

Exploring Digital Media Research in Vocational Education: A Bibliometric Analysis from Scopus Database

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Abstract: - Rapid technological improvements present both opportunities and difficulties for teaching and learning, elevating digital media to the forefront of vocational education discussions. This study investigates the evolution of digital media research in vocational education to determine its impact on current and future educational practices. The Scopus database was used to conduct a bibliometric analysis of 28 publications published between 2005 and 2024. Despite rare oscillations, the main research trend is steadily increasing, particularly after 2020. The analysis identified four key research areas: (1) innovative digital learning via virtual reality, simulation, and e-learning platforms; (2) technological adaptation and teacher preparedness; (3) industry relevance and employability enhancement; and (4) inclusive and ethical digital transformation. Co-authorship and keyword network studies show that developing nations have contributed very little to this field's research, which is still largely regional in scope. The focus of recent research has switched to data analytics, immersive learning, and artificial intelligence (AI)-driven personalization, which reflects the intersection of emerging technologies and digital pedagogy. This paper proposes the Digital Media Integration Framework for Vocational Education Transformation, which links digital media platforms, AI integration, pedagogical innovation, and institutional preparation, based on the findings presented. The findings highlight the need for inclusive, interdisciplinary, and policy-supported strategies to assist the digital transformation of vocational learning and provide valuable insights about how digital media is changing in Technical and Vocational Education and Training (TVET).

Key-Words: - artificial intelligence, bibliometric analysis, digital media, digital transformation, immersive learning, GCHIP, TVET, vocational education.

Received: March 25, 2026. Revised: May 14, 2026. Accepted: June 15, 2026. Published: October 1, 2026.

1 Introduction

Digital media refers to the medium of information, such as texts, images, animations, and videos, that

emphasizes the characteristics of digital communication and information through modern [1]. Digital media technology shows strong

inclusivity of information and innovation in its processing. In terms of vocational education, digital media has the potential to significantly improve the level of teaching and diversify teaching techniques in modern educational environments, especially online [2], [3], [4]. In addition, digital media significantly impacts equality and participation in education and social life, particularly in the provision of education for disabled people with disabilities [5].

Advances in technology and information have progressed rapidly over the years, with digital media and social media becoming almost an integral part of human life, both for personal and professional purposes. Currently, there are 5.61 billion users of digital media worldwide [6] that include a range of social networking platforms, instant messaging applications, and video conferencing platforms accessed through the use of technology such as cell phones, tablets, and computer devices [7], [8]. However, existing research on digital media and employment rarely focuses on young generations in the field of vocational education [9]. Therefore, systems and curricula for vocational education must comprehensively consider the implementation of new technologies to ensure the availability of up-to-date and extensive knowledge.

Bibliometrics is an online tool developed and openly visualized using RStudio as a computing methodology to identify contributions to significant research and authorship as well as their connection within a specific field or topic [10], [11], [12]. By carrying out analysis of digital media in vocational education using structured and measurable bibliometric data, it will be possible to understand the development of specific and relevant topics, author central, contributing countries, research concentrations/foci, and past and present trends [13], [14], which will ultimately help academics and practitioners in more effective direct field studies [15], [16].

Bibliometric analysis is a superior statistical analysis of literature, with computing index, analysis networks, and image maps of data that are more objective and reliable as well as support the Web of Science (WoS) and Scopus databases [17], [18], [19], [20]. This makes it possible to search for publications on digital media in vocational education to examine the development of research on related topics. Such analysis enables: 1) the observation of publication trends over time; 2) the identification of key contributors; and 3) the evaluation of their impacts and relevance. With the increasing number of academic articles published each year, it becomes more challenging to keep up

with research developments in certain fields [10], [21]. The findings of this study offer broad perspectives and recommendations on the current state of digital media research in vocational education worldwide.

