Shaping the Future: Bibliometric Insights on Teaching Strategies in Vocational Education

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ABSTRACT

This bibliometric study analyzes teaching strategies in vocational education from 2015 to 2024, focusing on research trends, interdisciplinary approaches, and technological advancements to enhance workforce readiness. Using Scopus as the primary database, 164 articles were analyzed with VOSviewer to map co-citation and co-occurrence patterns, identifying thematic trends and key scholarly areas. The findings show significant growth in research output, particularly in 2024, driven by global efforts to align vocational education with technological and industry needs. Key themes include problem-based learning, student-centered strategies, and the integration of digital tools such as e-learning and augmented reality to replicate real-world environments. Social sciences, computer science, and engineering dominate research in vocational education, while foundational fields like mathematics remain underrepresented, highlighting missed opportunities for interdisciplinary enrichment. Global disparities in research contributions reveal the United States and Germany as leaders with robust dual education systems while emerging contributors like Malaysia and Indonesia show potential through targeted investments. Challenges persist in leadership development, emotional engagement, and equitable access to digital tools. Addressing these gaps requires interdisciplinary collaboration, educator professional development, and inclusive practices. By focusing on these areas, vocational education can transform into a dynamic system, equipping learners with technical skills, emotional resilience, and adaptability to drive societal progress and economic sustainability.

Keywords: Vocational Education, Teaching Strategies, Technological Integration, Bibliometric Analysis, Interdisciplinary Collaboration

INTRODUCTION

The evolution of education as a field reflects a persistent quest to enhance learning outcomes, address dynamic workforce demands, and integrate technological innovations into pedagogical practices. Within this transformative landscape, teaching strategies and vocational education emerge as pivotal components, uniquely positioned to bridge academic theory with real-world applications. The essential role of education in promoting society development is shown by it's capacity to adapt depending on shifts in economic priorities, technological progress, and global issues. Teaching strategies underpin the effectiveness of education systems, serving as the conduit through which knowledge is imparted, skills are cultivated and critical thinking is

fostered. Contemporary research underscores the growing importance of adaptive and student-centered pedagogical approaches, particularly in vocational education. This subset of education, dedicated to equipping learners with practical and industry-relevant skills, has increasingly integrated problem-based learning, cooperative strategies, and technology-enhanced tools to align with evolving workforce needs (Tlili et al., 2024). Such innovations prepare students for immediate employment and cultivate resilience and adaptability in an ever-changing professional landscape. Vocational education's significance extends beyond individual learners to encompass broader socio-economic impacts. By aligning curricula with market demands, it addresses critical gaps in workforce readiness and economic disparities. Researchers like Álvarez-Nieto et al., (2022) and Mahendru et al., (2024) emphasize the role of dual education systems, which combine classroom instruction with hands-on industry training in fostering a deeper understanding of professional contexts. Furthermore, the incorporation of advanced technologies such augmented reality and artificial intelligence into vocational training signifies a shift towards immersive and tailored learning experiences that reflect real-world obstacles. While the field has made substantial progress, challenges persist. Cultural inclusivity, equitable access to technological resources, and the long-term effectiveness of innovative teaching methodologies remain underexplored. Addressing these gaps necessitates an interdisciplinary approach that blends technological advancements, pedagogical frameworks, and cultural awareness. Future research must aim to bridge these divides, ensuring that vocational education not only meets current demands but also anticipates future workforce trends. This article explores the interplay between teaching strategies and vocational education, emphasizing their collective potential to redefine learning and workforce readiness. By critically examining emerging trends, challenges, and opportunities within this nexus, it seeks to contribute to the discourse on how education can adapt to and shape an increasingly complex and interconnected world.

LITERATURE REVIEW

The field of education continuously evolves, driven by innovative research aimed at enhancing learning outcomes, adapting to technological advancements, and addressing the needs of diverse learner populations. Quality assurance remains a cornerstone in the pursuit of excellence in education. Significant pedagogical philosophies and teaching styles have influenced the development of vocational education. Dewey (2002) underscored experiential learning, promoting practical, real-world applications to connect theory and practice. Kolb (2005) presented the reflective learning paradigm, emphasizing the significance of active participation and adaptability in skill acquisition. Merriam and Caffarella (2007) concentrated on adult learning theories, emphasizing self-directed learning and practical problem-solving. Cabreros & Barbacena (2024) propose a management framework for technical education that emphasizes aligning curriculum design with industry requirements. Their findings highlight the significance of robust evaluative systems in maintaining educational standards. Similarly, Popova, (2024) delves into vocational education, offering a nuanced understanding of modern didactics. Her work underscores adapting traditional pedagogical strategies to meet contemporary educational demands, focusing on practical applications in professional education. Furthermore, Engström & Blom (2024) highlight the importance of "technical science capital" in STEM education, emphasizing the integration of interactive digital tools to foster engagement and skill development. These fundamental methodologies persist in shaping vocational education, guaranteeing that learners acquire practical skills, flexibility, and lifelong learning competences following workforce requirements.

Majid et al., (2024) emphasize cooperative learning and problem-based approaches as effective means of engaging students and enhancing critical thinking skills. Similarly,Shamseieh & Mousa, (2024) explore innovative pedagogical techniques using virtual reality. Their research illustrates how immersive learning environments could be linked theoretical knowledge with practical skills.Studies by Wulansari et al., (2024) further emphasize the role of gamification in engaging learners, particularly in vocational education settings, where experiential learning is critical. Additionally,Wang & Yang, (2022) discuss adaptive teaching methods tailored to individual learner profiles, which are increasingly recognized as crucial in fostering student engagement and academic success. Vocational education is a prominent issue, with academics emphasizing its significance in connecting education and work. Noguera et al., (2024) advocate for modernized vocational strategies that focus on industry alignment and skill relevance. In another significant contribution, Khazaie & Derakhshan, (2024) analyze the integration of dual education systems, which combine classroom learning with hands-on industry training. Their findings indicate that dual systems not only enhance employability but also

foster a deeper understanding of professional contexts. Meanwhile, Okolie et al., (2020) explore vocational education's potential to reduce socio-economic disparities by providing equitable access to market-aligned skills training. Research on employability centers around equipping students with skills aligned to market demands. Sappar et al., (2024) emphasize the role of transferable skills and academia-industry collaboration identifies key strategies for bridging skill gaps, a critical challenge in vocational education. Mulders (2022) explores virtual reality's impact on skill development and reveals that immersive technologies provide unique opportunities for practical learning, significantly enhancing the skill acquisition process. In addition, Smith & Jones (2003) introduced competency-based learning models, prioritizing skill mastery rather than time-based training. Johnson (2010) called for curricula linked with workforce needs, emphasizing engagement with industry to guarantee the learning of job-specific skills. Taylor (2015) examined the integration of digital tools, emphasizing the significance of Learning Management Systems, virtual simulations, and AI-enhanced training in improving vocational education. Collectively, these innovations enhance contemporary vocational training by guaranteeing proficiency, industry pertinence, and technological flexibility.

