Contribution of Neuroscience to Educational Management and Pedagogical Processes

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Abstract

A documentary review was carried out regarding the production of research papers concerning the study of Neuroscience applied to educational models during the period between 2016 and 2020 worldwide, through which general aspects of scientific publications registered in Scopus database are highlighted, such as year of publication, specific area of knowledge, participating authors, country of origin and type of publication, which allows to quantitatively describe the evolution of the theories that are framed in strategies derived from neuroscience to be applied in the area of educational management. In this way, a total of 1,257 documents registered in Scopus were identified, of which a bibliographic analysis was also carried out to know the opinion of different authors regarding the topic mentioned above, thus carrying out a qualitative analysis of the bibliographic records, which allows knowing the degree of incidence of some strategies proposed from neuroscience regarding the pedagogical processes in educational institutions.

Key words: Neuroscience, Educational Management, Pedagogical Processes, Educational Institutions.

1. Introduction

Knowing how the brain works is an important reason why scientists around the world direct their efforts to analyze the different learning patterns and disorders that limit the learning process, a subject in which there is still no consensus on how many learning difficulties can be let alone typify them (Marina, 2012) .

However, it can be mentioned that in recent years, research has focused on the characterization of disorders of executive functions such as autism, intellectual retardation, motor control, among others, which in education require special treatment due to the complexity of the teaching-learning process.

The application of neuroscience models in the different levels of knowledge formation in people who suffer from some physical or psychological disorder that does not allow an ideal learning and requires strategies for the appropriation of new knowledge based on the discoveries that neuroscience contributes from the identification of how the brain learns and how the transmission of information works in it, goes through different challenges from the current paradigms of education, that is to say, the traditional models that often continue to be rooted in the institutions and teachers, as well as governmental policies which exert a decisive power in the allocation of economic resources for research that allow advances in terms of technology and theories that serve as a basis for the continuous development of strategies for the improvement of the welfare and quality in the education of patients with special conditions. Therefore, it is sought that the educational

systems really seek inclusion through equity in opportunities for access to professional training, as well as a suitable and qualified teaching staff in competencies that allow the applicability of strategies in the articulation of technological resources that help the training of students (Román & Poenitz, 2018). . Based on the importance that research has on the development of new technologies that aim to improve the quality of life of patients with psychological disorders through quality education, the following question is then posed How has been the scientific production of research papers related to Neuroscience applied to Education during the period 2016-2020?

2. General Objective

To analyze from a bibliometric and bibliographic perspective, the production of high impact research papers on the variable Neuroscience applied to Education during the period 2016-2020.
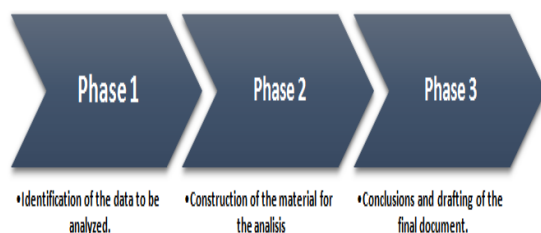
3. Methodological design

Figure 1. Methodological design
Source: Own elaboration (2021)

3.1 Phase 1

Phase 1 identifies the research papers that will be analyzed. They will be identified using the SEARCH tool available on the Scopus platform web page and will be classified according to the following parameters:

- Research papers published in the area of Neuroscience applied to Education.

- Research published during the period from 2016 to 2020.
- Neither country of origin nor specific area of knowledge will be taken into account.

After applying the search filters, a total of 1,257 research papers that meet the requirements were identified and will be organized through the execution of phase 2.

3.2 Phase 2

The information is classified using graphs, figures and tables with the help of EXCEL and VOSviewer tools for subsequent analysis. The organization of such data will be done by means of the following distribution.

- Distribution of scientific production according to year of publication.
- Distribution of scientific production by country of origin.
- Distribution of scientific production by area of knowledge.
- Distribution of scientific production according to participating authors.