2 Problem Formulation

This study uses data taken from the Scopus database to map publications in the field of digital media in vocational education at the international level, with the following search query:

TITLE-ABS-KEY ("digital media", "vocational education")

Analysis was carried out on 26 articles about digital media in vocational education from 2015 to 2024. Data were exported from Scopus and analyzed using the Bibliometrix R package (Biblioshiny).

3 Problem Solution

The bibliometric analysis in this study utilized the R software with metadata sourced from Scopus. The overall analysis results are presented in Table 1.

Table 1. Main information in the articles

Description	Results
Timespan	2015:2024
Sources (Journals, Books, etc)	23
Documents	26
Author	158
Annual Growth Rate %	19.58%
Document Average Age	4.19
Average citations per doc	4.308

Source: created by the authors

According to data on existing research from 2015 to 2024 (Table 1), global research production related to digital media in vocational education has proliferated in the last decade, with an annual growth rate of 19.58%. Over that time, 158 authors have produced a total of 26 pieces. Additionally, the average number of citations per document was 4.308, and the average age of the documents examined in this study was 4.19 years. In addition, 738 references were cited in all documents. This large number of references shows the great efforts made by researchers to refer to relevant and reliable literary sources on the topic of digital media in vocational education.

Annual scientific production refers to the number of scientific articles published each year [22]. Data

on the annual scientific production is presented in Figure 1.

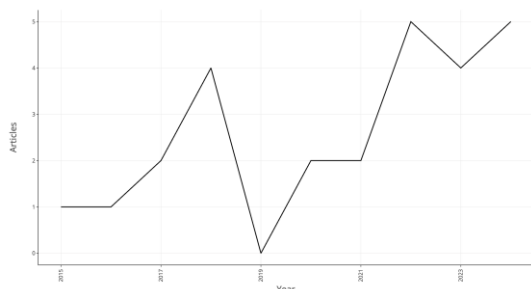


Fig. 1: Annual Scientific Production
Source: created by the authors

Figure 1 shows that the first research on digital media in vocational education was conducted in 2015. But in 2019, there were no academic publications on this topic, which made the graph clearly decline. The quantity of publications on digital media in vocational education began to increase between 2020 and 2024; however, this trend was unpredictable. Because there was just one paper published in 2023 vs the previous year, the graph slopes dramatically.

3.1 Co-Authorship Analysis

Co-authorship analysis is an approach used to see the connection between authors in a scientific publication. The pattern of collaboration between authors can reflect the level of interaction, knowledge exchange, and synergy formed in the research process. This cooperation can occur at various levels, ranging from collaboration within one institution, across disciplines, to between countries. With this collaboration, researchers have the opportunity to strengthen the quality of research, expand academic networks, and produce more innovative findings. Through co-authorship analysis, collaborative relationships can be mapped that show the dynamics and direction of development of a field of research.

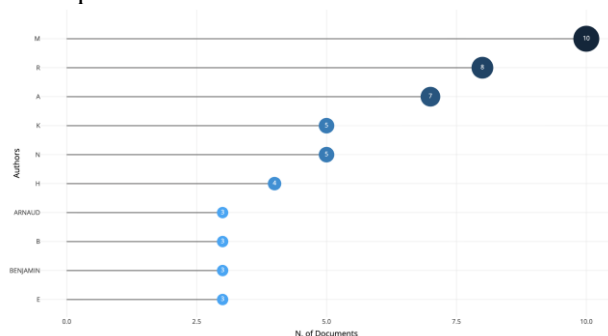


Fig. 2: Top Author by Number of Documents
Source: created by the authors

Figure 2 shows a list of the top 10 authors based on the number of articles written. M is the author who has the most articles on this topic, with a total of 10 articles. The next step was followed by R writing 8 articles. And then A wrote 2 articles. K and N have 5 articles, and H has 4 articles. Arnaud, B, Benjamin, and E each have 3 articles. Networks or connectivity are also analyzed in this section. As a result, several authors are interconnected and have a relationship in their research.