Meanwhile, Zhao & Ko (2024) further discuss how collaborative projects between academia and industry can nurture graduates who are better prepared for dynamic professional environments. The reviewed studies collectively emphasize the interplay between quality assurance, teaching strategies, vocational education, employability, and technology integration. However, gaps remain in addressing cultural inclusivity and the long-term impact of technological interventions. Future research should explore interdisciplinary approaches that blend technological, pedagogical, and cultural perspectives to create inclusive and sustainable educational frameworks. Furthermore, longitudinal studies assessing the effectiveness of educational strategies over time would provide deeper insights into their practicality and scalability.

The recent advancements in educational research provide a solid foundation for enhancing learning outcomes and preparing students for future challenges. By addressing existing gaps and fostering collaboration across disciplines, education can continue to evolve as a dynamic and inclusive field. As highlighted by all the scholars, the continued focus on adaptive and innovative practices will shape a more equitable and impactful educational landscape.

Objectives

This bibliometric study focused primarily on the following questions:

1. What drives fluctuations in research publication trends from 2015 to 2024?
2. How do disciplinary trends in research publications reflect global priorities, and what strategies can promote balanced and interdisciplinary academic progress?
3. How can research balance dominant fields with underrepresented disciplines to foster equity and interdisciplinarity?
4. How can teaching strategies in vocational education integrate technology, leadership, and motivation to enhance student engagement and workforce readiness?
5. How can interdisciplinary approaches and emerging innovations in teaching strategies enhance the effectiveness of vocational education?
6. How can teaching strategies in vocational education be optimized to integrate technology, enhance student-centered learning, and align with industry demands?

METHODOLOGY

The process of merging, structuring, and evaluating bibliographic data from scientific literature is referred to as bibliometrics (A. Verbeek et al., 2002; Deli et al., 2024; Gusenbauer & Gauster, 2025).In addition to general

descriptive statistics like the principal author classification, publication year, and publishing journals. It also includes sophisticated methods like document co-citation analysis (Wu & Wu, 2017). A comprehensive bibliography and trustworthy outcomes necessitate an iterative process in a good literature review, which involves selecting pertinent keywords, performing a literature search, and executing a detailed analysis (Jusoh & Ishak, 2024a). The study focused on recognized papers, as they offer significant insights into the theoretical perspectives shaping the discipline. Data was collected from the SCOPUS database to ensure reliability.(Amarathunga, 2024; Tomaszewski, 2023). Additionally, books and lecture notes were purposefully excluded in order to guarantee the inclusion of high-quality publications; only articles published in academic journals that undergo rigorous peer review were taken into consideration (Appio et al., 2014). Notably, Elsevier's Scopus, recognized for its extensive coverage, facilitated the collection of papers from 2015 to December 2024 for subsequent analysis.

Data Search Strategy

A screening sequence was used in the study to identify the search phrases for retrieving articles. The study was started by using an online query to search the Scopus database TITLE ("teaching strategy" OR "instructional approach" OR "pedagogical method" OR "educational technique" OR "learning methodology" OR "teaching methodology" OR "instructional design" OR "educational strategy" OR "learning strategy" OR "pedagogical approach" OR "educational framework") AND ("vocational education" OR "technical education" OR "career and technical education" OR "skills training" OR "workforce education" OR "professional education" OR "job training programs" OR "occupational training" OR "career education" OR "employment-oriented education" OR "trade education") thereby assembling 1308 articles. The results were then reduced to 244 articles when the query was honed to concentrate on particular study genres, such as conference papers, book chapters, and articles. Only research articles written in English and in the final stages of publication within the last 10 years were included in this further filter. Ultimately, a total number of 164 articles was identified for 10 years, from 2015 to 2024. The study covered every publication on the teaching strategy and vocational education found in the Scopus database as of December 2024. These 10 years were chosen in order to provide reliable data on research trends about vocational education and teaching strategy. (Rogers et al., 2020)stated that the use of fewer than 200 papers in bibliometric analysis results in higher variance in quantitative metrics such as the Category Normalized Citation Impact (CNCI), such sample sizes are considered analytically viable for qualitative reviews or exploratory bibliometric studies. These smaller samples can provide meaningful insights when the focus is not on precise quantitative representation but rather on indicative trends or targeted analysis.

Table 1:The search string.

Scopus	TITLE ("teaching strategy" OR "instructional approach" OR "pedagogical method" OR "educational technique" OR "learning methodology" OR "teaching methodology" OR "instructional design" OR "educational strategy" OR "learning strategy" OR "pedagogical approach" OR "educational framework") AND ("vocational education" OR "technical education" OR "career and technical education" OR "skills training" OR "workforce education" OR "professional education" OR "job training programs" OR "occupational training" OR "career education" OR "employment-oriented education" OR "trade education")

Table 2: The selection criterion is searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Time line	2015 – 2024	< 2015
Literature type	Journal (Article) and Proceeding	Review,Note,Short Survey,Erratum

Source: Moher et al., (2009)

Data Analysis

The user-friendly bibliometric program VOSviewer was created by Nees Jan van Eck and Ludo Waltman of Leiden University in the Netherlands(N.J.Van Eck & L.Waltman, 2017, 2010). The application which is widely used for studying and presenting scientific literature, is excellent at producing network visualizations, density maps, and other clusters that are easy to use. Its adaptability gives scholars a thorough grasp of research landscapes by enabling them to examine co-authorship, co-citation, and keyword co-occurrence networks. Dynamic and effective analysis of big datasets is ensured via an interactive interface and regular updates. Scholars looking for insights into challenging study topics might benefit from VOSviewer's ability to compute metrics, build visualizations, and interface with a variety of bibliometric data sources.

VOSviewer is a well-known tool for turning complex bibliometric data into easily understood visual representations, such as maps and charts. Known for its capacity to generate density maps, examine keyword co-occurrence patterns, and group related items, the software is a master at network visualization. Its intuitive design appeals to both new and experienced researchers, allowing for a thorough investigation of research landscapes. Ongoing updates ensure that VOSviewer remains a leader in bibliometric analysis, offering dependable measurements and configurable display capabilities. Its versatility in handling many bibliometric data types, such as co-authorship and citation networks, renders it an indispensable resource for scholars seeking to enhance their comprehension of academic disciplines.