3.3 Phase 3

Once the information was identified and organized, it was analyzed, and then the construction of conclusions and the drafting of the final document.
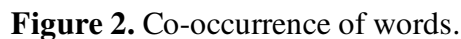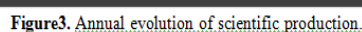
4. Results

4.1 Bibliometric analysis

The scientific production related to the application of neuroscience to education has multiple areas of action and knowledge that carry out studies focused on the mentioned topic, within which, as shown in Figure 1, the keywords with the highest co-occurrence are related. There is a high frequency of studies related to the Human component, brain functioning, skills, medical education, learning and self-care. Thus, it can be inferred that self-management knowledge strategies are associated with specialized treatment in neuronal aspects and the development of

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techniques associated with pedagogical processes. Similarly, the words are directly related to the area of health and educational processes focused on patients with some type of pathology associated with the functioning of the brain, so that medicine, nursing, clinical psychology, health education, among others, also show a high degree of co-occurrence.

Figure 2. Co-occurrence of words.
Source: Own elaboration (2021), based on data provided by Scopus.

4.2 Distribution of scientific production by year of publication

Figure3. Annual evolution of scientific production.
Source: Own elaboration (2021), based on data provided by Scopus.

During the period 2016-2020, as shown in Figfure3, a relatively stable production going from 266 researches to 227 between 2016 and

2017 as the latter year in which the lowest number of documents is registered within which the paper entitled "The defense of music education from neurosciences" (Penalba, 2017) stands out, which aims to analyze the different trends in the promotion of music education programs through cognitive neuroscience.

In 2018, a record 232 papers were achieved including one entitled "Incorporating sleep medicine content in medical school through the neuroscience core curriculum" (Salas, et al., 2018) which seeks to justify the importance of including sleep medicine in medical training programs, defending through the contributions of neuroscience techniques in the learning process, ratifying the feasibility of incorporating such thematic in the educational management of educational institutions.

By 2020, the production has reached a total of 291 published papers, being this year the one with the highest number of publications related to neuroscience in education. Among the papers published is "Environmental Education and its Relationship with Educational Technologies, Transculturality, Educational Inclusion, Neuroscience and Teacher Training" (Fernandez & de Barros, 2020). whose objective is to measure the perception of teachers on environmental education among other relevant topics at present and the incorporation of neuroscience technologies and techniques in environmental education training plans, concluding that teachers perceive inclusive education as necessary from different approaches with the purpose of integrating students with current topics properly focused on environmental education.

4.3 Distribution of scientific production by country of origin.
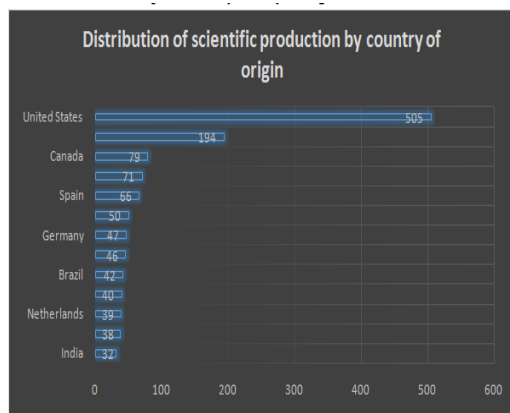

Figure4. Distribution of scientific production by country of origin.
Source: Own elaboration (2021), based on data provided by Scopus.

For the purposes of this research, no filter was taken into account that did not allow the registration of a specific country, thus seeking to know how the existing bibliography on the topic of study is distributed at a global level.

