Technical and Vocational Education and Training (TVET) Conceptual Map: A Bibliometric Analysis

Stephen Murray Universidad Popular Autónoma del Estado de Veracruz
Victor M. Castaño Universidad Nacional Autónoma de México
Cesar Aguado Cortes Universidad Nacional Autónoma de México

Abstract: *The article analyses a number of issues associated with Technical and Vocational Education and Training (TVET) using contemporary bibliometric methods. It is divided into two parts. The first deals with keyword frequencies in TVET in refereed publications and, on this basis, in which countries and institutes TVET research is most common. The second part makes a contrast between some of the most common focuses of these research projects and other themes that have attracted less attention. Through these means, the author makes a point that there is still a lot of work to do on the realities and potentialities of TVET and research into it.*

Keywords: *Technical Training, Vocational Education, TVET, Technical and Vocational Education and Training, TVET Publications, Bibliometric Analysis, Countries, Institutions, Authors, Developing Countries and Training, Returns on Training, Labor Division, Complementarity, Appropriability.*

1. Introduction

The rationale for this study argues that "classical" literature on the subject of technical and vocational education and training (TVET) – by authors such as Middleton et al. (1991), Bennell (1999), Johanson (2001), Grierson (2002), Ziderman (2002), Johanson and Adams (2004), Haan (2006), Asian Development Bank (2009), Pilz (2017), Guile *et al*. (2019), and ILO (2019) – does not adequately address the issue in terms of the skills within the company (intrafirm) and between companies (interfirm), and knowledge of the training.

The following investigation was carried out as a result of the clear recognition of two factors. In the developing world today there is a deep recognition that the provision of training can be improved if it is developed along with business needs. There is also a growing number of companies, of many types and sizes, that enter more directly into the field of training, either as clients of public or private training institutions, or as hosts of their own internal competence development. At the same time, an absence was clearly identified: a gap in research on firm-level training or at least the gathering of pertinent comments and advances that have occurred recently.

An analysis was undertaken of raw data relating to published documents on TVET using bibliographic sources such as Scopus The bibliometric tool was used in order to provide statistical analysis of the quantitative data provided by the scientific literature, in this way supporting some of the methods and conclusions reached. Thus, data was thoroughly analyzed, data that included annual distribution of key words, the main research institutions and cooperation between them, keyword matching, and distribution by topic and country (Rongyin and Limin (2010), Cobo *et al*. (2011)).

Training and skills are a part of the knowledge pool; framing and interlinking them is organizational knowledge. Effectively this comprises a means and a structure so that whatever

abilities are created through skills development activities are then put into use and produce some sort of benefit (Dosi *et al*. (2000), Leahy (2012). The resulting capabilities and competencies become part of the problem-solving, production-enhancing and strategy-adjusting resources of the particular firm. On the same theme, this also means that ideally a balance should be reached between the actual capabilities/competencies and hoped-for performance goals of the firm and those responsible for skills production. Otherwise, there is no full exploration of the talent produced or, vice versa, the training is inadequate to real needs.

The author considers the issue to be very important due to the following reasons: the growing leadership of certain companies in the proper and well-managed development of training and education, the innovative role of the company and institutional groupings in financing (with possible government assistance), as well as the indirect effects of the provision of professional skills and related support. Literature has not yet fully investigated these developments.

2. Methodology

To analyze this research field, raw data was collected for all the published documents on TVET using the bibliographic sources available in Scopus. This activity centered on keyword analysis that permitted a clearer understanding of the development of disciplines or topics within the general theme.