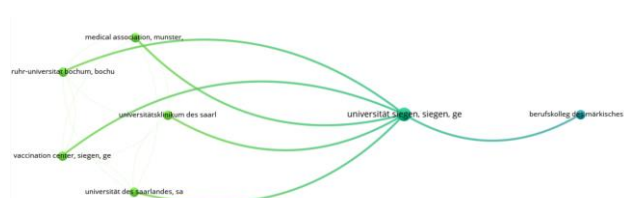


Fig. 3: Affiliation Network
Source: created by the authors

The co-authorship collaboration map in the Figure 3 shows the connections between institutions/organizations that contribute to research-related scientific publications. It is seen that Universität Siegen, Siegen, GE is the main center of collaboration, with an extensive and intensive network with various other institutions such as the Medical Association, Münster, Ruhr-Universität Bochum, Bochum, Universitätsklinikum des Saarl, Vaccination Center, Siegen, GE, as well as Universität des Saarlandes, SA. In addition, there is also the involvement of a vocational education institution, namely Berufskolleg des Märkisches, which adds a dimension of cooperation across levels of education. The thickness of the lines between the nodes in the map indicates the frequency and strength of collaboration, where the most dominant collaboration is seen to be directed to the research center at Universität Siegen. This pattern illustrates that the research that develops is not only at the university level, but also involves hospitals, vaccination centers, medical associations, and vocational institutions, which reflects the multidisciplinary nature of digital media research in vocational education.

Based on the results of this mapping, it can be concluded that Universität Siegen plays a central role in the network of research collaborations, as well as being the main link between institutions in different fields. The dominance of the role of the university shows the existence of a strong research capacity and the ability to build cross-institutional cooperation. The involvement of medical institutions, vaccination centers, and vocational schools indicates that research related to digital

media and vocational education has wide relevance, involving the perspective of health, higher education, and vocational education. Thus, this pattern of collaboration not only enriches the quality of research, but also expands the scope of its use in a multidisciplinary context.

3.2 Citation Analysis

A publication's impact on the scientific community is evaluated through citation analysis. The text with the most citations is typically regarded as a significant source that provides a basis or starting point for further investigation. The publications that academics from various nations most regularly cite are the most widely cited globally, indicating the significance and relevance of the work to the advancement of research. The identification of important books that significantly influence the advancement of study in particular subjects is made possible by this strategy. In this study, Table 2 presents a list of documents that have the highest global citations and are the main reference in related studies.

Table 2. Most globally cited documents

Paper	DOI	Total Cit.	TC per Year
FW, 2022, CHILDREN	10.3390/chil-dren9111724	33	8.25
RM, 2023, J. DENT. EDUC.	10.1002/jdd.13085	15	5.00
C, 2017, EUR. J. TRAIN. DEV.	10.1108/EJT-D-07-2016-0052	14	1.56
B, 2023, INT. J. ENVIRON. RES. PUBLIC HEALTH	10.3390/ijerp-h20031970	12	4.00
A, 2017, IEEE GLOB. ENG. EDUC. CONF. EDUCON	10.1109/EDUCON.2017.7942890	10	1.11
T, 2018, TECH. VOCAT. EDUC. TRAIN.	10.1007/978-3-319-73093-6_1	6	0.75
A, 2016, INDUSTRIA	10.1430/85405	4	0.40
Y, 2023, J. EDUC. E-LEARN. RES.	10.20448/jee-lr.v10i3.4668	3	1.00
N, 2022, TRIALS	10.1186/s13063-022-06231-x	3	0.75
A, 2024, Z. FUR SEX.	10.1055/a-2283-4009	2	1.00

