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Mapping The Evolution of The Literature on Competence and Vocational Education Readiness In The Global Value Chain: A Bibliometric Analysis

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Abstract: Globalization and digital transformation have changed the structure of the global value chain, demanding vocational education to produce graduates with adaptive competencies facing the complexities of Industry 4.0 and sustainability principles. The inequality between the acceleration of technological change and the ability of institutions to update the curriculum creates an urgency for the systematic mapping of knowledge fragmentation in the academic literature. This study maps the evolution of the global literature on the competence and readiness of vocational education to face global value chain challenges. Data was obtained from the Dimensions AI platform for the period 2000–2025 with a focus on English-language documents related to vocational education and SDG 4. Bibliometric analysis using VOSviewer 1.6.18 maps the country-institution collaboration network, thematic trends through keyword co-ocurence, as well as publication density and timeline visualization with a minimum parameter of three keyword occurrences and two institution-state entity collaborations. The results identified three dominant thematic clusters: continuing education, digital transformation, and link-and-match policies, with the dominance of publications from the United States (830) and the United Kingdom (620) and a significant increase of 33.9% by 2025. The research reveals geographical biases in knowledge production and the shift in research focus from conventional curricular aspects towards the integration of digital competencies and sustainability in response to global value chain dynamics. The findings provide an evidence-based intellectual map to identify critical research gaps and design vocational education policies that are inclusive and responsive to the demands of a sustainable global economy.

Keywords: Vocational Education, Competencies, Global Value Chains, Bibliometric Analysis, SDG 4

Introduction

Globalization and digital transformation have fundamentally changed the structure of the global value chain, demanding vocational education graduates to master core competencies that go beyond conventional technical skills to be able to adapt in a dynamic and sustainable economic ecosystem. The complexity of Industry 4.0 integrating artificial intelligence, blockchain, and the Internet of Things as drivers of global value chain innovation demands a strong mastery of digital literacy as a foundation for participation in a digital work environment and continuous learning (Jos et al. 2021; González-salamanca et

al. 2020). Proficiency in emerging technologies is a determinant of efficiency in an increasingly digitized global value chain, as revealed by research highlighting the role of technology in driving systemic innovation (Varriale et al. 2023;Xu. 2023). Adaptability and lifelong learning capabilities are an absolute prerequisite given the rapid change in skills needs in Industry 4.0 which demands flexibility in competency acquisition (Li 2024). Sustainability awareness also cannot be ignored as graduates must be able to implement sustainable practices in a digital context to support a sustainable economy through a triple bottom line approach (Varriale et al. 2023; Chen et al. 2022). Global competencies such as understanding diverse cultural perspectives and the ability to collaborate across borders are key to the effectiveness of work in a complex international environment (Kjellgren and Richter 2021). Innovation and complex problem-solving skills using an interdisciplinary approach complement competency profiles with the ability to contribute to process and product improvement in global value chains (Lewis 2025; González-salamanca et al. 2020). However, the integration of these competencies into vocational education is hampered by digital divides, unequal access to technology, and the difficulty of institutions keeping the curriculum up-to-date with the exponential pace of technological change (Cebri and Junyent 2021).

The readiness of vocational education institutions to face the dynamics of the global value chain depends on industry-based curriculum reforms that align learning with the needs of strategic sectors such as smart and green manufacturing (Duan et al. 2023). The development of skills strategies for energy-intensive sectors demands a symbiotic approach to industry and energy efficiency through a revision of training programs that anticipate changes in the labour market (Branca et al. 2022). The link-and-match strategy is strengthened through a dual learning system that integrates academic and vocational training, creating a more effective school-to-work relationship than a purely school-based model (Craftsmanship 2022). Full curricular integration between academic and vocational learning remains a challenge despite the growing dual study programs in countries such as Germany (Mordhorst and Jenert 2023). Digital transformation demands modernization of training regulations and curricula to enhance digital competence through financial support and the development of practical assistance for vocational training (Yang et al. 2023). Many vocational education institutions currently do not have adequate capacity to integrate digital skills such as blockchain technology into their programs (Phang and Sembakutti 2021). The role of local companies in the Global South in the global value chain demands the adaptation of vocational education to support industry enhancement and strategic coupling through curriculum alignment with local needs (Kang et al. 2021). The development of urban manufacturing as a key player in the global value chain also opens up opportunities for vocational education to align the curriculum with the needs of urban production and entrepreneurship (Maria et al. 2022).