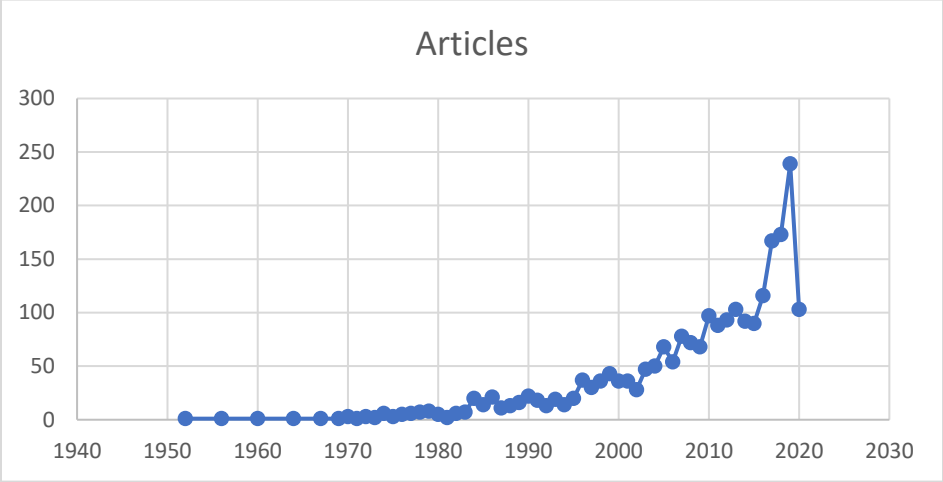
3. Results and Discussion

Section 1: Analysis of Keywords in TVET Research using Bibliometric Methods, and Country and Institute Locations

The author made a bibliometric investigation of scientific databases, which involves the analysis of previous investigations through a process of identification, grouping and consultation of elements in the literature that are useful for the purposes of studying the main themes of this work. Applying this bibliometric methodology, we identified in the Scopus scientific database 2,315 articles, which coincided with our criteria.

According to the results, there is a lot of literature on several key topics in this field of research: technical and vocational education and training (TVET) (259 articles), provision of training (505), training in the company and between companies (77), the return through training (33), its costs (1,320), compensation for "graduates" of training (21), innovation and training (90), and of course specialized training in specific sectors (mines, oil industry, etc.). These numbers show very clearly that there is a very strong interest in TVET due to its role in the economic development and industrialization of countries. In the area of academic research, there was a very revealing growth in terms of research publications related to technical and vocational training, especially during the last five years, and the trend seems to show that it will continue to grow in the coming years (Figure 1).

Fig. 1 Annual scientific production: Annual growth rate of the term TVET – 15.41%



However, we discovered that there is very little research on many important topics in this study: training needs within business firms, complementarity between business formation and organization, the relationship between training/division of labor/specialization, training system upstream vs. downstream, appropriability of training at the firm level, training system between companies, spillover of and returns on training, and knowledge of tacit and coded training, among others (Table 1 and Figure 2). This article will address these shortcomings in its latter paragraphs.

Table 1. Most frequent words

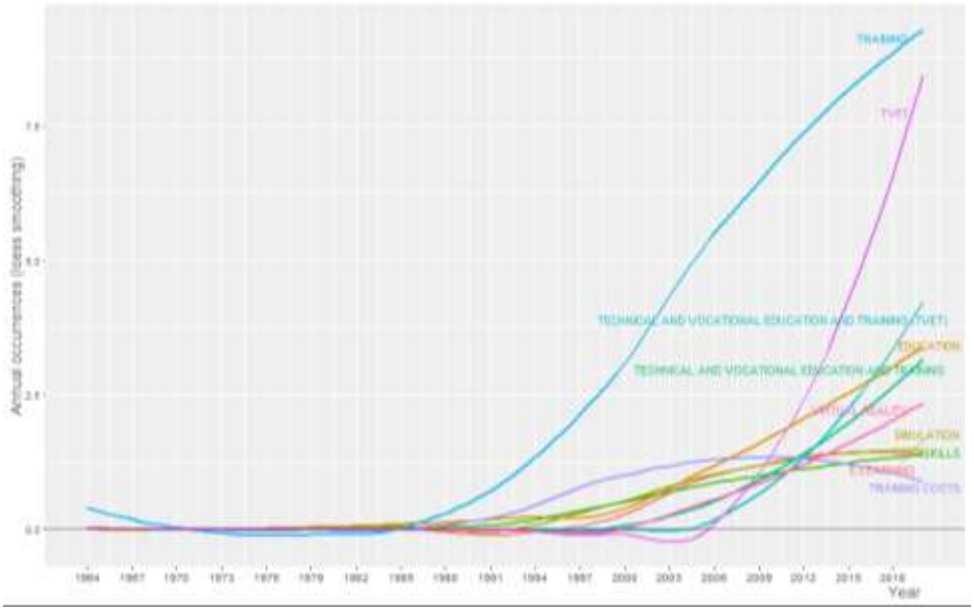
Words	Occurrences
training	158
TVET	45
education	42
training costs	31
simulation	27
technical and vocational education and training	26
e-learning	25
technical and vocational education and training (tvet)	25
skills	24
virtual reality	22
innovation	21
deep learning	19
human capital	19
vocational training	19
machine learning	16
vocational education	16