Source: created by the authors

Table 2 lists the most frequently cited articles that are relevant to research on the topic of digital media and vocational education. The most influential article in this study was published by FW (2022) in the journal Children, with 33 citations total, an average of 8.25 citations per year, and a normalized citation count of 4.13. The Journal of Dental Education subsequently published 15 citations for RM (2023), while the European Journal of Training and Development published 14 citations for C (2017). Two further works with significant contributions are A (2017) at the IEEE Global Engineering Education Conference (10 citations) and B (2023) at the International Journal of Environmental Research and Public Health (12 citations). Since the publication is still relatively new, the article with the greatest normalized citation is A (2024) in the Zeitschrift für Sexualforschung, which has a value of 2.50 despite having just two citations. Overall, these findings indicate that while recently released publications have the potential to have a significant future influence, as indicated by the value of normalized citations, older documents often have a larger absolute citation count.

Table 3. Country scientific production

Region	Freq
Germany	54
China	5
Canada	3
Indonesia	3
Bulgaria	1
Chile	1
Hungary	1
Italy	1
Malta	1
New Zealand	1

Source: created by the authors

Table 3 shows that Germany has the largest number of publications on the topic of digital media in vocational education, with a total of 54 articles, indicating the significant contribution of researchers in this country. Meanwhile, only five scientific articles have been published in China. Other countries such as Canada, Indonesia, Bulgaria, Chile, Hungary, Italy, Malta, and New Zealand also contribute to scientific literature, although the numbers are not as large as those of Germany. These findings reflect the diversity of participation and contributions of different countries in the development of scientific knowledge. On the topic of digital media in vocational education, Germany remains the most dominant country with the largest number of publications. This shows Germany's

serious commitment as a global vocational education center.

Table 4. Authors' Production Over Time

Author	Title	DOI	T.C
M et al, 2022	PROBLEMATIC INTERNET USE AMONG ADOLESCENTS 18 MONTHS AFTER THE ONSET OF THE COVID-19 PANDEMIC	10.3390/children9111724	33
A, 2023	FACTOR ANALYSIS OF RISK PERCEPTIONS OF USING DIGITAL AND SOCIAL MEDIA IN DENTAL EDUCATION AND PROFESSION	10.1002/jdd.13085	15
M et al, 2023	EFFECTS OF AN APP-BASED INTERVENTION PROGRAM TO REDUCE SUBSTANCE USE, GAMBLING, AND DIGITAL MEDIA USE IN ADOLESCENTS AND YOUNG ADULTS: A MULTICENTER, CLUSTER-RANDOMIZED CONTROLLED TRIAL IN VOCATIONAL SCHOOLS IN GERMANY	10.3390/ijerph20031970	12
A, 2017	REQUIREMENTS ANALYSIS FOR THE DESIGN OF WORKPLACE-INTEGRATED LEARNING SCENARIOS WITH MOBILE DEVICES: MAPPING THE TERRITORY FOR LEARNING IN INDUSTRY 4.0	10.1109/EDUCON.2017.7942890	10
J, 2018	RECENT TECHNOLOGICAL CHALLENGES IN (VOCATIONAL) EDUCATION	10.1007/978-3-319-73093-6_1	6
A, 2016	TECHNOLOGY AND THE HUMAN FACTOR IN THE DIGITAL FACTORY; TECNOLOGIA E FATTORE UMANO NELLA FABBRICA DIGITALE	10.1430/85405	4
M et al, 2022	EFFECTIVENESS OF AN APP-BASED INTERVENTION TO REDUCE SUBSTANCE USE, GAMBLING, AND DIGITAL MEDIA USE IN VOCATIONAL SCHOOL STUDENTS: STUDY PROTOCOL FOR A RANDOMIZED CONTROLLED TRIAL	10.1186/s13063-022-06231-x	3
M et al, 2024	MOBILE APP INTERVENTION TO	10.2196/5130	2

Author	Title	DOI	T.C
	REDUCE SUBSTANCE USE, GAMBLING, AND DIGITAL MEDIA USE IN VOCATIONAL SCHOOL STUDENTS: EXPLORATORY ANALYSIS OF THE INTERVENTION ARM OF A RANDOMIZED CONTROLLED TRIAL	7	