A dataset comprising publication year, title, author names, journal names, references, and keywords in plain text format has been extracted from the Scopus database for the period 2015 to 2024. This data has been analyzed using VOSviewer software version 1.6.19. VOSviewer is used to analyze and generate maps based on the VOS collection and mapping technique. It is an alternative to the Multidimensional Scaling (MDS) method) N.J.Van Eck & L.Waltman, (2010)and serves the same purpose as MDS, which is to arrange items in a low-dimensional space so that the relationships and similarities between items can be seen through distance (Appio et al., 2014). Unlike MDS, which emphasizes the calculation of similarity measures such as the Jaccard index and cosine, VOS uses more appropriate techniques to normalize the frequency of co-occurrences N.J Van Eck & L.Waltman, (2007), for example, the association strength (ASij) is calculated as follows:

$$ASij = \frac{1}{4}\frac{Cij}{\sqrt{WiWj}}$$

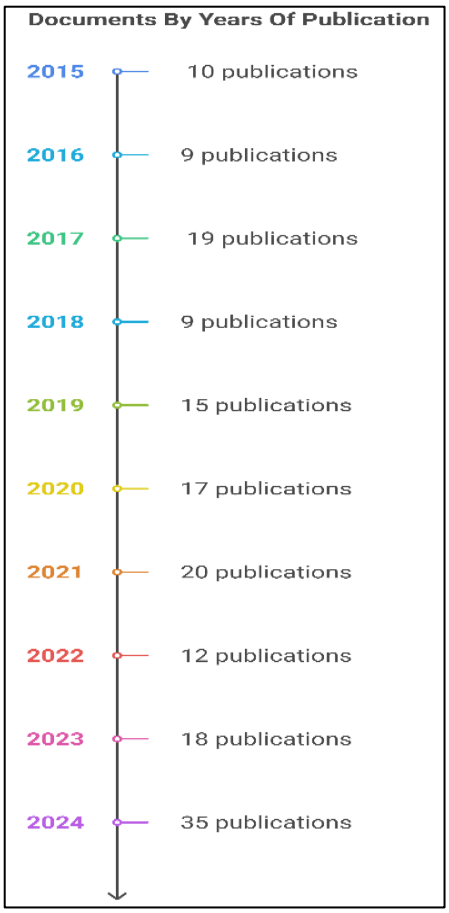
This index illustrates the ratio of the observed co-occurrences of i and j to the expected co-occurrences of i and j, under the assumption that the co-occurrences of i and j are independent statistics affecting parameters C and W (N.J.Van Eck & L.Waltman, 2010). Using this index, VOSviewer organizes objects into a map by minimizing the total of squared distances among all item pairs. LinLog/modularity normalization has been implemented (Appio et al., 2016). Additionally, employing visualization techniques via VOSviewer on the dataset has revealed patterns based on mathematical correlations, and analyses like keyword utilization, citation analysis, and author collaboration analysis have been performed. The evolution of research dimensions over a designated timeframe can be examined by keyword analysis by Z. Wang et al. (2018), which has effectively identified prevalent themes across multiple disciplines (Li et al., 2017). Bibliometric analysis is useful in detecting issues, trends, and essential research methodologies, while also examining the importance of the discipline's historical focus (Jusoh & Ishak, 2024b).Co-citation analysis or cross-referencing between authors contained in articles is one of the bibliometric methodologies frequently used(Appio et al., 2016; Fahimnia et al., 2015; Saad et al., 2024). The results depend on network theory to identify the data structure related to collaboration, institutions, and information about the authors (Al-Khoury et al., 2022).

ANALYSIS AND FINDING

Here are the study's conclusions and related remarks based on the research question:

What drives fluctuations in research publication trends from 2015 to 2024?

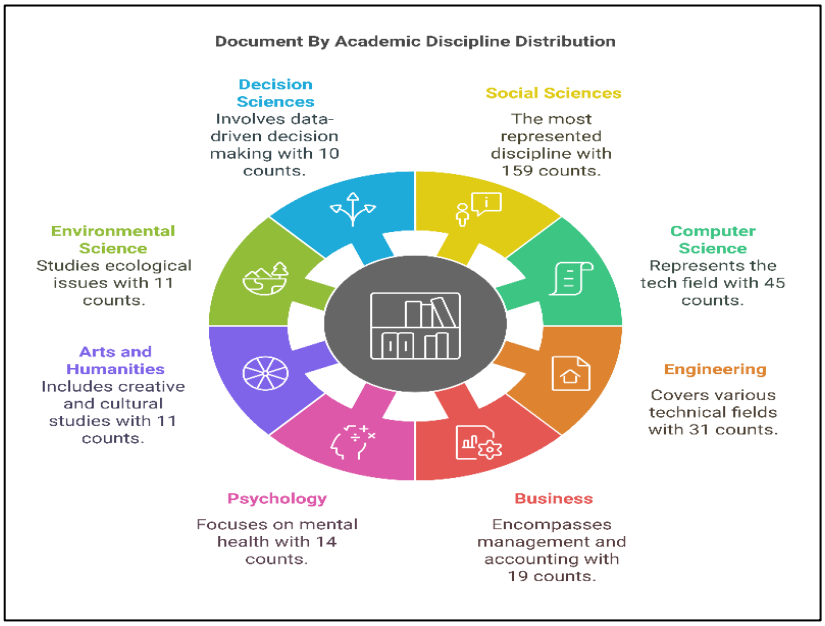
Figure 1: Document publication by years



Understanding the trends in research publications provides valuable insights into the progress and challenges of the global research ecosystem. This analysis highlights fluctuations in publication output over the past decade, revealing periods of growth, stagnation, and recovery. The significant rise in 2024 is particularly noteworthy, indicating a resurgence in scholarly activity. However, occasional declines emphasize the need for more adaptive and resilient systems.This discussion aims to explore these trends, draw meaningful conclusions, and provide practical recommendations to sustain research growth, enhance productivity, and ensure that academic contributions remain impactful and aligned with global priorities.The bibliometric findings extracted from the dataset provide meaningful insights into the temporal distribution of publications from 2015 to 2024. Analyzing this trajectory highlights significant trends that reflect both growth and fluctuation in scholarly output. Between 2015 and 2017, a clear upward trajectory is evident, with the quantity of publications rising from 10 in 2015 to 19 in 2017. This consistent growth may suggest intensified research activity, potentially influenced by emerging subjects or expanded funding opportunities during this timeframe. However, a notable decline occurs in 2018, where publication counts drop to 9. This dip could result from external factors, such as economic downturns or shifts in research priorities, but further investigation into these causes would enhance interpretation. From 2019 onward, a resurgence in publication numbers is observed, peaking in 2021 with 20 publications. This rebound may reflect the maturity of research programs initiated earlier or adaptive responses to previous challenges. Interestingly, the COVID-19 pandemic period (2020–2021) does not seem to disrupt publication activity significantly; instead, it aligns with stable or increased output. This phenomenon might suggest resilience in academic productivity, possibly through adaptations like remote collaborations or digital conferences.The subsequent drop in 2022 (12 publications) suggests a potential lag effect from prior challenges or a reallocation of resources to pandemic-related research, possibly diverting focus from other disciplines. However, 2023 and 2024 demonstrate another sharp increase, culminating in a dramatic rise to 35 publications in 2024. This significant surge could reflect a post-pandemic recovery, the fruition of long-term projects, or emerging research priorities, such as technological advancements or global challenges like climate change.

