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INCLUSION OF NEUROSCIENCES IN THE TRAINING OF UNIVERSITY TEACHERS

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Abstract. The objective of the research was to determine the relationship between the acquisition of knowledge about neurosciences in education in a sample of teachers belonging to the Autonomous University of Chihuahua and the acceptance by teachers to receive training on the disciplines that make up neuroscience. The study design was mixed, experimental with pre-test, intervention course and post-test, exploratory and correlational. An exclusive Ad hoc intervention course was designed for this research divided into five thematic areas with face-to-face classes and activities on the academic platform, the duration was one month. To measure the degree of initial knowledge about neurosciences, a survey adapted from what was published by Im (2015) to measure the gain in knowledge after having participated in the intervention course, the survey adapted from what was published by Herculan- Houzel (2002). A structured interview adapted from what was published by Howard-Jones, Pickering and Diack (2007) to measure the degree of acceptance of including neuroscience topics in their teacher training. The findings show that the previous knowledge possessed by the teachers allowed them a greater appropriation of the thematic contents, women obtained a greater gain in knowledge than men and the academic degree of master's or doctorate does not influence the gain of knowledge obtained by teachers. The most relevant result found is that teachers accept and consider it important to include neuroscience topics in their training.

Keywords: Neuroscience, brain, learning, teaching, university.

INCLUSIÓN DE LAS NEUROCIENCIAS EN LA FORMACIÓN DEL DOCENTE UNIVERSITARIO

Resumen. La investigación tuvo como objetivo determinar la relación entre la adquisición de conocimientos sobre neurociencias en la educación en una muestra de docentes pertenecientes a la Universidad Autónoma de Chihuahua (UACH) y la aceptación por parte de los docentes a recibir formación sobre las disciplinas que integran la neurociencia. El diseño del estudio fue mixto, experimental con pre-prueba, curso de intervención y post-prueba, exploratorio y correlacional. Se diseñó un curso de intervención Ad hoc, exclusivo para esta investigación, dividido en cinco rubros temáticos con clases presenciales y actividades en plataforma académica, la duración fue de un mes. Para medir el grado de conocimiento inicial sobre neurociencias se aplicó una encuesta adaptada de lo publicado por Im (2015), para medir la ganancia de conocimiento después de haber participado en el curso de intervención se aplicó la encuesta adaptada de lo publicado por Herculano Houzel (2002). Se aplicó una entrevista estucturada adaptada de lo publicado por Howard Jones, Pickering y Diack (2007) para medir el grado de aceptación de incluir temas de la neurociencia en su formación docente. Los hallazgos muestran que los conocimientos previos que poseen los docentes les permitió una mayor apropiación de los contenidos tematicos, las mujeres obtuvieron una mayor ganancia en conocimiento que los hombres y el grado académico de maestria o doctorado no influye sobre la ganancia de conocimiento obtenido por los docentes. El resultado más relevante encontrado es que los docentes aceptan y consideran importante incluir temas de la neurociencia en su formacion.

Palabras clave: Neurociencias, cerebro, aprendizaje, enseñanza, universidad.

Introduction

With the passing of time many paradigms have appeared in the field of education, recently ambitious studies have emerged as neurosciences that have given a new perspective of teaching-learning that comes to support and facilitate the work of teachers.

Neurosciences are a set of disciplines that arise from the need to know and understand the development and cognitive processes carried out in the brain, an organ that is considered the most complex of all the organs that make up the human body.

Until a few years ago, neuroscience and education had little or no rapprochement. The contributions that neurosciences have made to the field of education mark a watershed between traditional education and education based on discoveries about the functioning of the brain and cognitive processes. Nowadays, it is necessary for all those involved in education to know about how the brain works, especially teachers, since they are responsible for teaching their students.

Domínguez-Márquez (2019) highlights that in order to improve education systems it is first necessary to know how the brain works, what are its structures, areas, and main functions; and once you have this knowledge, you must understand how the learning process is; and when teachers have this knowledge, they will implement the contributions of neuroeducation in their teaching practices, promoting improvements in learning.

According to the world Educational, Scientific and Cultural Organization (UNESCO, 2015), recent developments in the various disciplines of neuroscience are increasingly arousing the interest of the different education communities that seek to better understand the interactions between biological processes and learning.