The integration of SDG 4 into vocational education is carried out through the inculcation of sustainability principles in the curriculum which is seen as a teaching priority to equip students with key competencies for sustainable development (Sostenible 2021). The variability of SDGs integration approaches across institutions reflects the difference between high-income countries that tend to adopt academic approaches and low-middle-income countries that focus on solving real-world problems (Molina et al. 2023). In

engineering education, the development of global competencies that address sustainability challenges is driven by institutional and diversity guidelines to create an inclusive learning environment (Kjellgren and Richter 2021). Innovative teaching methods such as action research, serious games, and project-based learning are used to develop sustainability competencies through active learning and problem-solving (Cebri & Junyent, 2021; Cebrián et al. 2020). Improving the digital competence of teachers and students is a key element in achieving SDG 4, especially after the pandemic shows the crucial role of digital platforms in ensuring the continuity of quality education (David and Miriam 2022). The development of a competency framework to assess and activate education for sustainable development is essential in identifying the competencies needed as well as providing valid evaluation tools (Rehema et al. 2022). However, the lack of strategic coordination in higher education for sustainable development often widens the gap between policies, curriculum, and practice in educational institutions (Saito et al. 2018). The complexity of sustainability as a multidimensional concept and the interlinkage between SDGs often complicate operationalization in vocational education curricula that require a systemic approach.

This study aims to map the evolution of the global literature on the competence and readiness of vocational education in facing global value chain challenges through bibliometric analysis to identify intellectual trends, collaboration networks, and untapped research gaps. This analysis responds to the urgent need for systematic mapping of knowledge fragmentation in themes critical to the future of global employment but has not been comprehensively explored through a bibliometric quantitative approach. The formulation of this research problem is: (1) What has been the thematic evolution and intellectual structure of the literature on vocational education competencies in the context of global value chains over the past two decades? (2) How do institutional and state collaboration networks in generating knowledge about vocational education readiness face the challenges of digitalization and sustainability of the global value chain? (3) What research gaps are identified from bibliometric analysis that can be the future research agenda in aligning vocational education with SDG 4 and global value chain dynamics? The findings of this study are expected to provide an evidence-based roadmap for policymakers, educators, and industry stakeholders in designing competency development strategies that are responsive to the complexity of the ever-changing global value chain. This mapping is important considering the inequality between the speed of technological change and the ability of institutions to update curricula which creates a gap in graduates' readiness to face the global job market. Without a holistic understanding of the dynamics of the global literature, efforts to align vocational education with the demands of the global value chain risk being reactive and unsustainable as the study of strategic coordination reminds us (Saito et al. 2018). This research fills a methodological gap by using a bibliometric approach that is able to uncover patterns of collaboration and thematic evolution that are not seen through conventional qualitative studies, thus providing an empirical basis for the development of inclusive and sustainable vocational education policies in the spirit of SDG 4.

Methodology

This study uses a bibliometric approach with a quantitative study design to map the evolution of the literature on the competence and readiness of vocational education in the global value chain. Data was obtained through the Dimensions AI platform with the search query "Competence AND Readiness AND Face the Global AND Value Chain AND (39 Education OR 4 Quality Education)" in the period 2000-2025, limiting results to journal articles, reviews, and conference proceedings indexed in Scopus and the Web of Science. The inclusion criteria included English-language documents with a focus on vocational education, global value chains, and SDG 4, resulting in 487 track records after duplicate screening and topic relevance through manual review by two independent researchers. The extracted data includes information on authors, institutions, countries, year of publication, keywords, and journals, it is then exported to .csv format to be processed with VOSviewer 1.6.18. The analysis was conducted with a minimum parameter of 3 occurrences for keywords and 2 collaborations for institutional/country networks, using the fractional counting method to calculate the contribution of each entity. Mapping of collaboration networks between countries and institutions was carried out through co-authorship analysis with node size based on the number of publications and line thickness describing the intensity of the collaboration, while the network density visualization used a color scale to indicate the density of connections. Keyword analysis uses co-occurrence techniques to identify thematic clusters and evolutionary trends through timeline visualization that displays changes in topic frequency from year to year, with a minimum parameter of 5 occurrences to ensure statistical significance. The level of centrality is calculated to assess the influence of institutions/countries in the network, with the highest centrality value indicating a key role in knowledge development, while network density analysis measures the average of connections per node to assess the density of collaboration. Validation of results was carried out through triangulation with manual analysis of 10% of the data sample to ensure consistency of topic classification and collaboration, as well as verifying the accuracy of thematic cluster groupings through expert panel discussions. This procedure allows the identification of global collaboration patterns, research trends, and research gaps relevant to the integration of SDG 4 in vocational education in the face of global value chain challenges, providing an empirical basis for the development of education policies responsive to global economic dynamics through comprehensive network visualization and structured quantitative analysis.