cost-effectiveness	**14**
productivity	**14**
cost	**13**
blended learning	**12**

We can also see which are the most popular words in the scientific databases related to this topic of TVET, among which the following stand out for being directly connected to training and new communication and information technologies: training (158), TVET (45), education (42), e-learning (25) and virtual reality (22) (Table 1).

We can also show the evolution over time of the frequency of words and phrases connected to TVET, in order to show their milestones and in what years they occurred (Figure 2). This information is based on articles published in refereed journals, and brings us closer to following the evolutionary line of words and phrases and their growth or decrease in a simple way, and also to understand their behavior regarding the importance of this topic in different countries.

Fig 2. Word dynamics



The works specifically on TVET published in peer-reviewed journals are mainly from the United States of America, the United Kingdom, and China, with between 120 and 280 articles published on this topic in each of these countries (Figures 3 and 4). Europe in general and Australia are very well represented: for example, in Germany there is a lot of research in this field perhaps for its highly developed culture of apprenticeship, while in the case of Australia it could be due to the importance of natural resources in its national economy. Many publications in developing countries have also been produced, assuredly because of their evaluations of necessary educational options and skills in terms of their own socio-economic growth (Malaysia, South Africa, Brazil, India and Iran).

Fig. 3. Country of the corresponding author

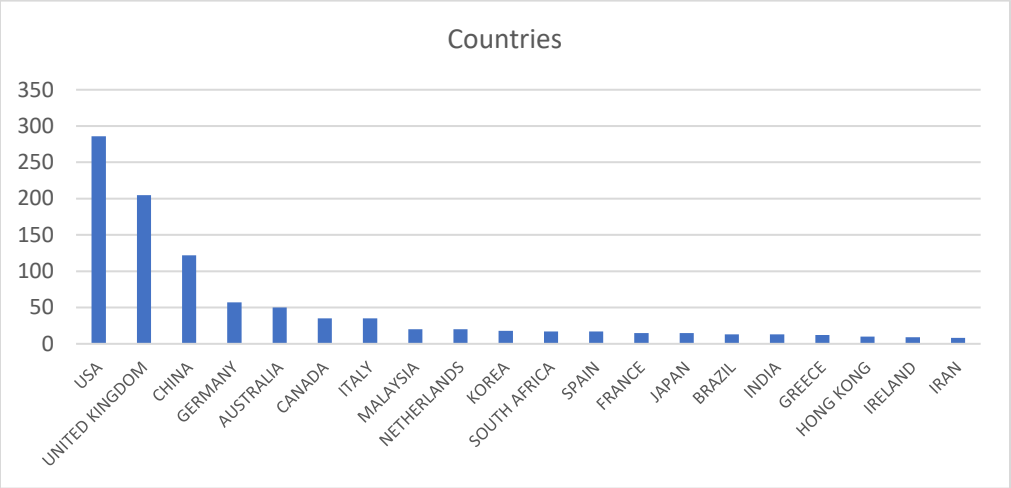
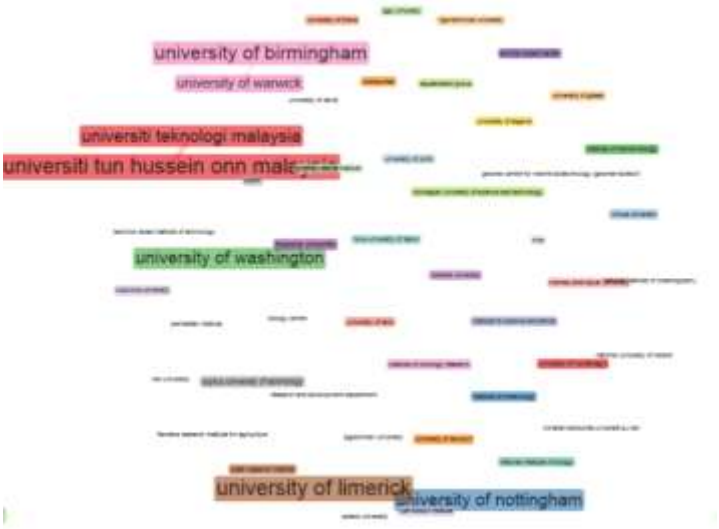