How do disciplinary trends in research publications reflect global priorities, and what strategies can promote balanced and interdisciplinary academic progress?

Figure 2: Academic Discipline in Teaching Strategy and Vocational Education Research



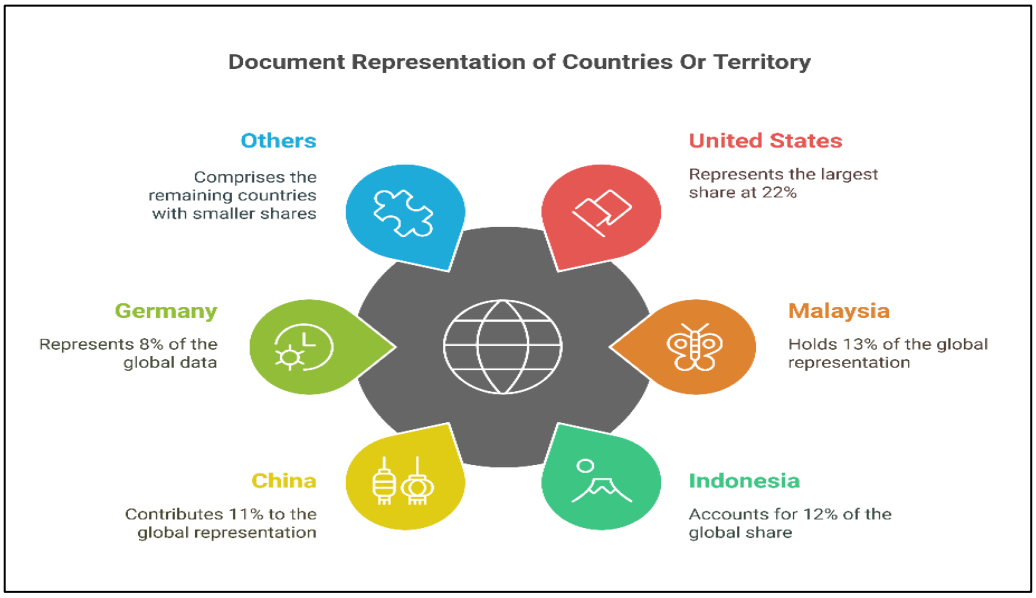
The distribution of research across academic disciplines offers a window into the intellectual priorities and focus areas shaping the academic landscape. By examining this distribution, we can gain insights into the dominant themes, emerging trends, and underrepresented fields within the dataset. This analysis seeks to understand the implications of these patterns and explore how they inform the direction of scholarly inquiry.The dominance of the Social Sciences, with 159 publications, highlights its central role in addressing critical societal issues and fostering interdisciplinary collaborations. This prominence likely reflects the pervasive applicability of social science methodologies in examining complex human-centered challenges, such as social policy, education, and behavioral studies. The field's ability to intersect with domains like psychology, business, and environmental science positions it as a cornerstone of contemporary research.With 45 publications, Computer Science stands as a testament to the growing reliance on technology and data-driven methodologies across disciplines. Its significance is evident in fields like artificial intelligence, machine learning, and computational modeling, which increasingly underpin advancements in medicine, engineering, and decision sciences. This prominence underscores the evolving landscape of research, where computational tools play a transformative role in solving complex problems.Engineering and Business, Management, and Accounting, contributing 31 and 19 publications respectively, reflect the practical orientation of research efforts toward solving technical challenges and optimizing organizational processes. Engineering's focus on innovation and technological advancements resonates with global priorities such as sustainability and infrastructure development, while the presence of business studies indicates a continued interest in understanding market dynamics, management strategies, and economic resilience.

Smaller contributions from disciplines like Psychology (14), Arts and Humanities (11), and Environmental Science (11) reveal the diversity of the research landscape. Psychology's focus on mental health and human behavior is especially relevant given global concerns about well-being. Similarly, arts and humanities provide critical perspectives on cultural, historical, and creative expressions, enriching the broader discourse. Environmental science's representation aligns with the increasing urgency of addressing ecological and climate-related challenges, reflecting the global shift toward sustainability. Fields such as Decision Sciences (10), Energy (8), and Medicine (7) exhibit targeted yet impactful research activity. Decision sciences emphasize the importance of data-driven approaches in business and technology, while energy and medicine address pressing needs in sustainability and public health. However, the limited representation of these fields may suggest niche research activity or a need for greater prioritization.The minimal contributions from disciplines like Mathematics, Economics, and the natural sciences, including Physics, Biochemistry, and Agricultural Sciences, raise important questions about the balance of research priorities. While these fields are

foundational to scientific and technological progress, their underrepresentation could reflect either concentrated specialization or gaps in resource allocation and funding.The analysis highlights the interdisciplinary nature of modern research, with a focus on social sciences, technology-driven fields, and applied disciplines. However, the lack of representation of foundational and natural sciences suggests opportunities for fostering diversity and balance in research priorities. Promoting interdisciplinary collaborations between dominant and underrepresented fields could lead to more holistic progress. Understanding the drivers behind dominant disciplines can guide strategic investments in emerging areas. Vocational education should integrate fields like engineering, business, computer science, and decision sciences to prepare learners for real-world challenges. Addressing underrepresented fields can broaden opportunities and diversify workforce skills.

How can research balance dominant fields with underrepresented disciplines to foster equity and interdisciplinarity?

