

WHAT WE TALK ABOUT WHEN WE TALK ABOUT INNOVATION AND VOCATIONAL EDUCATION? A SCIENTOMETRIC ANALYSIS OF THE RESEARCH FRAMEWORK

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Abstract

The role of education in innovation is well-established, but little is known about how innovation is understood in vocational education. This study used bibliometric analysis to explore the relationship between vocational education and innovation. The results showed that research on this topic is still limited, with only 539 articles published over a 53-year period. Furthermore, most authors (93.6%) only published one paper on the subject and none were affiliated with technical institutions. These findings suggest that research on innovation in vocational education requires a multidisciplinary approach and more collaboration between countries, authors, and institutions. Given the broad definition of innovation, it is likely that different contexts will yield different definitions. Thus, expanding research on this topic is crucial.

Keywords: *Education, innovation, vocational education, bibliometric analysis, technical education.*

1. Introduction

The literature suggests that education has an important role in driving innovation, with institutional cultures often identified as the primary barrier to knowledge transfer. Overcoming this challenge requires the use of intermediaries and a focus on experiential learning. Within this context, much of the existing literature emphasizes the role of universities as hubs for training in innovation (Jones & Grimshaw, 2016; Kitson, 2019; Valero & Van Reenen, 2019). To this end, several theoretical models and case studies have highlighted the need for curricular and organizational changes, as well as greater collaboration with external partners from both academia and industry (Kolomytseva & Pavlovska, 2020). Etzkowitz & Leydesdorff, (2000) influential study underscores the need for universities to become more entrepreneurial in nature. However, as noted by (Datta et al., 2019), given the heterogeneity of universities, strategic clustering is essential to increase their contribution to national innovation systems. This in turn necessitates the adoption of mechanisms that promote interest and facilitate collaboration with other stakeholders in the innovation system (Giraldo Gutiérrez et al., 2020).

Research in innovation systems also emphasizes the importance of technical education, which is seen to offer certain advantages over universities in some aspects of innovation, particularly due to its close relationship with small and medium-sized enterprises (Rosenfeld, 1998). Similarly, Brunet & Böcker Zavaro (2017) has called for greater contributions from the vocational education and training (VET) system to innovation in companies, especially SMEs, which may have limited resources for innovation. Such contributions can be facilitated by VET's mediating role between knowledge creators (i.e., researchers and institutions) and knowledge users (Moodie, 2006).

Against this backdrop, the present study seeks to analyze the intellectual and conceptual organization of research on innovation and VET. Specifically, we aim to provide insights into how this research field is structured and conceptualized. By achieving this aim, we hope to contribute to the advancement of research in this area, which is of critical importance for achieving sustainable economic growth and development.

2. Materials and methods

The search was carried out on Elsevier's Scopus database from January 1968 to December 2021 using several terms related to vocational education and innovation. After removing duplicates and

non-pertinent journals or topics, the selected articles were manually inspected to exclude those that were irrelevant to the quantitative analyses.

The systematic review included original and review articles in English and Spanish language from 25 distinct Scopus subject areas, whose title, abstract, or keyword contained at least one of the terms Vocational Education and Innovation, or, TVET and Innovation, or, Technical education and innovation, or, VET and innovation. The relevant bibliometric indicators extracted from the selected studies included the number of articles, sources, keywords, average citations per article, number of authors, authors appearances, article per author, annual scientific production and citations, top five productive authors, author's indices, top five cited articles and cited references, top five productive countries and institutions, top five relevant sources and top five relevant keywords and topics.

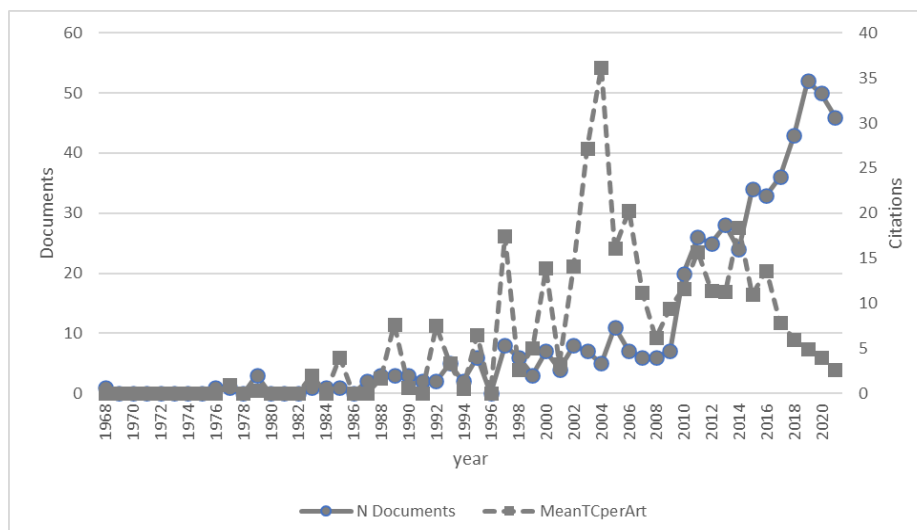
The collected data was analyzed using statistical graphs, descriptive analyses, and science maps generated by the bibliometrix R-package, an open-source science mapping program. Bibliometric indicators with the same ranking number were separated by a gap, and only the first five rated data for each indicator studied were considered for ranking reasons. The Hirsch index (h-index), and g-index were used to quantify the number of publications and number of citations per publication for each author.