Fig. 4 Production of documents on TVET – Country

Fig. 5 Network of collaborating institutes



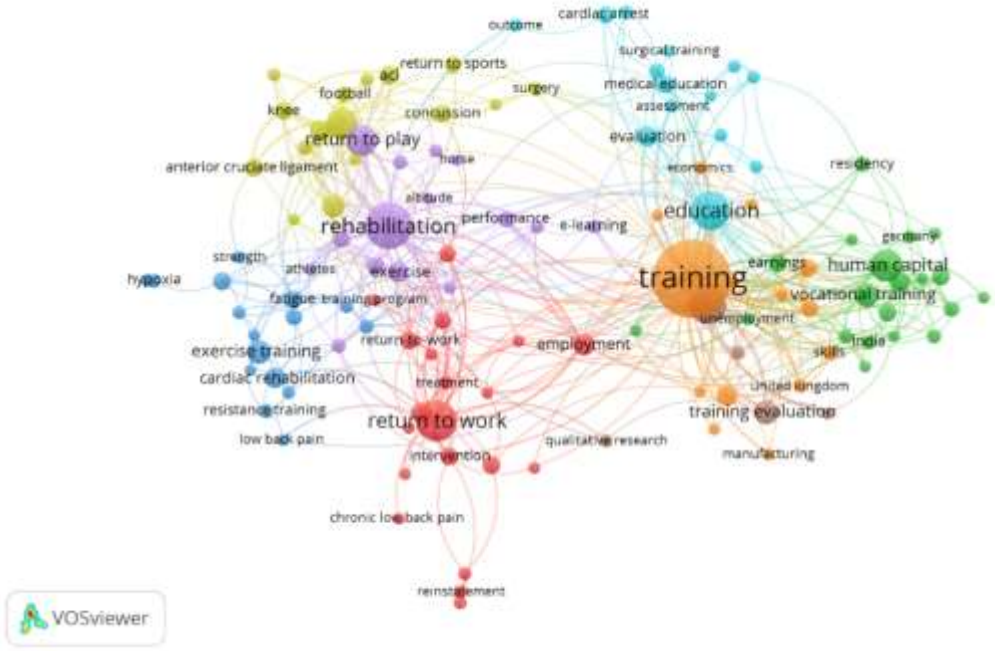
According to our research, there are some institutes of higher education where research on the subject does have a relatively strong importance; in addition, the connections that are identified in Figure 5 allow us to see the collaborations that the institutions have: among the more active institutions are the Universiti Teknologi and Universiti Tun Hussein Onn in Malaysia, and the universities of Limerick (Ireland), Nottingham, Warwick and Birmingham (United Kingdom), and the University of Washington (USA). If an institute focuses on technical education or something similar, the explanation is obvious. In these cases, it generally has something to do with the support of the national government (which might give targeted financing or other encouragement in the context of a national development plan), general interest in practical issues involving local industrialization, demand for graduates with this ability, and occasionally a response to identified needs of firms seeking improvements in their own technical performance – there are many reasons and none is exclusory.