Figure 3: Distribution of Document Representation by Country or Territory



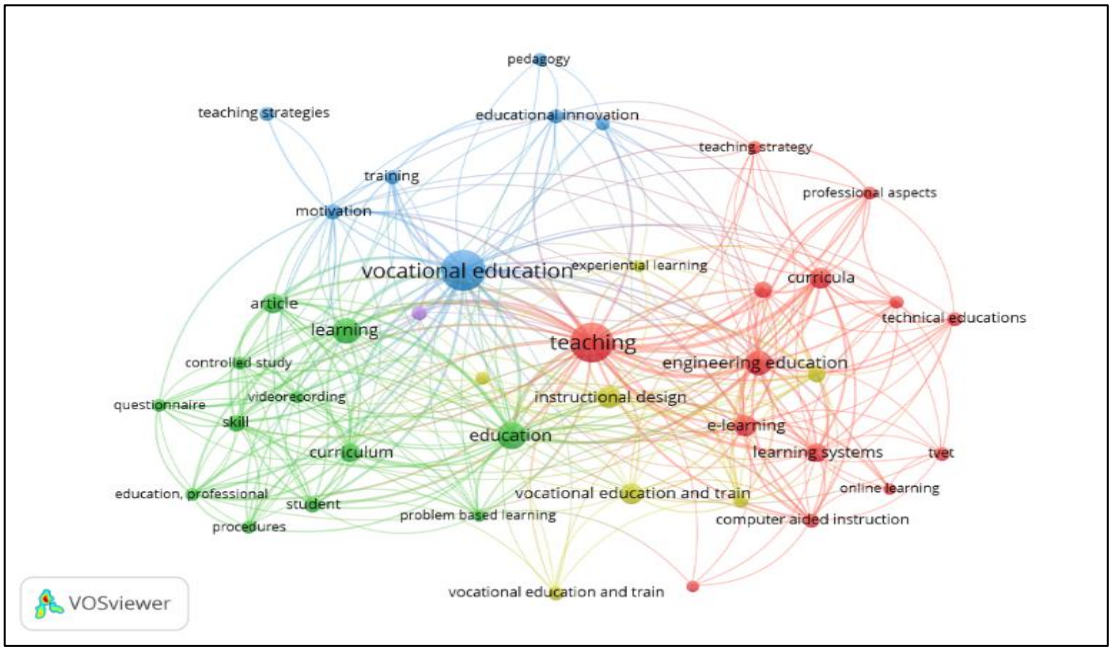
The global distribution of research contributions provides valuable insights into the dynamics of academic productivity and the disparities that exist across regions. By analyzing the representation of countries in research output, we can better understand the dominant players, emerging contributors, and the opportunities for fostering inclusivity in global academic collaboration.The United States, leading with 22% of the global share, reflects its robust integration of research with industry and education, particularly in applied and technical disciplines. This leadership is indicative of a system where vocational education plays a critical role in translating research advancements into workforce skills. Vocational programs in the United States benefit from access to cutting-edge research, enabling the alignment of curricula with emerging trends and industry demands. Similarly, Malaysia (13%) and Indonesia (12%) demonstrate the rising influence of Southeast Asia in academic research. These countries' representation highlights their efforts in aligning research with national development goals, where vocational education serves as a key driver for economic growth. By integrating research outputs into vocational training, Malaysia and Indonesia are equipping their workforce with the skills required for industries like technology, engineering, and environmental management. China (11%) continues to solidify its global academic standing through significant investments in research and innovation. The country's vocational education system, often linked to its research ecosystem, focuses on preparing a technically skilled workforce for its rapidly advancing industrial sectors. This alignment underscores the potential for vocational education to bridge academic knowledge and practical applications, contributing to global competitiveness.Germany, contributing 8%, reflects its well-established dual education system, which integrates vocational education with academic research. Germany's success in fostering innovation-driven industries is largely attributed to this system, where vocational education benefits from and supports academic advancements in engineering, applied sciences, and industrial solutions.The "Others" category, comprising 34%, represents a diverse group of countries with smaller shares in research output. These nations often rely

on vocational education to address local workforce needs, making it essential to strengthen the link between research and training.

Smaller countries can enhance their vocational education systems by fostering international collaboration and adopting best practices from leading nations, ensuring that research findings translate into practical skills.Vocational education is essential in connecting academic research with global workforce development. In nations with predominant research representation, like the US and Germany, it facilitates the swift application of innovations to industrial requirements. Emerging nations like Malaysia, Indonesia, and China leverage research outputs to build a technically skilled workforce. Smaller nations can strengthen their vocational education systems by engaging in global collaborations and adopting models that link research with workforce development. By fostering international collaboration and emphasizing equity in research and education, the global community can ensure vocational education continues to play a pivotal role in workforce challenges and economic development.

How can teaching strategies in vocational education integrate technology, leadership, and motivation to enhance student engagement and workforce readiness?

Figure 4: Network visualization map of co-occurance keywords

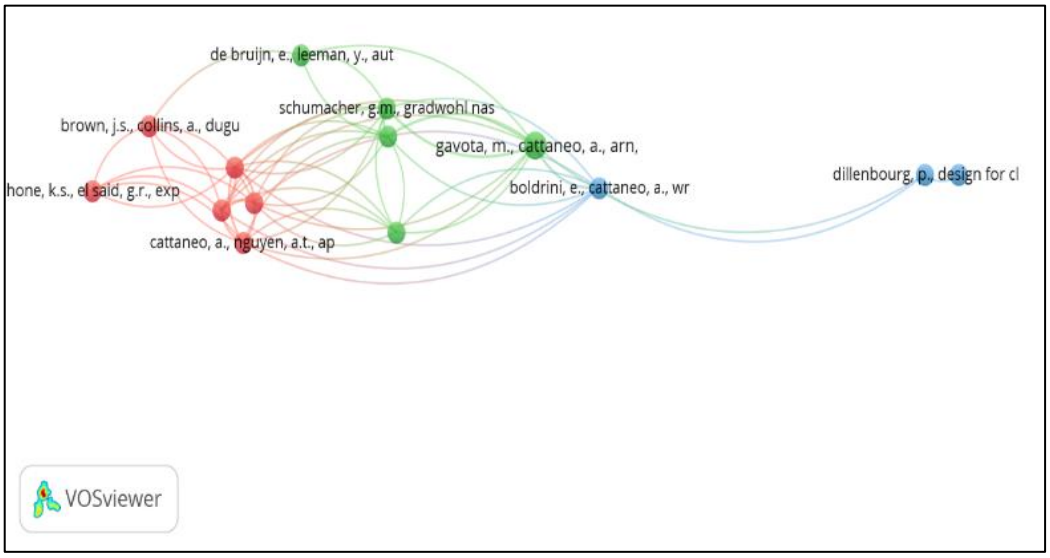


The analysis of keyword co-occurrence provides a comprehensive view of the thematic focus and emerging priorities within teaching strategies in vocational education. This examination not only highlights the foundational elements of pedagogy but also reveals areas for innovation and improvement to meet the evolving demands of the workforce. Teaching,vocational education, and learning emerge as the central pillars of research in this field, underscoring the foundational importance of pedagogy and skill development. These themes reflect a concerted effort to design teaching strategies that effectively combine theoretical knowledge with practical application, ensuring that vocational learners are well-prepared for workforce demands. The prominence of terms such as instructional design, curricula, and problem-based learning further demonstrates the focus on structured and student-centered approaches. These methods are integral to fostering critical thinking and adaptability, traits essential for success in real-world settings. The growing emphasis on integrating technology is evident in keywords like e-learning, online learning, and augmented reality. These terms signal a significant shift towards leveraging digital tools to enhance teaching and learning experiences. By adopting these technologies, vocational education is becoming more accessible and engaging, offering students immersive and interactive environments that closely mirror industry practices. Furthermore, the inclusion of phrases like motivation, teacher training, and professional education underscores the human-centric aspect of teaching strategies. This focus recognizes the importance of emotional engagement and the professional growth of educators in fostering effective teaching and sustained learner motivation. While the

