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EARLY VIEW

Characterising The Literature on Science Teacher Identity: A Bibliometric Study

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ABSTRACT

This article reports a bibliometric analysis of 44 articles chosen from 55 articles on science teacher identity studies, published in the Scopus database from 2011 to 2019. The study analyzed the trend of science teacher identity based on the number of citations, publication year, country contribution, and co-occurrence of keywords in these journal articles. This study showed that there was an increase in the publication of the topic of identity for science teachers in the last ten years. The results of the analysis showed that studies related to science teacher identity had been carried out in various countries where the United States is the country with the most contributions. We also identified core research topics concerning science teachers' identity, such as identity development, professional identity, identity context and implication, which receive more attention than the other topics. This study concluded with suggestions for future projects to consider exploring the intersection of agency and practical work with identity and between social categories, especially in elementary education.

Keywords: Bibliometric, science teacher identity, Scopus, VOSviewer

INTRODUCTION

Identity has forced an attention in the last decade. Recognising identity and its related issues might be a challenging endeavor (Beauchamp & Thomas, 2009). Identity is a complex framework, difficult to define adequately (Lawler, 2014), and interpreted in multiple ways by many researchers (Le et al., 2019; Olsen, 2008). It is difficult to define a single overarching definition of what identity is, how it developed and how it worked (Trede et al., 2012). Identity is difficult to study because of the dynamics of identifying who we really are and how we come to see ourselves as some kind of people (Aschbacher et al., 2010; Le et al., 2019). There is a lot of things to be learned if someone appreciates the role of identity in the development of teachers.

Recently, the importance of identity in teacher development has been emphasized in the field of education. In many works of literature, this term is also often termed professional identity. Professional identity and its development are complex constructs embedded in the array of experiences, interactions, thinking, and responses of the individual teacher. This identity is a reflection of a teacher who describes his or her characteristics as a teacher. Avraamidou (2014a) perceived identity refers to how a teacher reflects herself through her personal views, orientations, behaviors, content knowledge, knowledge, and beliefs about science teaching, and how someone behaves within particular contexts. According to Gee, (2000), identity is a certain kind of person who is recognised as "being" at a given time and place, can change or become

unstable. Lawler (2014) offered a set definition of identity. She argued that identity is the way individuals are very similar or identical to others. Individuals will share a common identity with certain people but will be very different from others because each human has unique aspects that make them special from each other to varying degrees.

In science, study identity is important for understanding the development of a science teacher. It has been assumed that several features make up the identity of the science teacher. Teaching and learning and the nature of science conceptions are two of the most common aspects of educators to be positioned at the core of science teachers' identity (Badia & Iglesias, 2019). Several researchers from across the world have been exploring science teacher identity. Wei et al. (2019) said that there is a strong correlation between practical work and scientific inquiry that shapes the development of teachers' identity. Childs (2018) explores the nature of the identity of science teachers in an unfamiliar society to teachers. Teachers enhance identity when enacting real-world educational activities (Silvestri et al., 2019). Therefore, based on the nuance of science teacher identity study, it is important to analyze the study trend in this field.

The bibliometric study could be used to explore a research topic trend. For example, researchers conducted a bibliometric study to measure research trends in the field of education in general (Huang et al., 2020) and specific areas such as science education (Chang et al., 2010), educational technology (Chen et al., 2019), augmented reality in education (Karakus et al., 2019), academic dishonesty (Marques et al., 2019), and other topics in education. However, there are still few or perhaps no studies related to bibliometric analysis on the topic of science teacher identity. In order to know the pattern and future analysis of the identity of science teachers, we conducted a bibliometric study to make easy find gaps for researchers and to do deep analyzes to establish the aspect of science teacher identity. The research question in this study is as follows:

1. What is the trend of science teacher identity study?
2. Which countries, based on the countries in which authors were located, contributed to journal publications in science teacher identity?
3. Which are the core authors and journals published in the field of science teacher identity?
4. What are future science teacher identity topics that provide opportunities for further research?