Section 2: Bibliometric Analysis of Returns on Training and its Complementarity and Appropriability

In this section we would like to address a number of concrete subjects according to bibliometric analysis: the first focuses are on consequences of investing and providing training, the latter focuses are to do specifically with the complementarity and appropriability of training. The first themes are discussed in a great many publications, the second appear in far fewer studies.

The topic of returns on investment in training is one of the most important in the context of various considerations: of course, it stands as such in terms of the question of the existence of TVET *per se*, as well as other factors such as its sophistication, modality, duration, and benefits for all participants, among many issues. The number of documents on this key topic – 10,888 – clearly shows the role it plays in TVET's analysis and development in real terms (Figure 6).

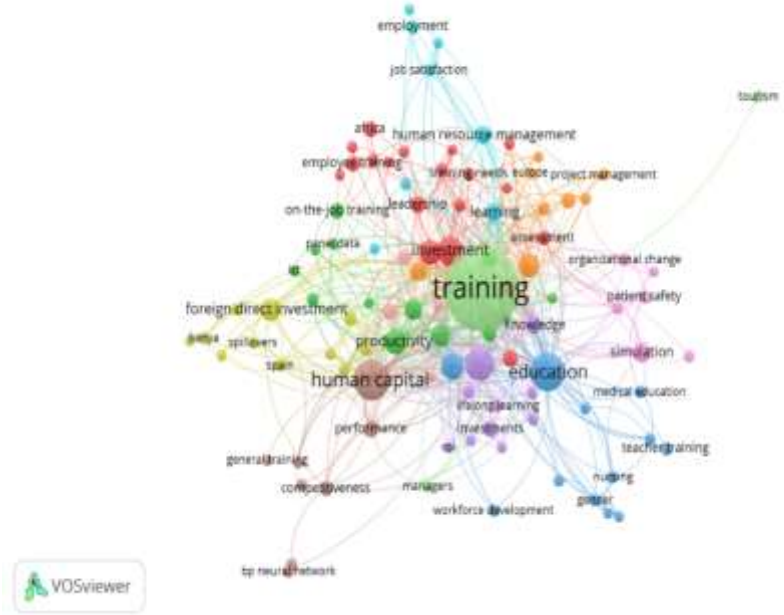
Fig. 6. Return on Training: 10,888 document results



The topic is linked to various fields in the literature: employment and unemployment, human capital, vocational training and income, education and evaluation/counselling, and return to work.

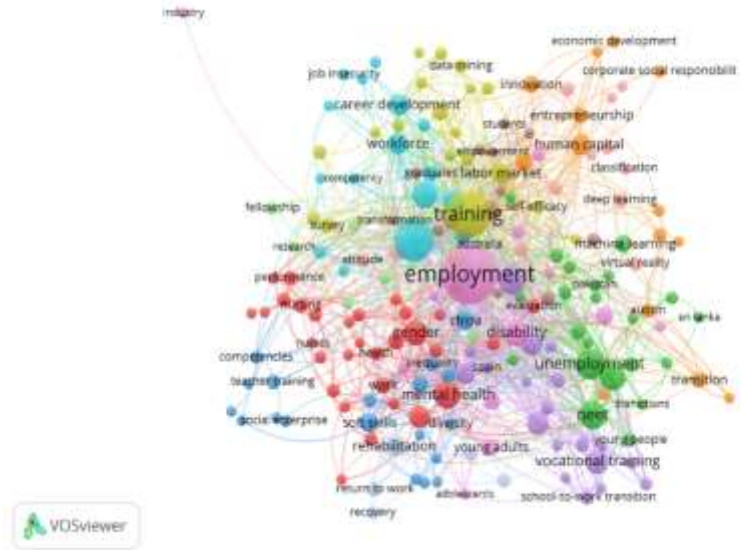
Equally, the relationship between investment and training is a very important research topic and has led to a huge number of publications: our analysis yielded 10,853 results. The general theme is related to a range of fundamental topics related to the well-being and development of TVET. The most important are investment (linked to leadership, training needs and human resource management), foreign direct investment and indirect effects, human capital (competitiveness and performance), and other fields such as project management, lifelong learning and organizational change.