analysis reveals substantial progress, certain gaps are evident. Themes such as leadership and emotional dimensions are less integrated into broader pedagogical frameworks, suggesting opportunities for further exploration. Similarly, the holistic incorporation of digital tools, like augmented reality and e-learning, into teaching strategies remains underdeveloped, pointing to areas for improvement. The co-occurrence analysis highlights a multidimensional approach to teaching strategies in vocational education, emphasizing the integration of structured pedagogy, technological innovation, and human-centered learning. However, future efforts should address the identified gaps by exploring interdisciplinary strategies that blend leadership, motivation, and advanced digital tools into teaching frameworks. By doing so, vocational education can evolve into a dynamic system that equips learners with the technical skills, emotional resilience, and adaptability needed to thrive in a rapidly changing global workforce.

How can interdisciplinary approaches and emerging innovations in teaching strategies enhance the effectiveness of vocational education

Figure 5: Network visualization map of co-citation cited references



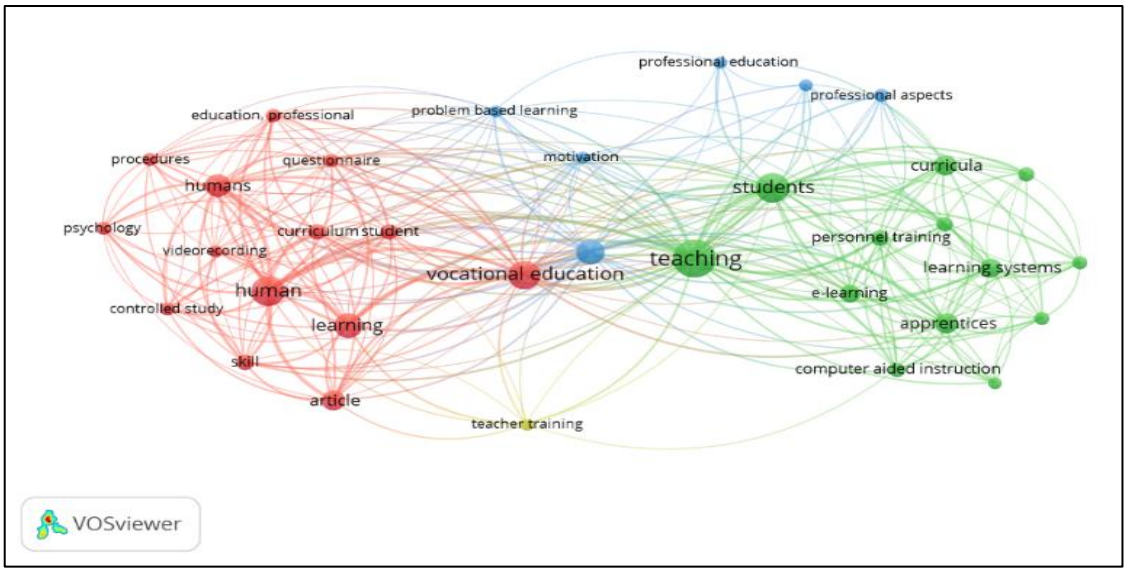
The co-citation network analysis provides a detailed overview of the intellectual foundations and thematic connections within the research on teaching strategies in vocational education. The analysis reveals clusters of closely related references, indicating distinct thematic groups that underpin this area of study.The central nodes in the co-citation map represent highly influential works that serve as the backbone for research in teaching strategies. These fundamental references encompass a synthesis of theoretical and practical research that tackles essential elements of pedagogy, including the creation of effective learning environments, the incorporation of technology in education, and the customization of teaching to accommodate the distinct requirements of vocational learners. The presence of highly co-cited references highlights the emphasis on shared foundational knowledge within the field, suggesting a robust theoretical grounding. Notably, the map also indicates links between smaller nodes, representing more specialized or emerging areas of inquiry. These connections suggest ongoing efforts to integrate newer perspectives into established pedagogical practices. For instance, the appearance of works related to e-learning and professional development indicates a shift towards incorporating digital tools and enhancing teacher competency in vocational education.

The network further underscores the importance of interdisciplinary approaches in teaching strategy research. Connections between references from diverse fields, such as psychology, curriculum design, and technology integration, highlight the multidimensional nature of vocational education. These links emphasize the need for teaching strategies that address both the technical and human-centered aspects of learning, ensuring that students acquire not only technical skills but also critical thinking, motivation, and adaptability. However, the co-citation network also reveals certain gaps. For instance, the relative sparsity of connections in some areas of the map suggests underexplored themes or limited integration between certain subfields. This highlights opportunities for future research to bridge these gaps, fostering a more cohesive understanding of how diverse teaching strategies can be aligned to enhance vocational education outcomes.The co-citation analysis of

teaching strategy research in vocational education demonstrates a well-established theoretical foundation with emerging connections to innovative practices and interdisciplinary approaches. The centrality of influential works underscores the importance of shared knowledge in shaping effective teaching strategies, while the links to specialized and emerging themes highlight the dynamic evolution of the field. To advance this area of study, future research should focus on bridging gaps between subfields, fostering a deeper integration of innovative technologies, and exploring the interplay between theoretical frameworks and practical applications. By addressing these areas, the academic community can develop teaching strategies that are not only evidence-based but also adaptable to the changing demands of vocational education.

How can teaching strategies in vocational education be optimized to integrate technology, enhance student-centered learning, and align with industry demands?

Figure 6: Network visualization map of co-occurance index keywords



The co-occurrence map generated using keywords from the uploaded documents provides a bibliometric overview of teaching strategies in vocational education. This visualization demonstrates the interconnectedness of critical concepts, such as teaching, learning, vocational education, and students, offering insights into the thematic focus and trends within this domain. Analyzing these patterns sheds light on how teaching strategies can be optimized to address the specific needs of vocational education.The keyword teaching occupies a central position, underscoring its pivotal role in vocational education. Its strong connections with ideas such as students, learning systems, and curriculum suggest an emphasis on the creation and implementation of educational approaches tailored to the specific needs of vocational learners. The incorporation of terms like e-learning, computer-aided instruction, and learning systems indicates an increasing focus on integrating technology into teaching strategies. This trend reflects the push towards digital transformation in education, driven by the need to equip students with skills for modern, technology-driven workplaces.Another significant cluster revolves around vocational education and its linkage to themes like teacher training, professional education, and motivation.