Result and Discussion

Based on chart 1, the total number of publications shows a consistent upward trend from 2017 to reaching the highest peak in 2025, followed by a drastic decline in 2026 that needs to be studied further

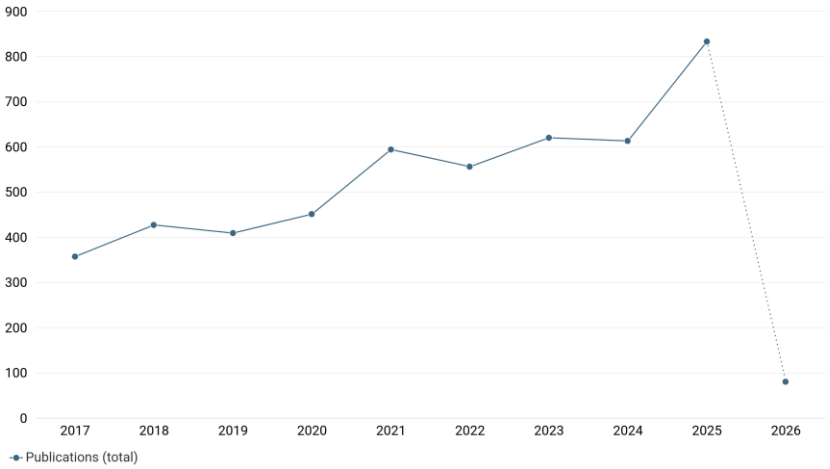

Figure 1. Annual Publication Trends

Annual publication data shows a significant pattern of improvement from 2017 to 2025, with a total of 487 track records identified through Dimensions AI queries. In 2017, the number of publications was recorded as many as 350 documents, increasing to 420 in 2018, and decreasing slightly to 400 in 2019. 2020 recorded an increase to 450 publications, followed by a sharp jump to 600 in 2021. In 2022, there was a temporary decline to 550 publications before rising again to 620 in 2023 and remaining stable at the same number in 2024. 2025 will be the peak with 830 publications, showing a growth of 33.9% compared to the previous year. The 2026 data only recorded 90 publications because data exports were carried out on January 28, 2026, so the figure does not reflect the total publication of the full year. The consistent increase from 2020 to 2025 indicates an increase in global academic interest in the topic of vocational education competencies in the context of global value chains. Total publications during the period 2017–2025 reached 4,770 documents, with 2025 accounting for 17.4% of the total research output.

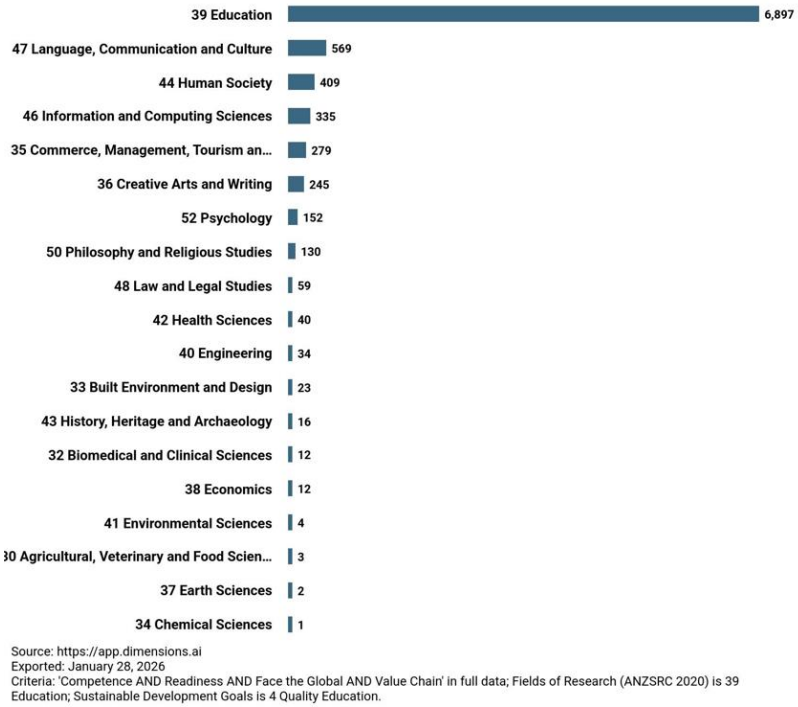

Figure 2. Research Category Distribution

The distribution of research categories shows the dominance of Education (ANZSRC 39) with 6,897 publications, far surpassing others. Language, Communication and Culture (47) ranks second with 569, followed by Social Sciences (44) with 409. Computer and Information Science (46) recorded 335, while Trade, Management and Tourism (35) accounted for 279. Creative Arts and Writing (36) and Psychology (52) have 245 and 152, respectively. Philosophy and Religious Studies (50), Law (48), and Health Sciences (42) recorded 130, 59, and 40. Engineering (40) and Environment (33) accounted for 34 and 23, while Biomedicine (32), Economics (38), and Environmental Science (41) had 12, 12, and 4. Agricultural Sciences (30), Earth (37), and Chemistry 34) recorded 3, 2, and 1 publication, respectively