Fig. 7 Investment and Training: 10,853 documents



The issue of training and employment involves a large multiplicity of questions and thus led to a huge number of results in our bibliometric analysis: our search led to in 19,485 results. This double topic in the literature has been investigated in conjunction with gender and diversity, unemployment, human capital and entrepreneurship, the labour market as well as professional development and the graduate labor market, in addition to job insecurity, social development and the transition from school to job.

Fig. 8 Training and employment: results of 19,485 documents



These issues of returns on increased investment and training, leading to an increase in employment levels, lead to the following conclusions:

1. If the skilled worker is simplistically thought of as the more productive type of employee over his unskilled alternative, and if whatever extra costs associated with him do not eliminate this cost/productivity advantage, then the skilled worker should be preferred under these conditions and in view of the support he will give to future firm-wide developments. Thus, training should reduce job precariousness and indeed should help in promotion.
2. If a training system is immature or not present (and there is a time issue) then the firm might prefer to employ skilled workers even from a great distance to create the necessary skills pool immediately. On the other hand, should a training system be in place, either internally or locally, then the unskilled/semi-skilled might be taken on in comparatively larger numbers than otherwise and developed according to the skills gaps and projections of the firm.
3. Again, according to the same model of a functioning training system, the perception of success in training outputs might lead to an expansion of job offers to similarly unskilled/semi-skilled candidates. The contrary could occur, needless to say, and the firm decides to develop other options to replace a skills development experiment that, for whatever reason, didn't work. This absence will mean that, if the local pool is in general unskilled, then this will affect their ability to enter the firm or, once contracted, their ability to rise through a process of upskilling (Hogrefe and Wrona, 2015).
4. There are other possible scenarios. One common one consists in the firm hiring the more senior people from outside (e.g., multinationals with a pool of easily transferable employees), at least in the early stages though often this is long-term, and concentrating their capacity-building efforts on local entrants who operate in relatively simple, lowly paid but essential positions such as truck-drivers, electricians, bricklayers, miners, and so on. While there might exist non-business reasons (community relations and licensing commitments, etc.) for undertaking this, it makes perfect business sense to take on underdeveloped locals if their educational level does not make them training-recalcitrant, if an existing viable alternative is not to hand, and if the work the trainees will do is not particularly fundamental to operations and needed urgently.

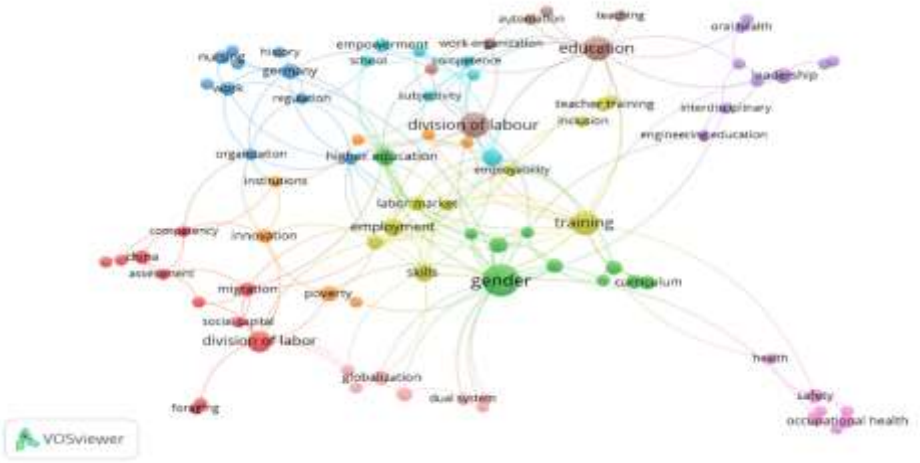
We can now pass on to a number of relatively underdeveloped themes in the field of research on TVET. The question of training complementarity is a relatively recent issue, confirmed by the comparatively low number (472) of documents identified in our bibliometric analysis. According to this activity, the most important topics are institutional complementarity, human capital, accreditation and virtual learning. Other issues – process, networks, diversity, classifying combination – appear in a few publications.