These connections suggest that teaching strategies in vocational education are closely tied to the professional development of educators and their ability to deliver contextually relevant and engaging instruction. The presence of problem-based learning highlights the practical, hands-on nature of vocational education, emphasizing the importance of strategies that simulate real-world scenarios and foster critical thinking among students.The analysis also reveals a strong link between learning and humans, reflecting the human-centered nature of vocational education. This connection suggests that teaching strategies are not only designed to impart technical skills but also to support personal growth, motivation, and emotional engagement. Concepts like psychology, curriculum design, and teacher training further underscore the multidimensional approach required in vocational education to balance cognitive, emotional, and technical learning.Despite the comprehensive nature of the map, certain areas, such as e-learning, appear less connected to broader teaching

strategies, suggesting an underexplored potential for fully integrating digital tools into vocational curricula. Similarly, keywords like apprentices and personnel training highlight areas where teaching strategies could be more deeply aligned with workforce preparation and industry expectations.The bibliometric analysis of teaching strategies in vocational education highlights the centrality of pedagogical design in fostering effective learning. The strong links between teaching, learning, and vocational education emphasize the need for strategies that are both student-centered and aligned with industry demands. The increasing role of technology, as evidenced by keywords like e-learning and computer-aided instruction, signals a shift toward digital transformation in vocational teaching.

However, the findings also point to gaps in the integration of digital tools and alignment with apprenticeship models, suggesting opportunities for further research and development. By addressing these gaps, educators and policymakers can enhance teaching strategies to ensure vocational learners are equipped with the skills, knowledge, and adaptability needed for success in modern workplaces. This analysis underscores the importance of continuously refining teaching practices to meet the evolving needs of vocational education.

DISCUSSION

The bibliometric analysis of the teaching strategy and the development of vocational education during the period from 2015 to 2024 has demonstrated considerable progress in the production of research output and shifts in the subject matter. The consistent upward trend in publication volume especially in the year 2024 indicates a regained attention in the amalgamation of new teaching methodologies and technological tools following the pandemic. It is however appreciated that the increasing trend also indicates that there has been a gradual change that seems to be geared towards meeting the supply side expectations of vocational education. Nonetheless, the fluctuations in the volumes observed point to the need for moving towards more flexible research systems so as to keep generating output rather than meet international standards. In addition, the review demonstrates the problem of lack of diversity in the use of interdisciplinary approaches particularly in the sciences and mathematics. These breaches if filled could promote the enhancement of teaching strategies and the creation of a less specialized research environment.The integration of technology into vocational education emerges as a recurring theme, with tools like e-learning, augmented reality, and digital simulations significantly enhancing teaching strategies.

CONCLUSION

These innovations support practical skill acquisition and student engagement, essential for workforce readiness. However, challenges persist in achieving seamless integration of these tools within curricula and ensuring equitable access for diverse learner populations. Additionally, while research predominantly emphasizes student-centered learning and problem-based approaches, themes like leadership development and emotional engagement remain underexplored. To address these gaps, targeted professional development for educators and a redefined pedagogical framework that integrates cognitive, technical, and emotional aspects of learning are necessary, eventually promoting adaptation and resilience in students.Global disparities in research contributions highlight opportunities for more inclusive collaborations to enhance the impact of vocational education. Countries such as the United States and Germany exemplify successful models where vocational education aligns with research to address workforce needs, while emerging contributors like Malaysia and Indonesia demonstrated the potential of strategic investments in research-driven vocational systems. Smaller nations face challenges in leveraging limited resources, emphasizing the importance of adopting international best practices and fostering global partnerships. Strengthening these collaborations and addressing gaps in technological integration and interdisciplinary research will enable vocational education to better equip learners with the skills and adaptability required for a rapidly evolving global workforce, driving societal and economic progress.

REFERENCES

1. Al-Khoury, A., Hussein, S. A., Abdulwhab, M., Aljuboori, Z. M., Haddad, H., Ali, M. A., Abed, I. A., & Flayyih, H. H. (2022). Intellectual Capital History and Trends: A Bibliometric Analysis Using Scopus Database. Sustainability (Switzerland), 14(18). https://doi.org/10.3390/su141811615