LITERATURE REVIEW

Identity is complex. As quoted in the book of Avraamidou (2016) that "identity is not an identity on its own, its meaning derives from the whole self that is systematic, continuous, social, contextually and culturally situated whole self." Teacher identity is strongly linked to self-concept and the social systems in which the teacher experiences what it means to be a teacher. Teacher identity formation has been shown to be a complex and culturally based process that occurs over time and in a variety of contexts (Edwards & Edwards, 2017). Developing a professional identity as a teacher takes time and effort. The lack of explicit definitions of teacher identity frequently leads readers to assume its meaning, which contributes to the concept's lack of clarity and makes it even more difficult to establish a dialogue among the various disciplines and methodologies that study identity processes (Sfard & Prusak, 2005; Solari & Martín Ortega, 2020).

Studies related to the identity of science teachers have been carried out in various research contexts ranging from systematic reviews (Avraamidou, 2014b), case study (Wei et al., 2019), and narrative inquiry (Avraamidou, 2014a), and another research context. Avraamidou (2014b) synthesize 29 articles about teacher identity in the science education context. This study examines the useful insight and important findings of some studies in the science teacher identity field. She succeeded in providing an

overview and a knowledge base on science teacher identity research-based. She highlighted the complexity of the identity construction of a teacher. Therefore, she wrote four recommendations in her study. Firstly, identity could be explored as a process. Secondly, reform in education should be linked with identity study. Thirdly, an identity study is possibly conducted over a long-term period. The last, the identity of a teacher in the classroom context could be analyzed.

Another study conducted by Avraamidou (2014a) was conducted a study of beginning science teachers. By combining the identity framework and narrative framework, she found four themes. The identities built by the participants in this study strongly believe in inquiry learning as reformative learning. In addition, the identity of the novice teacher was significantly influenced by his interactions with mentors, lecturers, and student teacher candidates. Context of university, the field experience context, and the first-year-of-teaching context were also found to influence the participant's identity as a science teacher. Finally, in relation to gender, participants in the study had a positive view of female teachers compared to male teachers. In short, the identities that are constructed by a novice teacher are formed in a complex way through interactions within oneself and with others.

Rushton and Reiss (2021) conducted a systematic review on science teachers' identity at the middle and high school levels using the social identity approach (SIA). From 79 empirical and theoretical publications on science teacher identity with a time span from 2000–2019, the authors highlighted the importance of shared identity and group membership in the development of science teachers' identities.

Wei et al. (2019) conducted a case study on outstanding students as novice teachers. Over the course of 10 months of observing and conducting multiple interviews and using the framework of their personal, social, and situational identities, they found the correlation between scientific practice and scientific inquiry was very strong. Furthermore, this condition will affect the formation of teacher identity. In general, this study shows four main themes that shape teacher identity, namely: personal characteristics, contextual constraints, sustainable interpretation of experiences with practical work, and a sense of agency. In particular, the teachers observed in this study strongly believe that science learning should be taught with an emphasis on the inquiry process.

Glass (2019) emphasizes that teacher education programs must engage teacher candidates in reflective practice in order to make them aware of the various ways in which their experiences have shaped their identities. Prompting teachers to develop a clearer view of their own identity formation may allow them to identify significant moments in their own past that they can recreate, or reinvent, to promote their students' engagement with and love of science.

In brief, identity is a very contextual concept in teacher education. Identity is formed through experience and environment (Marco-Bujosa et al., 2018). Therefore, every science teacher has a special way and form related to how he evaluates himself as a science teacher. Finally, although it is not as popular as other topics in teacher education, teacher identity in science education still deserves to be considered as a potential part of the development of pedagogy and education.

METHODS

We utilized bibliometric analysis in this study. This method enables researchers to examine topics in a research field, trends in the topics, and interrelationships between these topics in a large corpus of literature (Ellegaard & Wallin, 2015). In addition, bibliometrics can also analyze the bibliographic network of the authors (Ha et al., 2020; Karakus et al., 2019) and analyze possible gaps or future research on a topic (Gao et al., 2021; Marín-Marín et al., 2019). There are five steps to process the literature in

order to ensure that the reviews are carried out systematically and that the data obtained is reliable (Fahimnia et al., 2015). These steps are presented in Figure 1.