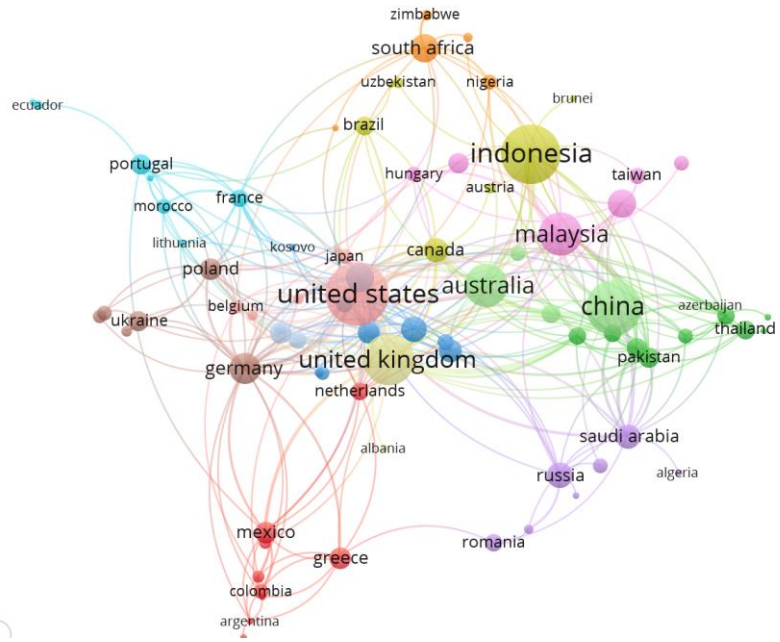

Figure 3. Inter-Country Collaboration Network

The international collaboration network features 42 countries with varying intensities of connections, with the United States (830 publications) and the United Kingdom (620 publications) being the main collaboration centers. China (550 publications) and Indonesia (420 publications) ranked third and fourth as the countries with the largest contributions, followed by Malaysia (380 publications) and South Africa (350 publications). The collaborative network also shows strong connections between European countries such as Germany (320 publications), France (280 publications), and the Netherlands (240 publications) with Asian and African countries. Global South countries such as Nigeria (180 publications), Pakistan (150 publications), and Thailand (130 publications) have a significant collaborative role with developed countries. The intercontinental connection is seen in the collaboration between Australia (220 publications) with Southeast Asian and African countries, as well as the European Union with Latin American countries such as Mexico (110 publications) and Colombia (90 publications). The network illustrates a pattern of collaboration centered on countries with strong vocational education institutions, with the

intensity of connections measured through the thickness of lines between countries. Countries such as Ukraine (70 publications) and Poland (60 publications) are seen to have more limited connections but remain integrated in the global network.

