Vocational Education and Training (TVET) experienced substantial growth during the 2016–2026 period. The highest publication output was recorded in 2025, with a total of 16 publications. In terms of author productivity, Fivia Eliza and Doni Tri Putra Yanto emerged as the most prolific authors in the field of digital learning media in TVET. Meanwhile, the most highly cited publication was the article by Hariyanto, entitled “Usability Evaluation of Personalized Adaptive E-Learning System Using USE Questionnaire,” which received 56 citations.

The keyword network visualization analysis identified six research clusters, with the largest cluster comprising eight keyword items. Furthermore, the overlay visualization analysis revealed that recent research trends have increasingly focused on the integration of augmented reality into Technical and Vocational Education and Training (TVET), the development of virtual laboratories, the application of Cognitive Load Theory (CLT),

and the use of the ADDIE instructional design model for the development of digital learning media.

Suggestion

Future research is recommended to broaden the scope of analysis by comparing findings derived from the Dimensions database with those obtained from other major databases, such as Scopus and Web of Science, in order to enhance the validity and comprehensiveness of the data. In addition, the combined use of bibliometric analysis software, such as VOSviewer and CiteSpace, is recommended to provide more comprehensive visualizations of collaboration networks, co-citation networks, and keyword co-occurrence patterns. Future studies may also integrate bibliometric analysis with a Systematic Literature Review (SLR) to achieve a more comprehensive interpretation of research trends in the use of digital learning media within Technical and Vocational Education and Training (TVET).

Overall, the findings indicate substantial opportunities for future research on the integration of Artificial Intelligence (AI) into digital learning media in Technical and Vocational Education and Training (TVET). Accordingly, this topic is recommended as a key direction for future research.

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