(Figure 1 here)

The first step is determining the database. The database used in this study is Scopus. The main reason for choosing Scopus as a database is that Scopus is a fairly large peer-reviewed article database with several journals covered by around 15,000 journal titles (Neuhaus & Daniel, 2008).

The second step is the bibliographic search. By using Publish or Perish (PoP) software (https://harzing.com/) in September 2020, we have been looking for articles with the title word "Science Teacher Identity" for the last ten years (2010-2019). Publish or Perish software can be used to query some databases in a bibliometric study (e.g., Setyaningsih & Indarti, 2018).

The next step is refining the search result. We refined the initial search through some criteria. For example, we exclude duplicate articles, chapters, and conference papers. After refining the data, we compile the data by using Zotero software. Through this software, we checked and added incomplete metadata and then extracted it to RIS format.

The final step is analyzing the data. Bibliometric analysis and bibliometric visualization methods were used in this study. In a bibliometric analysis, descriptive and evaluative approaches are used to represent research trends and characteristics of a set of publications (McBurney & Novak, 2002). Meanwhile, bibliometric visualization strategies are employed to illustrate a structural overview of a particular topic area (Garfield, 2009). Microsoft Excel and VOSViewer software (http://www.vosviewer.com/) were used to visualize the data.

There are some parts to analyzing the data. Firstly, this study analyzed the citation data from the PoP software query result. Secondly, we also classified the article database based on the year of publication and visualized it into a diagram. Thirdly, in order to investigate country contributions, we analyze the authors' affiliation in every paper and then count their contributions by using a formula introduced by (Howard et al., 1987).

$$Score = \frac{\left(1.5^{n-i}\right)}{\sum_{i=1}^{n} 1.5^{n-i}}$$

While (n) is the number of authors in the article and (i) is the order of an author in the article. The results obtained are ranked and presented in tabular form. Finally, we explore the occurrence and the link strength of the terms in the science teacher identity topic by using VOSviewer.

RESULTS

The findings of this study are portrayed from more general results to more specific results. According to Karakus et al. (2019), this information flow helps readers to follow the relationships from the most general information to discover detailed details that explain the previous ones, respectively.

The initial search results using the PoP program found 55 papers from 2010 to 2019. This series of articles was then refined to include only the research paper. Some types of publications were excluded from the

list. Five conference papers, five chapters, and five review articles were not included in further analysis. Therefore, 44 articles that analyze in this study. The overall metric data is present in Table 1.

(Table 1 here)

In order to illustrate the research trend over the last ten years, we visualize the data in Figure 2. Figure 2 shows the publication trend in the science teacher identity field. Researchers' interest in the topic of science teacher identity has tended to increase over the last ten years. For example, there was a double rise in 2019 from 2018 and twelve times from 2011.

(Figure 2 here)

Using the formula Howard et al. (1987), we present countries' contributions to the field of science teacher identity field. The data are present in Table 2. The findings revealed that studies on the identity of science teachers had been conducted in a number of countries across several continents. The United States, however, dominates publications in this field. On the other hand, this study is still rarely disclosed in Asian and African countries. In Asia, only China, Macau, and Thailand have been recorded as contributing to teacher identity science research.

(Table 2 here)

To analyze the impact of scholarly publication, we presented the list of top ten cited articles about science teacher identity in the Scopus database as presented in Table 3. In addition, according to the number of articles published, we listed the top five journals on the topic studied in Table 4.

(Table 3 here)

(Table 4 here)

Table 3 shows that the most cited article on this topic is an article from Avraamidou (2014b) that was cited 50 times. The title is "studying science teacher identity: current insights and future research directions," which was published in the Studies in Science Education journal. Of the top 10 articles, five were published in 2014, such as Avraamidou (2014b), Hanuscin et al. (2014), Akerson (2014), and Danielsson and Warwick (2014). The newest most cited article was published in 2017 with the title

"Killing curiosity? An analysis of celebrated identity performances among teachers and students in nine London secondary science classrooms."