Figure 5 shows the United States as the country with the highest number of publications on the application of neuroscience to education, with a total of 505 documents, including the paper "Undergraduate education in neuroscience: facing the challenges of the 21st century", which aims to analyze the pedagogical models currently being implemented, especially after the world faced a pandemic such as that generated by the emergence of COVID-19 and the need to migrate the pedagogical models that are currently being implemented, especially after the world faced a pandemic such as that generated by the emergence of COVID-19 and the need to migrate the pedagogical models currently being implemented (Ramirez, 2020) which aims to perform an analysis of the pedagogical models that are currently implemented, especially after the world faced a pandemic such as the one generated by the appearance of COVID-19 and the need to

migrate teaching processes to the use of digital platforms, so the paper highlights the effort and commitment of teachers of the neuroscience program, in achieving objectives through the challenges represented by the changes that the world has had to face thanks to the pandemic mentioned above.

The United Kingdom and Canada are in second and third place with 194 and 79 research papers published respectively, followed by Australia with 71. Spain is the Spanish-speaking country with the highest production registered in the Scopus database with 66 papers, including the article "Systematization of psychomotor skills and cognitive development", whose objective was to test how Cognitive Neuroscience practices can be implemented in the cognitive development of children through habitual psychomotor practices at an early age (Mas, Jimenez, & Riera, 2018) whose objective was to prove how Cognitive Neuroscience practices can be implemented in the cognitive development of children, through usual psychomotor practices at an early age. The study proves that the practice of physical-motor exercises in children benefits their cognitive development in the school stage.
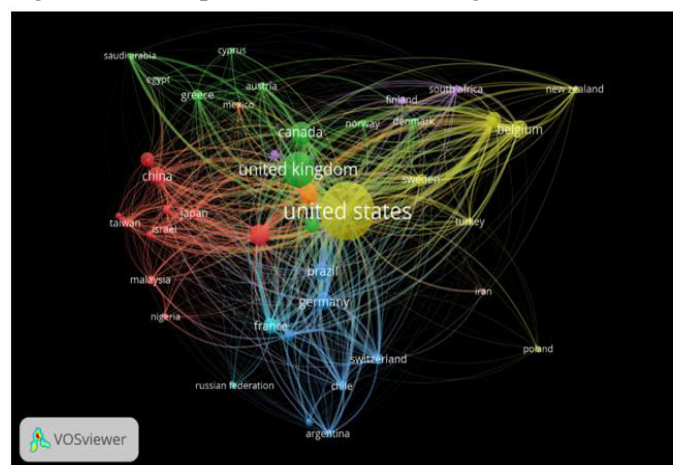

Figure 5. Countries participating in the bibliographic production.
Source: Own elaboration (2021), based on data provided by Scopus.

It is worth noting that the documents recorded in Figure 5 represent the volume of

production by country, bearing in mind that an article may be registered by one or more countries depending on the degree of international collaboration of the institutions and their developers. Figure 4 shows the participation between countries in the development of research papers and their subsequent publication.

Figure 2 shows 4 main groups of countries that have presented research works together and with greater frequency. The most representative group is led by the United States, which, together with Switzerland, Turkey, Belgium and New Zealand, has contributed to research related to the application of neuroscience in education. Likewise, the United Kingdom has contributed in research works, which precisely leads the second group of countries that have collaborated in the bibliographic production of the topic under study, and has the participation of Canada, Austria, Greece, among others. The next group is made up of countries from the Asian continent, with Japan, China and Taiwan making important contributions to the study of education based on neuroscience techniques. Lastly, Brazil, Germany and France also carry out research with contributions from authors from institutions in these countries.

As an example of the above, we find the paper entitled "Effective participatory science education in a diverse Latin American population", with the participation of authors affiliated with institutions in Bolivia and the United States (Ferreira, et al., 2019). which has the participation of authors affiliated with institutions in Bolivia and the United States, which takes as a case study a Bolivian population where a participatory methodology was introduced in areas of study related to biology to measure the impact it could have on the choice of courses or programs, related to areas such as

neuroscience, microbiology, generative biology, among others. Thus, highlighting that there was a significant acceptance by the students analyzed, regardless of social aspects such as level of study and socioeconomic level.