3. Results

3.1. Main information

The systematic review initially identified 1105 articles, but only 539 were included in the quantitative analyses. These articles had an average citation per article of 9.25 over the period from 1968 to 2021 and were authored by 1368 authors, with an average of 0.39 articles per author from 369 different sources. The annual percentage growth rate of article publication was 10.04%, with most of the growth occurring in the last 12 years and two peaks observed in 2013 (28 articles) and 2019 (52 articles). In terms of average total citations per article, the highest peak was observed in 2004 with a mean of 36.2 citations, while the lowest was 0.0 citations, with exceptions, between 1968 and 1996. These findings provide insights into the quantity and quality of published research related to innovation in vocational education and training (figure 1).

Figure 1. Annual Production and citations per article.



3.2. Countries, institutions and productivity by affiliation

The analysis of the scientific production of the countries showed that the number of documents in which the corresponding author corresponds to a specific country varies from 1 article to 69 articles, as in the case of the United States. The most productive countries in terms of published articles related to innovation and VET were the United States (n=224, 41.6%), followed by the Netherlands (n=89, 16.5%) and the United Kingdom (n= 82; 15.2%). These 3 countries accounted for more than half (73.3%) of the productivity in the study area.

The highest number of citations was attributed to the United States (n=1444 with a mean number of citations per article of 20.93), followed by the Netherlands (n=702 with an AQM of 18.9) and the United Kingdom (n=563, with a mean number of citations per article of 13.1) (table 1).

Table 1. Top 5 most productive countries.

Country	Total Documents	Total Documents Corresponding Author	Total Citations	Average Article Citations (Corresponding author article)
USA	224	69	1444	20.93
NETHERLANDS	89	37	702	18.97
UNITED KINGDOM	82	43	563	13.09
AUSTRALIA	67	32	255	7.97
SPAIN	58	20	91	4.55

The University of Massachusetts Boston and the University of Washington in the United States occupy the first and second place in terms of institutional productivity, with 12 (2.2%) and 10 (1.8%) published articles, respectively. They are followed by Lobachevsky State University, Russia, with 8 (1.5%) published articles.

Among the top five institutions, there are no technical education institutions, all of them being universities (table 2).

Table 2. Top 5 most relevant affiliations.

Affiliation	Articles
UNIVERSITY OF MASSACHUSETTS BOSTON	12
UNIVERSITY OF WASHINGTON	10
LOBACHEVSKY STATE UNIVERSITY OF NIZHNY NOVGOROD	8
SIMON KUZNETS KHARKIV NATIONAL UNIVERSITY OF ECONOMICS	7
TILBURG UNIVERSITY	7

3.3. Journals, articles and keywords

The study found that the "Journal of Vocational Education and Training" was the most productive source, with 35 articles published in the period of 1968-2021, followed by "Journal of Technical Education and Training" (n=10) and "International Journal for Research in Vocational Education and Training" (n=8) (table 3). Sixty percent of the most relevant journals (n=12) corresponded to sources from the field of education, and six of them were related to the field of technical education. The rest of the journals (n=8) belonged to fields outside education, such as public policy, management, science, engineering, and technology (data not shown).

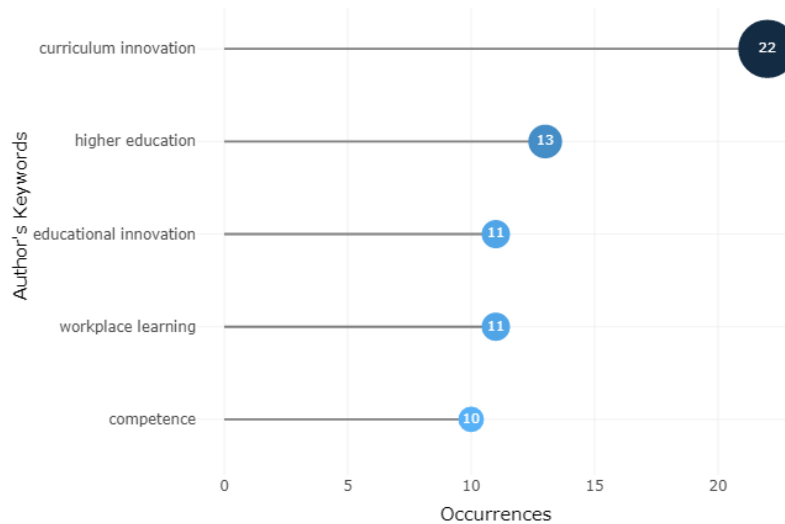
Table 3. Top 5 most relevant sources.