Within ten years periods, the number of articles about science teachers' identity published in the top five journals is still less than ten. Among all journals, Cultural Studies of Science Education publish the most articles. All five top journals are under the first quartile (Q1). Four of the five are categorized in Social Sciences Citation Index (SSCI), and one the other is categorized in Emerging Sources Citation Index (ESCI). All journals are hybrid or transformative journals that authors can choose between open access or subscription publication, based on their preferences, funder or institutional requirements, and article processing charge (APC) funding availability. The journals are under the auspices of three well-known publishers, two journals from Springer, two from Taylor and Francis, and one from Elsevier.

Extracting from the title and abstract fields, full counting with the minimum number of occurrences set to 5, we get 1156 terms and 66 items meeting the threshold. After being analyzed, the result of the VOSviewer program was exported to be an image of network visualization (Figure 3), Overlay visualization (Figure 4), and density visualization (Figure 5). The network, overlay, and density visualization analyses are used to map the relationship between the keywords that appear the most frequently in the articles analyzed.

(Figure 3 here)

From network visualization (Figure 3), there are five clusters of the topic area studied that are distinguished by color. The first cluster is represented with red; the second cluster is represented with green, the third cluster with blue, the fourth cluster with yellow, and the fifth cluster with purple. Using the VOSviewer, we can investigate the frequency of occurrence of terms and the strength of the relationship between terms. The larger the circle, the more times a keyword appears in all documents (Zhang et al., 2022, p. 19). Lines between items represent links. By default, only the first 1000 lines are shown, representing the 1000 strongest links between items.

The first three clusters are relatively large compared to the other two clusters. The keywords with the highest co-occurrence within each cluster represent the concepts that have received the most attention and constitute an emerging theme. For example, in cluster 1, the occurrence of the term "identity" is relatively large (86) and has a high enough link strength with the "experience" term (42). This implies that identity-related studies are closer to participants' experiences. On the other hand, for the practical work topic, there were only 11 occurrences with a strong association with identity 38. These data indicate that there is an opportunity to explore this topic.

In cluster 2, the core term of this cluster is identity development (24). Interestingly, there is no relationship between identity development with some important terms such as reform, practical work, and agency. Identity development is discussed more with the topics of course and practice. Meanwhile, in cluster 3, there is the science teacher identity term. Since the main keyword of this work is science teacher identity, the term has a fairly good network, among other terms. However, science teacher identity in this study does not have a relationship to several terms such as NOS, elemental teacher, practical work, and agency.

(Figure 4 here)

This overlay visualization (Figure 4) is identical to the network visualization, except that items are colored differently. The overlay visualization describes the relationship between terms with the year of publication. There are different color degradations for each term that are displayed, ranging from purple to yellow. The purple color indicates that the terms are from an older publication, whereas the yellow color indicates that the terms are from a more recent publication. For example, a study about the relation between the identity term with practical work and the agency term is relatively new (2018). On the other hand, the study about the identity of elementary teachers and NOS has been done for quite a long time.

(Figure 5 here)

In line with network and overlay visualization, The density distribution of the keyword co-occurrence network (Figure 5) effectively reflects how "hot" or "cold" a research topic is (Huang et al., 2020). The brighter the color of the image, the more often the term is used in research. Higher density indicates a closer distance and strong correlation between topics or terms. For example, identity and context or implication are the "hotter" or more popular a specific research topic. On the other hand, terms like NOS, student-teacher, reform, agency, and practical work have not been widely investigated in research related to the identity of a science teacher. Therefore, it needs more effort to evaluate these terms in science teacher identity research-based.

DISCUSSIONS

This study offered an overview of the study on science teacher identity in the Scopus database. The data was collected, analyzed, and visualized in a bibliometric study. By using a quantitative approach, the researcher conducted a bibliometric evaluation and visualization using the VOSviewer software. In this study, specific information to the general public regarding teacher identity science research trends has been presented in the form of general descriptions related to article citation, the contribution of countries involved in the topic of study, topic characteristics, and the relationship between topics related to the teacher identity science literature.