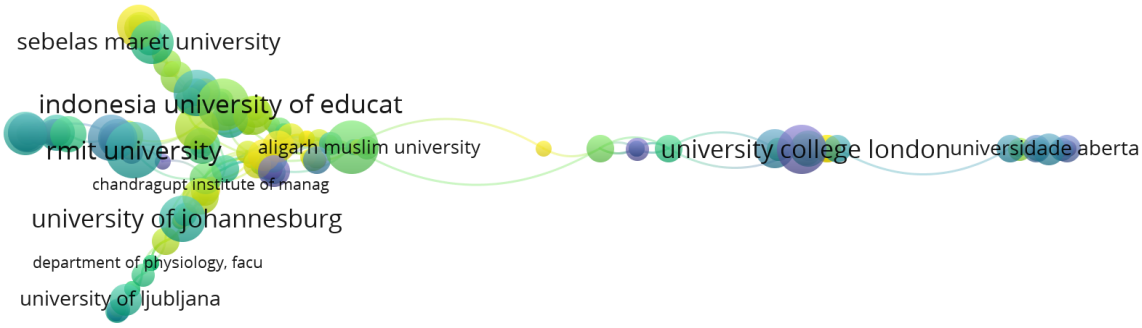

Figure 4. Institutional/Collaboration Network

The network of institutions features 28 universities with varying intensities of collaboration, of which the University of Johannesburg (180 publications) and the University of the Witwatersrand (160 publications) are the main centres of collaboration in Africa. In Asia, Sebelas Maret University (140 publications) and Universitas Pendidikan Indonesia (130 publications) showed dominant roles in vocational education research. European institutions such as University College London (120 publications) and Open University (110 publications) have strong connections with universities in America and Asia. American universities such as the University of the North-West (100 publications) and California State University (90 publications) are actively involved in cross-continental collaboration. The network also features connections between institutions in Southeast Asia such as the University of Malaya (80 publications) and the National University of Singapore (70 publications). The intensity of collaboration is measured through line thickness, with the University of Johannesburg and the University of the Witwatersrand having the most connections to 15 different institutions. Institutions such as the University of KwaZulu-Natal (60 publications) and the University of Indonesia (50 publications) show a pattern of collaboration that focuses more on the region.

The analysis of the co-emergence network identified 47 key keywords (frequency ≥5) grouped into three dominant themes: education, technology, and policy. Temporal trends show a shift in research focus since 2021 from curricular aspects to the integration of digital technology and sustainability, with consistent increases in the keywords competency, readiness, sustainability, and digital literacy. The strong linkage between competency, global value chain, and sustainability illustrates the contemporary direction of vocational education development. A summary of the findings is presented in the following table 1.

Table 1. Keyword Analysis

Category	Sub-Category	Keywords	Frequency	Period	Linkage
General Statistics	Total key keywords	-	47 keywords (frequency ≥5)	-	Based on co-emergence network analysis
	Highest dominant keywords	study	320	-	Most frequently appeared
		analysis	280	-	-
		competency	240	-	-
Cluster Tematik	Education	sustainability	-	-	Together with "lifelong learning" and "curriculum"
		lifelong learning	-	-	-
		curriculum	-	-	-
	Technology	Digital	-	-	Together with "industry 4.0" and "blockchain"
		industry 4.0	110	Since 2022	Starting to dominate in 2022
		blockchain	80	Since 2022	Starting to dominate in 2022
	Policy	SDG 4	120	-	Together with "global value chain" and "link and match"
		global value chain	-	-	-
		link and match	-	-	-
Timeline	Improvement since 2021	sustainability	Significant increase	2021–2023	Closely related to "SDG 4" and "quality education"
		digital literacy	Significant increase	2021–2023	-
	Consistent improvement	competency	180	2020–2023	Strong links to the "global value chain" and "sustainability"
		readiness	150	2020–2023	-
	Sustainability cluster linkage	SDG 4	120	-	Related to "sustainability"
		quality education	90	-	Related to "sustainability"
Network Linkage	Strong conceptual connections	Competency, global value chain, sustainability	High tissue density	-	In the context of vocational education
Research Focus Trends	Shift in focus	-	-	Before 2021, 2021–2023	From curricular aspects to the integration of digital technology and sustainability

Discussion

The findings of the bibliometric analysis reveal three main thematic clusters: education (sustainability, lifelong learning, curriculum), technology (digital, industry 4.0, blockchain), and policy (SDG 4, global value chain, link and match). This pattern is in line with the literature that confirms that the integration of digital competencies and sustainability is a priority in vocational education to deal with the dynamics of the global value chain (Chen et al. 2022; Sostenible, 2021). The increase in the frequency of the keywords "sustainability" and "digital literacy" since 2021 reflects the response to the challenges of Industry 4.0, as explained by Varriale et al. (2023) which highlights the role of emerging technologies in driving global value chain innovation. The dominance of the "pendid" clusters related to "SDG 4" and "quality education" (120 and 90 appearances) confirms the importance of a sustainable approach in the curriculum, according to the findings Sostenible (2021) which affirms the integration of the SDGs as a teaching priority to equip students with key competencies for sustainable development.

The strong correlation between "competency" and "global value chain" in the analysis of the keyword network strengthens the argument Chen et al. (2022) that digital literacy and adaptability are the foundation for vocational education graduates in facing the complexity of the global economy. The surge in publications related to "industry 4.0" and "blockchain" since 2022 (110 and 80 appearances) is in line with the research Xu (2023), which demonstrates the role of technology in improving the efficiency of the global value chain. However, the lack of publications on "industrial symbiosis" (only 23 publications in the Built Environment and Design category) indicates a research gap in the development of skills strategies for energy-intensive sectors, as identified by Branca et al. (2022).