Source: created by the authors

Authors' production over time refers to the analysis of authors' results or productivity in terms of publication activities over various periods. [23] Table 4 shows a list of publications that are important references in research related to digital media and vocational education. The article with the highest number of citations is the work of M et al. (2022) titled Problematic Internet Use among Adolescents 18 Months after the Onset of the COVID-19 Pandemic, published in Children, with a total of 33 citations and an average of 8.25 citations per year. Another publication with a fairly high number of citations is A (2023), which discusses the analysis of risk perception factors for the use of digital media in dental education, obtaining 15 citations with an average of 5 citations per year. Furthermore, M et al. (2023) on application-based interventions to reduce the use of addictive substances, gambling, and digital media among vocational students in Germany obtained 12 citations with an average of 4 citations per year. A classic article that is also quite influential is A (2017) related to the analysis of needs in mobile-based learning design in the Industrial Era 4.0, with 10 citations. In contrast, more recent studies on mobile application interventions in vocational students, like M et al. (2024), have only received two citations, despite having a comparatively high average annual citation count (1), suggesting their possible long-term influence. All things considered, this data demonstrates that the use of digital media, application-based interventions, and technological difficulties in vocational education are significant issues in the international literature.

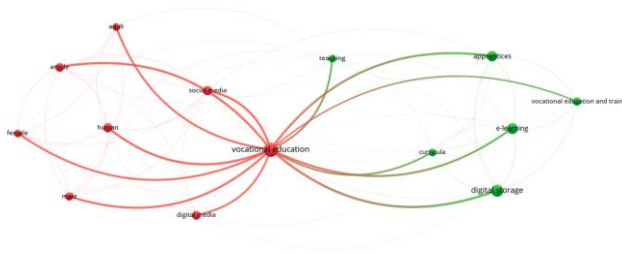
3.3 Keyword Co-Occurrence Analysis

In this study, data were then visualized in the form of WordCloud and co-occurrence networks. WordCloud is a representative technique for analyzing unstructured text data for visualization and analysis purposes [24]. In WordCloud, more frequently mentioned words in the text appear larger and more prominent, while less frequently mentioned words appear smaller. In the context of

play an important role in the formation of artificial intelligence literacy (AI literacy), which has an impact on access and use of technology in vocational education institutions. Meanwhile, another study by [26] confirms that social contexts such as the digital gap between regions and gender are still fundamental issues that affect the equitable distribution of technology use in vocational education in Indonesia.



Furthermore, the relationship between "social media" and "digital media" shows that digital media is now the main means in the vocational learning process. According to research conducted by [27], digital literacy has a significant positive relationship with the learning outcomes of vocational school students because it increases adaptability and access to online learning resources. This shows that the role of social media and digital platforms is not only as a communication tool, but also as a collaborative learning vehicle that strengthens students' competencies in the digital era.



In contrast, the green cluster in the visualization gives rise to keywords such as "teaching," "curricula," "apprentices," "e-learning," and "digital storage," which reflect the research orientation towards technology development and learning innovation in vocational education. The "apprentices" node signifies the importance of apprenticeships and work-based learning in the vocational education system. A study by [28] shows that the application of a webcast-based smart learning model is able to increase the flexibility and effectiveness of practical learning in vocational institutions. In this context, e-learning and digital storage are symbols of modern learning infrastructure that allows knowledge transfer across time and location, while supporting vocational education systems that are more open and adaptive to industrial changes.

The relationship between social and technological clusters in the visualization also shows interesting dynamics. The connecting line between the two clusters indicates that vocational education research is increasingly moving towards integration between social and technological dimensions. For example, topics about adult learning and digital literacy are now often associated with AI-based adaptive learning or online platforms. This means that technology is not only a technical tool, but also serves as a link between social experience and the learning process. This is in line with the findings of [29], who revealed that AI research trends in vocational education are starting to shift from technology development to the use of

AI to support social engagement, personalization, and continuous learning.