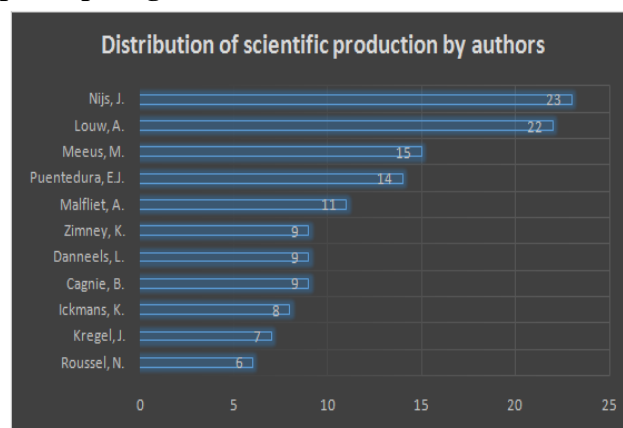**4.4 Distribution of scientific production by participating authors**

Figure 6. Distribution of scientific production by participating authors.
Source: Own elaboration (2021); based on data provided by Scopus.

Nijs, J. is shown in graph 6 as the author with the highest scientific production worldwide, in the subject studied in this article with a total of 24 documents. It is worth noting that, as in the case of the countries analyzed above, the authors who participated in the production of some research work and its subsequent publication, also add each unit as their own according to their participation in it. In other words, the same published article can be counted as a unit by one, two or more authors. Figure 6 shows the level of citations or joint works that authors related in the previous ranking have had throughout the period 2016-2020.
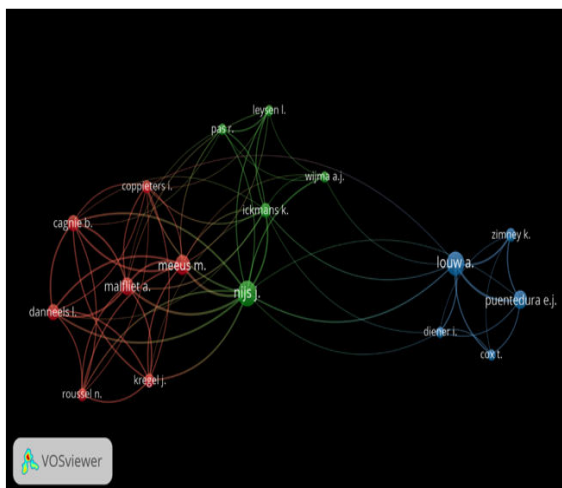
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Figure 7. Countries participating in the bibliographic production.
Source: Own elaboration (2021), based on data provided by Scopus.

Nijs, J. is also the author with the greatest participation in research related to the application of neuroscience in education, together with the authors Ickmans, K. and Meeus, M., as in the case of the article "Development and feasibility testing of a pain neuroscience education program for children with chronic pain: treatment protocol", whose objective was to develop an academic program in pain neuroscience for children with chronic pain and test its feasibility (Pas, et al., 2018) whose objective was to develop an academic pain neuroscience program for children suffering from chronic pain, and to test its feasibility. The published work is helpful in the case of scientists and educators seeking to explain to children the source and treatment of their physical conditions through neuroscience strategies, thus constituting an important contribution to the research base related to the design of neuroscience education programs.

The author Louw A. located at the other end of figure 2 and who occupies the second place in terms of the volume of bibliographic production in topics related to neuroscience applied to education, also collaborates with authors such as Puentedura, E.J. with whom he published "Education in neuroscience of

pain given by a physician for the gradual reduction of opioids: report of a case", which aims to describe the case of a patient with chronic low back pain who has been treated with opioids for more than 15 years and who presented a set of symptoms associated with the provision of such treatment (Agarwal, Louw, & Puentedura, 2020) whose objective is to describe the case of a patient with chronic low back pain who has been treated with opioids for more than 15 years and who presented a set of symptoms associated with the provision of such treatment. The patient was referred to a series of medical appointments and received Pain Neuroscience Education (PNE) along with the controlled tapering of opioids and other medications associated with his pathology, significantly decreasing the symptoms associated with the provision of drugs as well as his chronic pain, which constitutes its main finding by proving with the case study, how training in pain neuroscience, can help patients to control their physical conditions.