Sources	Articles	% of total
JOURNAL OF VOCATIONAL EDUCATION AND TRAINING	35	6,5%
JOURNAL OF TECHNICAL EDUCATION AND TRAINING	10	1,9%
INTERNATIONAL JOURNAL FOR RESEARCH IN VOCATIONAL EDUCATION AND TRAINING	8	1,5%
JOURNAL OF ENGINEERING EDUCATION TRANSFORMATIONS	6	1,1%
SUSTAINABILITY (SWITZERLAND)	6	1,1%

In terms of the most cited journals in the references of the 539 articles included, "Journal of Vocational Education and Training" was the most cited with 138 articles, followed by "Research Policy" (117 articles) and "Anatomical Sciences Education" (75 articles). Among the most cited articles and references, seventeen were original articles and three were review articles. The first ranked article was BIEMANS H et al, 2004 with 170 global citations and 9 local citations, followed by "DILULLO C, 2011" with 139 global and 1 local citation and "TRELEASE RB, 2016" with 123 global citations and no local citations (data not shown).

The analysis of the keywords assigned by the authors showed that after eliminating the terms contained in the search definition of the database (vocational, education, training, innovation), the three most relevant keywords were curriculum innovation, higher education, and educational innovation, appearing 22, 13, and 11 times, respectively (figure 2). When analyzing the evolution of keywords, it was observed that topics related to curricular innovation (pedagogy, educational innovation, and the like) addressed mainly between 2014 to 2016, have given way to topics related to entrepreneurship, technological innovation, and industry 4.0 (2016 to 2021) (data not shown).

Figure 2. Most relevant author's keywords.



3.4. Author productivity

The analysis of the authors revealed that Albizu, E and Lava C are the most productive authors with 5 articles, followed by authors who have written only 1 article, which accounts for 93.6% of the total number of authors. When it comes to the highest indexes, Albizu E and Lava C have an h-index and g-index of 4 (table 4).

Table 4. Top 5 most relevant author.

Authors	Articles	h-index	g-index
ALBIZU E	5	4	4
LAVA C	5	4	4
BRUNET ICART I	4	2	3
OLAZARAN M	4	3	4
OTERO B	4	3	4
TONER P	4	4	4

4. Discussion

This study analyzed the global scientific activity on the relationship of vocational education and training (VET) and innovation, using bibliometric indicators to help researchers better understand the history and future direction of research in this area. The study identified that the US, the Netherlands, and the UK were the main countries publishing and receiving citations in this field. However, research on the topic is still incipient, with only 539 articles specifically addressing innovation and technical education issues over a 53-year period (1968-2021). The study found that there is a lack of collaborative efforts between authors from different countries, and there is a need for more in-depth studies to evaluate the development of countries in promoting research on VET and innovation.

The study also found that there is a multidisciplinary approach needed in research on VET and innovation, with journals from different areas, such as management, business, and economics, publishing articles related to this topic. The authors suggest that if more articles are published in journals specialized in innovation, professionals in this area will be more aware of the existing gap, which would allow for an

increase in research in this area. Moreover, the study identified that the concept of innovation from VET has been approached mostly from improvements in teaching plans, and focused on higher education.

The study recommends that researchers need to address the gap in research on the relationship between VET and industry and establish guidelines for the integration of VET into innovation ecosystems. Finally, the study concludes that there has been a significant increase in the number of publications on VET and innovation in the last 10 years, probably because innovation is an attractive topic, but from the point of view of education, there is no consensus on how to adopt innovation in its work.

5. Conclusion

- Research on the relationship between vocational education and training (VET) and innovation has grown significantly in the past decade, with the US, the Netherlands, and the UK being the leading countries publishing and receiving citations.
- Only 539 articles specifically address innovation and technical education issues over a 53-year horizon, indicating that research on this topic is still incipient.
- There is a need for more in-depth studies to evaluate the development of countries in promoting research on VET and innovation.
- Collaborative efforts with authors from other countries are scarce, and there is a lack of research on this topic in Latin America.
- The relationship between VET and innovation should be more represented in the field of management or social sciences.
- There is a gap in research on the relationship between VET and industry, as the most cited articles focus on improvements in teaching and learning practices or the adoption of technologies and innovations in teaching practices.
- Recent publications have addressed topics related to entrepreneurship, technological innovation, and industry 4.0, indicating a shift in research focus.
- The study provides valuable insights into the history and future direction of research on VET and innovation, which can help researchers identify knowledge gaps and future research directions.

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