However, from this visualization, it can also be seen that there are research areas that are still underdeveloped. Nodes such as "ethics," "AI readiness," "inclusivity," and "employability" have not yet appeared prominently, even though these themes are increasingly relevant in the context of sustainable and equitable vocational education development. The study by [30] reveals that the primary obstacles that must be incorporated into research and use of AI in the education sector, particularly vocational education, are ethical issues, algorithmic justice, and data bias. Overall, the duality present in the evolution of contemporary vocational education is reflected in this keyword network map: on the one hand, it is focused on curriculum and technology innovation, while on the other, it stresses social values, inclusion, and humanity in the educational process.

4 Conclusion

Digital media is a crucial and dynamic topic that follows developments in science and technology. Vocational education, which operates in the field of education and training, has a strong attachment to the use of digital media. Vocational education is essential to produce work-ready graduates who have considerable knowledge and skills needed by global industry in accordance with current and future conditions. In the learning process, vocational education cannot rely solely on traditional methods, thus requiring long-term research and analysis to predict the need for new skills in the future.

The findings of this bibliometric study empirically show that the integration of digital media has a central role in transforming vocational education towards an adaptive and technology-based learning ecosystem. Based on the results of the concept connectedness analysis visualized in Figure 6, it was found that "digital media" serves as the main axis that connects three key dimensions namely AI Integration, Pedagogical Innovation, and Institutional Readiness. These findings confirm that the use of digital media is not only limited to learning aids, but also as a catalyst that drives systemic changes in vocational education, both in terms of curriculum, teaching strategies, and institutional management.

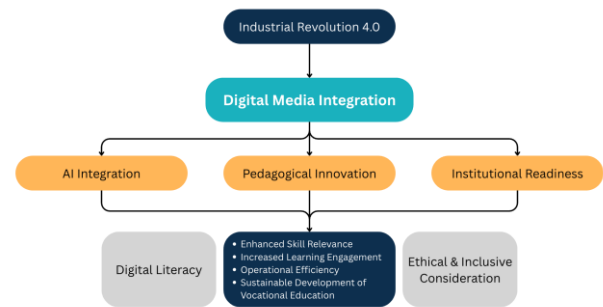


Fig. 6: Framework for Vocational Education Transformation

Source: created by the authors

The application of artificial intelligence and digital media is able to create learning that is more personalized, efficient, and relevant to the needs of modern industry. In the context of AI integration, the findings indicate a rise in interest in studies that highlight the application of AI for learning data analysis to support evidence-based decision-making, assessment automation, and learning personalization. However, the Pedagogical Innovation dimension demonstrates how the use of digital media is propelling the development of new learning models that enhance students' practical skills, like project-based learning, simulation-based learning, and virtual reality training.

In order to ensure the durability of digital transformation, the Institutional Readiness component highlights the significance of institutional readiness through bolstering policies, infrastructure, and teacher preparation. Adoption of digital technologies may be inconsistent and only temporary in the absence of significant institutional support. According to this paradigm, digital literacy is a reinforcing factor that guarantees teachers' and students' ability to use technology as effectively as possible. However, in order to guarantee that the integration of digital technology and AI continues to uphold the inclusion principle, ethical and inclusive considerations are crucial, particularly when it comes to vocational education for students with special needs.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process The authors wrote, reviewed and edited the content as needed and they have not utilised artificial intelligence (AI) tools. The authors take full responsibility for the content of the publication.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

All authors contributed substantially to the development of this scientific article. The authors were involved in the conceptualization of the research, methodology development, data analysis, interpretation of findings, manuscript preparation, and critical revision of the final version. All authors have read and approved the final manuscript.

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. The study was conducted using the authors' own resources.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article. The authors have no financial, personal, or professional relationships that could have influenced the research process or the interpretation of the findings.

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