Fig. 9 Complementarity of training: 472 results of documents

There appears to be a complementarity between the organizational structures, procedures and routines of firms and the training that fits, supports and indeed extends them. The question then is, is there a clear organizational culture or set of employment practices that dictate what training should be done, by whom, for whom and when? This involves identifying which are the internal determinants of the training regime. The skills development undertaken will thus be contextualized and credible through its recognized derivative relationship with the business objectives as well as the work practices operating in the firm itself.

The topic of the division of labor in the context of training, although again it is not so common in the publications that were identified (477), is related to a great diversity of issues. Regarding training and the division of labor, authors have written on teaching, organizational work, and automation; leadership; empowerment, competence and subjectivity; labor market, employment and skills; organization and regulation; gender and curriculum; labor division in terms of social capital, advice and migration; institutions, innovation and poverty; globalization and the dual system; occupational health and safety.

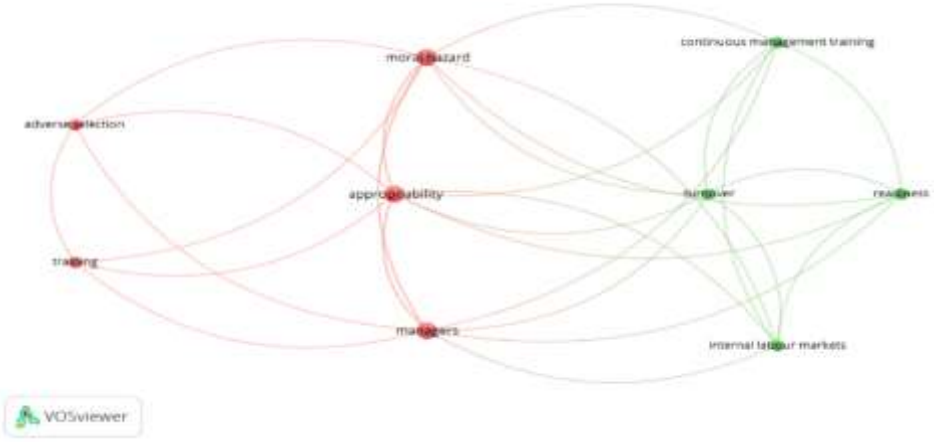
Fig. 10 Training and labor division: results of 477 documents



The results of a relative increase in supply of skills is that workers become capable of performing a wider range of jobs in a gradually more autonomous way, leading to the decentralization of task assignments and reduced division of labor (Mookherjee *et al*. (2010) and Milner *et al*. (2013)). This is certainly the case in many developed countries, but perhaps not so common or inevitable in the context of a developing country, unless (arguably) additional procedures are added to the training to emphasize autonomy of work and multi-tasking, and to counter ingrained behavioral and mental processes. As such, these additions must address such pro-business routines as worker interactions (Calvó-Armengol and Martí Beltran, 2009), decentralized as opposed to hierarchical working practices, the capability to learn competently by *doing* and not just by *studying* practices (Tapioca *et al*., 2019), and the elevation of workers as active decision-makers (Elms *et al*., 2010).

There is a paucity of publications on the subject of training appropriability. According to our bibliometric analysis, research activity has been quite restricted: the main ones are appropriability linked to moral hazard, adverse selection and manager training, and staff turnover linked to internal labor markets, training and preparation for continuous management.