The results of the analysis showed that there was a positive increase in peer-reviewed articles related to science teacher identity published from 2010 to 2019. This has also been explained in Huang et al. (2020) study, who stated that based on the results of systematic reviews in several top journals, it was found that teacher identity was one of the main topics of education research in the period 2008 to 2014. Several reviews show that teacher identity has so far been used as a framework and lens in observing various aspects of teacher careers and teacher education (Beauchamp & Thomas, 2009; Beijaard et al., 2004; Izadinia, 2013). Indeed, information related to the teacher's process of establishing identity can be a reflection and a consideration in preparing prospective teachers (Zembylas & Chubbuck, 2018).

Besides, the researchers also found that the United States was the country that contributed the most, followed by Cyprus, South Africa, and the United Kingdom. The large variety of countries involved in this topic implies that this topic is starting to receive attention from researchers. However, the contribution

of Asian countries is still relatively small, whereas countries in Asia such as Macau and Thailand are in the lowest ranks. The difference may be due to differences in countries' GDP. This was conveyed by Lee and Haupt (2020) that countries with high GDP tend to have more resources and funding for publishing. In addition, the government's attention to the quality of education is one of the factors. For example, in building the K-12 framework for science education in America, teachers are actively involved in providing input and compiling the framework (National Research Council (U.S.), 2012).

The number of publications in the top five journals in this study is still relatively small, namely less than ten articles for publications from 2010 to 2019. Based on the number of documents published, the journal Cultural Studies of Science Education is the journal that publishes the most science teacher identity articles, followed by the Journal of Science Teacher Education. The other important journals in this field were; the International Journal of Science Education, Research in Science Education, and Teaching and Teacher Education.

According to the number of citations, the most important article on the science teacher identity topic is the study of (Avraamidou, 2014b), and the second is the study of Katz et al. (2011). Avraamidou (2014b) explained that researchers carried out the framing of identity in various forms such as: identity as a lens for studying science learning, identity as a lens for teacher preparation, teacher identity, reform-minded teacher identity, and subject matter knowledge, and teacher identity. Katz et al. (2011) highlighted that incorporating an informal science education internship into a formal science teacher education program influenced participants' professional identity development as science teachers positively. These two articles provide a basic overview of what an identity is and how the science teacher identity develops. This area is particularly important for topics that are just beginning to receive attention in the field of science education research.

Based on the evaluative analysis using VOSviewer, we found some insights related to science teacher identity research trends. For example, the research method that is widely used in this topic is the case study. In addition, this study dominates the terms of experience and identity. This is certainly appropriate because the identity of a person is mainly formed from experience (Lutovac & Kaasila, 2018). The analysis results also showed that the strength of the relationship between NOS, elemental teachers, practical work, agency, and science teacher identity is very small. Therefore, this study suggests conducting a study on the identity of science teachers in elementary schools or exploring how practical work and agency can shape and develop the identity of a science teacher.

CONCLUSSION AND LIMITATION

This bibliometric analysis allowed us to examine a large corpus of studies about science teachers' identity. Academics' interests and attention to science teachers' identity topics tend to increase over recent years. Authors from the United States have contributed the most in this field. The core authors most referenced were Avraamidou (2014b) and Katz et al. (2011). Both of them present a conceptual foundation related to science teacher identity. In addition, the journal Cultural Studies of Science Education publishes the most science teacher identity articles out of all. We identified core research topics concerning science teachers' identity, such as identity development, professional identity, identity context and implication, which receive more attention than the other topics. We also revealed topics that researchers have not paid as much attention to, and it became an opportunity for researchers to do future research.

The main limitation of this study is the number of publications involved in the final analysis. Our search criteria of including only documents from the Scopus database and published in English may exclude relevant studies that were not available in the Scopus database or written in other languages. This

happened because of the limitations of the researchers, so we only used one database. We also realize that this also has implications for the analysis of VOSviewer results due to its limited keyword database. However, by not generalizing, the results of this study are still meaningful as a subset of results. In particular, this result at least provides a snapshot of the study of science teacher identity as a relatively new study in science education. Further research can be done using other databases such as WoS or Google Scholar.

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