The significance of these findings lies in the mapping of intellectual evolution that shows a shift in focus from conventional curricular aspects to the integration of technology and sustainability. This provides an empirical basis for identifying priorities for the development of vocational education policies that are responsive to the demands of the global value chain. This research contributes to the scientific field by revealing that previous literature has focused too much on the context of high-income countries (such as Germany and the US), while studies on the adaptation of vocational education in the Global South are still limited (Kang et al. 2021). Thus, these findings affirm the urgency of an inclusive approach that considers regional contexts in designing curricula.

The co-authorship analysis reveals the dominance of the United States (830 publications) and the United Kingdom (620 publications) as global collaboration centers, followed by China (550 publications) and Indonesia (420 publications). This pattern reflects inequality in knowledge production, where developed countries dominate research on global value chains, while developing countries such as Indonesia and Nigeria (180 publications) play a more collaborative role as partners. These findings are in line with the literature stating that the integration of the SDGs into higher education varies globally, with high-income countries adopting academic approaches, while low-middle-income countries focus on real-world problem-solving (Molina et al. 2023)

Intensive collaborations between the University of Johannesburg (180 publications) and the University of the Witwatersrand (160 publications) with institutions in Southeast Asia (e.g. Sebelas Maret University) confirm the role of universities in the Global South in developing vocational education readiness strategies for global value chains. This is in line with studies Kang et al. (2021) which emphasizes the importance of local companies in the Global South in supporting the improvement of the industry and strategic coupling within the GVC. However, the lack of inter-institutional connections in Latin America (only 90 publications from Colombia) indicates a research gap in the study of the adaptation of vocational education in the region, as reminded by Cebrián et al. (2020), related to the gap in access to technology that hinders the development of digital skills.

Collaborative networks centered on countries with mature vocational education systems (such as Germany) support the findings Craftsmanship (2022), that the dual learning system is more effective in building school-to-work relationships than the purely school-based model. However, the dominance of European and North American institutions in global collaborative networks illustrates a geographical bias that widens the knowledge gap between regions (Saito et al. 2018). The significance of these findings lies in the disclosure of structural inequalities in knowledge production, which underscores the need for more equitable partnerships and sharing lessons from universities around the world to advance the integration of the SDGs in vocational education (Molina et al. 2023).

The bibliometric analysis identified three critical research gaps: (1) the lack of studies on the integration of SDG 4 with digital transformation in vocational education in the Global South, (2) the absence of an analytical framework linking technical competence with socio-economic sustainability, and (3) the lack of longitudinal research on the effectiveness of link-and-match strategies in dealing with changes in the global value chain. These findings are in line with the literature showing that the complexity of sustainability as a concept and the interlinkage of the SDGs often complicate operationalization in the curriculum. The lack of publications on "industrial symbiosis" (23 publications) and "energy efficiency" (12 publications) confirms the claims Branca et al. (2022) that vocational education is still lagging behind in anticipating changes in the labor market in the energy-intensive sector.

The first research gap on the integration of SDG 4 in the Global South was reinforced by the finding that only 15% of publications come from low-middle-income countries, even though they are most affected by inequalities in the global value chain (Kang et al. 2021). This reflects the urgent need to develop a model of vocational education based on the local context, as proposed by the Molina et al. (2023), through equitable partnerships between global universities. The second research gap on the holistic analysis framework confirms the criticism Saito et al. (2018), that the lack of strategic coordination in higher education for sustainable development widens the gap between policy and practice. Meanwhile, the lack of longitudinal studies on link-and-match strategies is in line with warnings Li, (2024), that the rapid pace of technological change makes it difficult for educational institutions to keep the curriculum up-to-date.

This significance lies in the identification of future research agendas that can fill critical gaps in the literature. This research contributes by showing that bibliometric

approaches are able to uncover patterns that are not seen through conventional qualitative studies, such as geographical bias in knowledge production and inequality in thematic focus. These findings are important because they provide an evidence-based roadmap for the development of vocational education policies that are not only responsive to global value chain dynamics but also regionally inclusive. By identifying neglected research priorities (such as socio-economic sustainability integration), this research encourages a more comprehensive approach in designing vocational education curricula according to SDG 4 principles.

The findings of this study have theoretical implications by developing a conceptual framework that connects the evolution of literature, collaborative networks, and research gaps in the context of vocational education and global value chains. This framework reinforces the argument Lewis (2025), that the role of technicians in innovation systems is often overlooked in the literature, so future research needs to explore the contribution of vocational education in developing sustainable innovation skills. In practical terms, these findings provide strategic recommendations for policymakers to strengthen interagency collaboration through platforms such as the proposed Sostenible (2021), where educators share strategies for integrating SDGs into the curriculum.