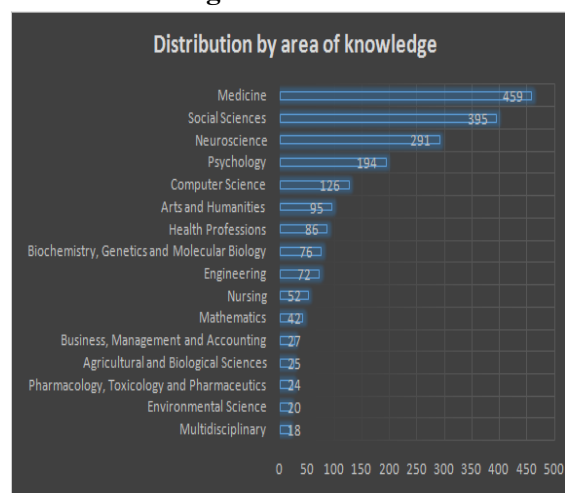**4.5 Distribution of scientific production by area of knowledge.**

Figure 8. Distribution of scientific production by participating authors.
Source: Own elaboration (2021), based on data provided by Scopus.

The importance of knowing the area of knowledge that makes more contributions in terms of neuroscience research applied to

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education, lies in knowing the state of the literature according to the specific area, which allows to be located in the advances that science makes with respect to pedagogical processes and the training of students in the specific area. Figure 8 shows the contribution that medicine, as the area of knowledge with the largest number of published researches, makes to the findings on the topic mentioned above. It totals 459 research papers, among which the paper "Advances in the brain-computer interface in neurosciences: applications and problems" stands out (Mudgal, Sharma, Chaturvedi, & Sharma, 2020) which proposes a review of the bibliographic production on topics related to the Brain Computer Interface (BCI) as one of the avant-garde technologies in neurosciences, which allows communication between the brain and an external device without going through normal neuromuscular means. This paper seeks to establish the characteristics that different authors give to the BCI and its application to different disciplines, since the study on this topic can be studied to be applied not only in medicine but also in nursing, engineering, administration of health care entities, among others. The contribution in the treatment of patients who require this type of help is, of course, highlighted.

Social Sciences and Neurosciences occupy the second and third place with 395 and 291 research papers published during the period 2016 and 2020 and psychology the fourth position with 194 papers within which stands out the one entitled "Annual review of research: educational neuroscience: advances and perspectives" (Thomas, Ansari, & Knowland, 2019) which aims to describe from the origins of neuroscience as a multidisciplinary area of wide application in education with the theories established in psychology regarding the diagnosis of

psychological pathologies through the use of neuroscience tools understanding the brain as a vital organ that must be in optimal health conditions to be able to take advantage of all learning processes.

Conclusions

The United States is the country with the highest scientific production on neuroscience applied to education during the period 2016-2020 in collaboration with countries such as Canada, United Kingdom, Bolivia, among others, which allows inferring that its technological advances in the study of the brain and its vital function as well as the pedagogical processes applied based on neuroscience, as a contribution to inclusive and quality education, is, thanks to research, in a better position compared to developed countries such as Germany, Brazil, France, Belgium, among others, who also participate in research related to the aforementioned topic, but with a lower volume of papers than the United States.

The tectological advances made in the area of medicine allow it to be precisely this, which holds the first place among the specific areas of knowledge that have investigated in neuroscience advances applied in education, highlighting the importance in any case, the preparation of professionals in the area of health, on issues related to neuroscience and not leave it only at the graduate level because the same technological advances have allowed to know success stories in patients with chronic diseases who have shown significant improvements through the use of neuroscience techniques.

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