Fig. 11 Suitability of training: results of 4 documents



This less-researched topic deserves some comment. Training in itself is not characterized by such restrictions on appropriability as secrecy, patents, continuous ground-breaking innovation and the dominance of complementary assets, as described in similar contexts by Su *et al*. (2013); rather it is eminently discoverable, available, transferable, adaptable and updatable. No matter what the general firm capabilities and on-site circumstances might be, ideally there should exist a level, content variety and amenable source of the required skills development. If done well and conditions are favorable, skills formation can be built up in stages, leading to increasing returns if carried out continuously and adapted to specific firm-level demands (Hage *et al*. (2013), Anadon *et al*. (2016)).

We can look at this further at the level of the firm, sectoral and non-sectoral cluster. If the training system within the firm is well-developed but focused towards in-house needs and practices, then it might have a high level of appropriability, particularly if its accumulated constituent components are not diffused; at the same time, some amount of diffusion might have advantages especially if competitive implications are not strong. At the broader interfirm and sectoral levels, if the shared training is extensive and well-endowed, then this indicates that widespread externalities exist: that interactive and diffusion activities – perhaps within selective limits based on competitive fears (Groenewegen y van der Steen, 2006) – would appear to be normal practice. Finally, looking beyond sectoral limits but still at the local level, the existence of a well-developed skills formation regime suggests that diverse local firms and institutions have separately and in partnership accumulated training capabilities in a network of localized training externalities.

5. Conclusions

The authors believe that the process of bibliometric analysis is a dependable and indeed compelling tool to be used in TVET research. Through it, it is shown that in terms of annual scientific production, TVET research has recently reached a healthy level of activity. Interestingly, while obvious keywords are dominant in the literature (education, training, TVET), other

keywords related to contemporary methods and equipment have recently become increasingly significant (e-learning, information technology). On the other hand, the same tool also reveals that certain areas are demonstrably lacking in concerted efforts at research.

Four countries are the homes of the most authors on this subject (the United States, the United Kingdom, China and Germany), but importantly a number of less-developed nations have a strong presence in published TVET research, an indication of concrete local demand for this knowledge. Our research even showed that two institutes in Malaysia have achieved a strong investigative culture in matters relating to TVET, easily the equal of any other institute at the global level.

The paper presented clear evidence that certain topics – the examples were return on training, investment in training, and training and employment – are associated with a large number of publications. And this was contrasted with the small investigative investment made in other areas, the examples being training in the context of complementarity, appropriability and division of labor.

The authors contend that certain sub-fields of TVET activity will offer a rich mine of material and insight. Equally, he argues that certain recent thoughts on such matters as the learning enterprise, innovation systems, and value chain theory, as found in the literature (Davila *et al*. (2006), Sheffi (2012a, 2012b), Powell, and McGrath (2014), etc.), could be adapted to better explain the recent and very large measures taken by companies and institutes in the field of training, as well as the internal and external consequences of training programs and standards related to business operations and performance, and even government-sponsored development projects.

In short, it is obvious that a more panoramic understanding of TVET in theory and practice should be created that addresses the reality of vocational and technical training, and its part in enabling and creating knowledge and innovation, particularly in the developing world.

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About the authors

Stephen Murray (smurrayk@cilatam.com) is general director of the CILATAM Institute in Mexico City and a director of the Institute of Existential Analysis of Mexico.

Victor Manuel Castaño (vmcastano@unam.mx) is a lecturer at the Universidad Nacional Autónoma de Mexico (UNAM – Faculties of Chemistry, Sciences, Engineering, Accounting and Administration, and Dentistry) and visiting professor at a large number of other universities, and was the founding Director of the Center for Applied Physics and Advanced Technology of the UNAM in Juriquilla, Querétaro. He is associate editor of several prestigious international journals and treasurer of the International Council for Materials Education.

Cesar Aguado Cortes (caguado@docencia.fca.unam.mx) is a lecturer in business administration at the Universidad Nacional Autónoma de Mexico (UNAM) and visiting professor in several other institutes.