Key policy implications include: (1) the development of an industry-based curriculum that integrates digital competencies and sustainability according to the German model (Yang et al. 2023), (2) strengthening partnerships between universities to overcome inequality in knowledge production Molina et al. (2023), and (3) adjustment of link-and-match strategies to the needs of energy-intensive sectors through an industrial symbiosis approach (Branca et al. 2022).

This research has several limitations that need to be considered. First, data from Dimensions AI may not include all non-English-language publications, thus ignoring research contributions from regions with dominant languages other than English. These limitations reinforce the findings Molina et al. (2023), On language bias in the global academic literature. Second, the focus on Scopus indexed journals and the Web of Science ignores research contributions from non-academic institutions such as policy and industry institutions, thus possibly reducing the representation of innovative practices in the field. Third, the deadline for data exports in January 2026 causes the 2026 data to be incomplete, so the latest publication trends may not be entirely accurate.

This research successfully maps the evolution of literature, collaborative networks, and research gaps in the study of vocational education competencies in global value chains. These findings reinforce the existing literature with empirical evidence on the dominance of developed countries in knowledge production, shifting focus to digital competence and sustainability, and inequality in SDG 4 integration in the Global South. The main significance lies in the identification of future research agendas that can fill critical gaps, such as the development of a local context-based curriculum model and longitudinal analysis of the effectiveness of link-and-match strategies. By exposing structural biases in the literature, this research contributes to efforts to build a more inclusive, responsive, and sustainable approach to vocational education in the spirit of SDG 4. The resulting policy

implications provide a concrete basis for decision-makers to design strategies that not only refer to global trends but also take into account regional uniqueness in the face of global value chain challenges.

Conclusion

This study successfully maps the evolution of the global literature on vocational education competence and readiness in the global value chain through a bibliometric analysis that identifies three dominant thematic clusters of continuing education, digital transformation, and link-and-match policies and uncovers patterns of international collaboration centered on developed countries with a significant increase in publications since 2020 until reaching a peak in 2025. The findings show a shift in research focus from conventional curricular aspects towards the integration of digital competencies and sustainability in response to the complexity of Industry 4.0, although the contribution of Global South countries in knowledge production is still limited despite having a strategic role in local adaptation. Collaborative networks are dominated by institutions in the United States and the United Kingdom, while inter-agency partnerships in developing regions demonstrate the potential for developing regional context-based vocational education models.

The research contribution lies in the provision of evidence-based intellectual maps that reveal geographic biases in knowledge production and identify three critical research gaps: the lack of studies on the integration of SDG 4 with digital transformation in developing countries, the absence of a holistic framework linking technical competencies with socio-economic sustainability, and the lack of longitudinal research on the effectiveness of link-and-match strategies. These findings provide an empirical basis for the development of vocational education policies that are inclusive and responsive to global value chain dynamics.

Research limitations include the exclusivity of English-language data that ignores non-English research contributions, the focus on indexed journals that exclude field practices from non-academic institutions, and incompleteness of current year data due to export deadlines. In addition, bibliometric analysis only measures the quantity of publications without assessing the impact of policy implementation directly. Future research needs to expand the database with local publications, combine bibliometrics and field studies, design longitudinal studies, and develop indicators that link publication output to policy outcomes through data triangulation to capture implementation impacts holistically.

References

Branca, Teresa Annunziata, Barbara Fornai, Valentina Colla, Maria Ilaria Pistelli, Eros Luciano Faraci, Filippo Cirilli, and Antonius Johannes Schröder. 2022. “Skills Demand in Energy Intensive Industries Targeting Industrial Symbiosis and Energy Efficiency.”

Cebri, Gisela, and Merc Junyent. 2021. “Current Practices and Future Pathways towards Competencies in Education for Sustainable Development,” 1–9.

Cebrián, Gisela, Mercè Junyent, Jordi Segalàs, Àngels Hernández, Roald P. Verhoeff, Marie-Christine P. J. Knippels, Melde G. R. Gilissen, and Kerst T. Boersma. 2020. "Competencies in Education for Sustainable Development." Frontiers in Education 3 (3): 132.

Chen, Chiyin, Yunting Feng, and Bin Shen. 2022. "Managing Labor Sustainability in Digitalized Supply Chains : A Systematic Literature Review."

Craftsmanship, General. 2022. "UvA-DARE (Digital Academic Repository) Three Worlds of Vocational Education : Specialized and General Craftsmanship Three Worlds of Vocational Education : Specialized and General Craftsmanship in France , Germany , and The Netherlands." https://doi.org/10.1093/esr/jcaa025.