2. Álvarez-Nieto, C., Álvarez-García, C., Parra-Anguita, L., Sanz-Martos,S., & López-Medina, I. M. (2022). Effectiveness of scenario-based learning and augmented reality for nursing students' attitudes and awareness toward climate change and sustainability. BMC Nursing, 21, 1–9. https://doi.org/https://doi.org/10.1186/s12912-022-01023-9
3. Appio, F. P., Cesaroni, F., & Di Minin, A. (2014). Visualizing the structure and bridges of the intellectual property management and strategy literature: a document co-citation analysis. Scientometrics, 101(1), 623–661. https://doi.org/10.1007/s11192-014-1329-0
4. Appio, F. P., Martini, A., Massa, S., & Testa, S. (2016). Unveiling the intellectual origins of Social Media-based innovation: insights from a bibliometric approach. Scientometrics, 108(1), 355–388. https://doi.org/10.1007/s11192-016-1955-9
5. Cabreros, B. S., & Barbacena, C. B. (2024). Management Framework for Quality Assurance to Strengthen Technology and TVET Pre-service Teacher Education. Journal of Technical Education and Training, 16(2), 37–54. https://doi.org/10.30880/JTET.2024.16.02.004
6. Dewey, J. (2002). Experience and Education. Kappa Delta Pi Lecture Series. Macmillan.
7. Engström, S., & Blom, J. (2024). Technical science capital in relation to how students manage within higher technical education. International Journal of Technology and Design Education, 34(4), 1419–1439. https://doi.org/10.1007/s10798-023-09870-6
8. Fahimnia, B., Sarkis, J., & Davarzani, H. (2015). Green supply chain management: A review and bibliometric analysis. In International Journal of Production Economics (Vol. 162, pp. 101–114). Elsevier B.V. https://doi.org/10.1016/j.ijpe.2015.01.003
9. Johnson, M. (2010). Aligning Workforce Curricula with Industry Needs: A Vocational Education Perspective. Workforce Development Journal, 15(2), 45-62.
10. Jusoh, M. Y. F., & Ishak, N. A. (2024). Energy And Sustainability In Education: A Bibliometric Analysis Of Research Directions (2019-2023). International Journal of Education, Psychology and Counseling, 9(53), 269–291. https://doi.org/10.35631/ijepc.953023
11. Khazaie, S., & Derakhshan, A. (2024). Extending embodied cognition through robot's augmented reality in English for medical purposes classrooms. English for Specific Purposes, 75, 15–36. https://doi.org/10.1016/j.esp.2024.03.001
12. Kolb, D. A. (2005). Experiential Learning: Experience as the Source of Learning and Development (2nd ed.). Pearson FT Press.
13. Li, Y., Li, J., & Xie, S. (2017). Bibliometric analysis: global research trends in biogenic volatile organic compounds during 1991–2014.Environmental Earth Sciences, 76(1). https://doi.org/10.1007/s12665-016-6328-4
14. Mahendru, N., Mai, N., & Hin, H. S. (2024). Elevating Students' Shared Learning Experiences with Augmented Reality in a Digital Marketing Classroom. International Journal of Learning, Teaching and Educational Research, 23(5), 87–106. https://doi.org/10.26803/ijlter.23.5.5
15. Merriam, S. B., & Caffarella, R. S. (2007). Learning in Adulthood: A Comprehensive Guide (3rd ed.). Jossey-Bass.
16. Majid, F. A., Sharil, W. N. E. H., Yau, S. A., & Kamaruzaman, M. F. (2024). Strategies in Developing Graduate Employability Skills:An Investigation on a TVET Programme in a Malaysian Public University. Asian Journal of University Education, 20(3), 807–821. https://doi.org/10.24191/ajue.v20i3.27868
17. Mulders, M. (2022). Vocational Training in Virtual Reality: A Case Study Using the 4C/ID Model. Multimodal Technologies And Interaction, 6(7). https://doi.org/10.3390/mti6070049
18. Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ, 339(jul21 1) b2535–b2535. https://doi.org/10.1136/bmj.b2535
19. N.J Van Eck, & L.Waltman. (2007). Bibliometric Mapping of the Computational Intelligence Field. http://hdl.handle.net/1765/10073
20. N.J.Van Eck, & L.Waltman. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics,84(2), 523–538. https://doi.org/10.1007/s11192-009-0146-3
21. Noguera, I., Quesada-Pallarès, C., & Sepúlveda-Parrini, P. (2024). Analysing student satisfaction with teaching strategies in vocational education. Education and Training, 66(10), 75–90. https://doi.org/10.1108/ET-02-2023-0062

22. Okolie, U. C., Nwajiuba, C. A., Binuomote, M. O., Osuji, C. U., Onajite, G. O., & Igwe, P. A. (2020). How careers advice and guidance can facilitate career development in technical, vocational education, and training graduates: The case in Nigeria. Australian Journal of Career Development, 29(2), 97–106. https://doi.org/10.1177/1038416220916814
23. Popova, I. N. (2024). Contours of modern didactics of professional education: an analysis of foreign studies. Perspektivy Nauki i Obrazovania, 71(5), 92–105. https://doi.org/10.32744/pse.2024.5.6
24. Rogers, G., Szomszor, M., & Adams, J. (2020). Sample size in bibliometric analysis. Scientometrics, 125(1), 777–794. https://doi.org/10.1007/s11192-020-03647-7
25. Saad, S., Lani, M. N., Wan Abdullah, W. Z., Daniel, M. D.-D., Azra, M. N., Nik Ubaidillah, N. H., Jusoh, M. Y. F., Yarlina, V. P., & Imathiu, S. (2024). Navigating Global Research Trends on Seafoods-Related Foodborne Diseases: A Decadal Bibliometric Analysis. Journal of Advanced Research in Applied Sciences and Engineering Technology, 275–296. https://doi.org/10.37934/araset.59.1.275296
26. Sappar, R., Mohammad Hussain, M. Azlan, & Zulkifli, R. M. (2024). The Implementation of Collaborative Industry Practices in Malaysian Vocational Colleges. International Journal of Academic Research in Progressive Education and Development, 13(2). https://doi.org/10.6007/ijarped/v13-i2/21140
27. Shamseieh, L. A., & Mousa, A. (2024). Assessing the Impact of Accepting Virtual Reality Technology and its Impact on Motivation in Vocational Schools in Palestine. An-Najah University Journal for Research - B (Humanities), 38(10), 1963–1984. https://doi.org/10.35552/0247.38.10.2284
28. Smith, J., & Jones, R. (2003). Competency-Based Learning Models in Vocational Education. Educational Press.
29. Taylor, L. (2015). Digital Integration in Vocational Education: The Role of LMS, AI, and Virtual Simulations. Journal of Technical Education, 28(4), 112-130.
30. Tlili, A., Salha, S., Garzon, J., Denden, M., Kinshuk, Affouneh, S., & Burgos, D. (2024). Which pedagogical approaches are more effective in mobile learning? A meta-analysis and research synthesis. Journal Of Computer Assisted Learning, 40(3), 1321–1346. https://doi.org/10.1111/jcal.12950
31. Wang, K. J., & Yang, S. H. (2022). Technical and vocational education strategy to prepare qualified professionals for industry 4.0- a case study. International Journal Of Engineering Education, 38(5), 1328–1339.
32. Wang, Z., Zhao, Y., & Wang, B. (2018). A bibliometric analysis of climate change adaptation based on massive research literature data.Journal of Cleaner Production, 199, 1072–1082. https://doi.org/10.1016/j.jclepro.2018.06.183
33. Wu, Y. C. J., & Wu, T. (2017). A decade of entrepreneurship education in the Asia Pacific for future directions in theory and practice. In Management Decision (Vol. 55, Issue 7, pp. 1333–1350). Emerald Group Publishing Ltd. https://doi.org/10.1108/MD-05-2017-0518
34. Wulansari, R. E., Fortuna, A., Marta, R., Primawati, P., Masek, A.,Kaya, D., Prasetya, F., Sakti, R. H., Luthfi, A., Rizki, I. A., Hasna, F. H., & Eshaghi, S. (2024). Revolutionizing Learning: Unleashing the Power of Technology Gamification-Augmented Reality in Vocational Education. TEM Journal, 13(3), 2384–2397. https://doi.org/https://doi.org/10.18421/TEM133-65
35. Verbeek, K. Debackere, M. Luwel, & E. Zimmermann. (2002). Measuring progress and evolution in science and technology - I: The multiple uses of bibliometric indicators. International Journal of Management Reviews, 4(2), 179–211.
36. Zhao, Y., & Ko, J. (2024). Orchestrating vocational education classrooms for adaptive instruction and collaborative learning. Cogent Education, 11(1). https://doi.org/10.1080/2331186X.2024.2351238