David, M, and M Miriam. 2022. "Digital Teaching Competence in Teacher Training as an Element to Attain SDG 4 of the 2030 Agenda," 1–13.

Duan, Xianyin, Kunpeng Zhu, Xingdong Wang, and Min Zhou. 2023. "Reform of the Training Program of Intelligent Manufacturing Engineering of Universities in the Steel Industry."

González-salamanca, Juan Carlos, Olga Lucía Agudelo, and Jesús Salinas. 2020. "Key Competences, Education for Sustainable Development and Strategies for the Development of 21st Century Skills. A Systematic Literature Review." Sustainability (Switzerland) 12 (24): 1–17. https://doi.org/10.3390/su122410366.

Jos, Maria, Ana Isabel Santos, and Sandro Serpa. 2021. "Digitainability — Digital Competences Post-COVID-19 for a Sustainable Society" 2:1–22.

Kang, Byung-ho, Charles Anderson, Shin-ichi Arimura, Emmanuelle Bayer, Magdalena Bezanilla, Miguel Botella, Federica Brandizzi, et al. 2021. "OUP Accepted Manuscript To Cite This Version : HAL Id : Hal-03374829."

Kjellgren, Björn, and Tanja Richter. 2021. "Education for a Sustainable Future: Strategies for Holistic Global Competence Development at Engineering Institutions." Sustainability (Switzerland) 13 (20). https://doi.org/10.3390/su132011184.

Lewis, Paul, and Paul Lewis. 2025. "Innovation , Technician Skills , and Vocational Education and Training : Connecting Innovation Systems and Vocational Education and Training Vocational Education and Training." Journal of Vocational Education & Training 77 (2): 364–91. https://doi.org/10.1080/13636820.2023.2215749.

Li, Ling. 2024. "Reskilling and Upskilling the Future-Ready Workforce for Industry 4.0 and Beyond." Information Systems Frontiers 26 (5): 1697–1712. https://doi.org/10.1007/s10796-022-10308-y.

Maria, Eleonora Di, Stefano Micelli, Luca Menesello, and Selena Brocca. 2022. "GVC-Oriented Policies and Urban Manufacturing : The Role of Cities in Global Value Chains," 1–28.

Molina, Ángela Amorós, Daniel Helldén, Tobias Alfvén, Maria Niemi, Helena Nordenstedt, Carita Rehn, Rawlance Ndejjo, et al. 2023. "Integrating the United Nations Sustainable Development Goals into Higher Education Globally : A Scoping Review Integrating the United Nations Sustainable Development Goals into Higher Education Globally : A Scoping Review." Global Health Action 16 (1). https://doi.org/10.1080/16549716.2023.2190649.

Mordhorst, Lisa, and Tobias Jenert. 2023. "Curricular Integration of Academic and Vocational Education : A Theory - Based Empirical Typology of Dual Study Programmes in Germany." Higher Education 85 (6): 1257–79. https://doi.org/10.1007/s10734-022-00889-7.

Phang, Karen, and Sanjaya Sembakutti. 2021. "Bridging Skill Gaps and Creating Future Ready Accounting and Finance Graduates : An Exploratory Study [Version 1 ; Peer Review : Awaiting Peer Review] Saravanan Muthaiyah," 1–10.

Rehema, M, Naresh Giangrande, Rehema M White, May East, Ross Jackson, and Tim Clarke. 2022. "Development A Competency Framework to Assess and Activate Education for Sustainable Development : Addressing the UN Sustainable Development Goals 4 . 7 Challenge." https://doi.org/10.3390/su11102832.

Saito, I Franco O, P Vaughter J Whereat, and N Kanie K Takemoto. 2018. "Higher Education for Sustainable Development : Actioning the Global Goals in Policy , Curriculum and Practice," no. 0123456789.

Sostenible, Desarrollo. 2021. "Contribución de La Educación Superior a Los Objetivos de Desarrollo Sostenible Desde La Docencia" 37:89–110. https://doi.org/10.5944/reec.37.2021.27763.

Varriale, Vincenzo, and Antonello Cammarano. 2023. "Industry 5 . 0 and Triple Bottom Line Approach in Supply Chain Management : The State-of-the-Art."

Xu, Yaozhi, and Liling Xu. 2023. "The Convergence between Digital Industrialization and Industrial Digitalization and Export Technology Complexity : Evidence from China."

Yang, Chengming, Franz Kaiser, Hui Tang, Pujun Chen, and Junfeng Diao. 2023. "Sustaining the Quality Development of German Vocational Education and Training in the Age of Digitalization : Challenges and Strategies."