Barrios-Tao (2016) explains that educational actors, scenarios, and processes should not only be aware of the link between education and learning with the neural and biological bases of these processes but should also know and consider strategies to strengthen the aspects of the environment that influence brain development.

For its part, the Organization for Economic Co-operation and Development (OECD, 2009) indicates that neuroscience should illuminate the role of the teacher, helping them to identify the methods that have the most profound impact on learning, and to recognize the key contribution of neuroscience to the educational purposes of students.

Literature review

The dizzying changes taking place in modern societies force education systems to reflect and provide answers to the following questions formulated by UNESCO (2015), "What education do we need for the 21st century? What is the purpose of education in the current context of social transformation? How should learning be organized?"

Thirty years ago, good teaching was defined as lectures, content classes, and quiet students sitting at their desks, the question that must be asked by the different stakeholders in education is the following, "Is this how students learn best?" Current education proposes that educators must combine the findings of brain research to improve their teaching strategies (Bonomo, 2017).

Stafford-Brizard, Cantor, and Rose (2017) explain that the transformation of teaching through science will come from deeper access and reciprocal connections between the fields of science devoted to human development and educational practice, and that scientists will have greater access to the complexity of learning environments and the many factors at play in these environments.

The emergence of brain research projects around the world highlights the importance of neuroscience research. Neurosciences are the set of disciplines whose research focus is the nervous system, with an emphasis on brain activity (Gago-Galvagno and Elgier, 2018).

Several authors have been given the task of structuring a definition of what neuroscience is, among them are Falco and Kuz (2016), who define neuroscience as a branch of knowledge in which several subdisciplines converge, which have in common the study of the nervous system and everything related to the factors that influence it.

UNESCO (1995, p. 1) states that neuroscience is "a new discipline that encompasses the biology of the nervous system, the human sciences, the social sciences, and the exact sciences."

The field of mind, brain, and education was established to connect multiple disciplines for the purpose of deepening and accelerating the impact of research and its translation into educational practice (Stafford et al., 2017).

The knowledge and understanding of what neurosciences are and the contributions they make to the field of education are of great importance for educators. Segovia-Baus (2016) explains that the new disciplines that have a powerful impact on the knowledge and understanding of the functioning of the brain bring together classical disciplines and novel interdisciplinary fields, with purposes oriented to the search for answers about the structure and functioning of the brain that allow the actors of education to improve the teaching and learning processes.

In the same vein, Stafford et al. (2017) note that multiple strands and fields of research must intersect to make connections and develop with each other, jointly contributing to a deep understanding of child and adolescent development and learning in the context of educational practice, as these interdisciplinary connections develop in the service of improving educational practice and collaborations emerge, it will be possible for scientists to employ and establish multiple lexicons and definitions to provide greater consistency and coherence between the fields of science and education.

The results of neuroscience research have contributed to the understanding of human learning from different perspectives, this knowledge should be taken up by teachers to support the teaching-learning process, as they serve as a basis for the curriculum (Calzadila-Pérez, 2017).

In the ongoing quest for better education at all levels, authors Immordino-Yang and Gotlieb (2017) assert that neuroscience aids educational research by elucidating the neural mechanisms underlying cognition, social and affective processing, and cultural learning. Specific benefits for education could include constraining and supporting existing educational theories by testing their biological plausibility and leveraging knowledge about brain mechanisms to inform the development of new educational theories and research questions.

The interdisciplinary area of educational neuroscience is made up of all the scientific disciplines of research that can contribute to education, including developmental psychology, cognitive neuroscience, genetics, and technology, together these disciplines carry out a valuable search with real potential to improve learning (Brookman-Byrne, 2016).

When a collaboration is established between the field of education and the disciplines of neuroscience, the figure of the educator emerges as a key to achieving progress towards an education that is based on scientific contributions. The researcher, Paniagua (2013), explains that since learning is a process that modifies the brain, the role of the educator is paramount in this new approach to education, and that through the acquisition of this knowledge all educators revalue their role and are committed to updating their knowledge in the area of neuroscience.

The authors, Campos, Lira, and Sabogal (2014), point out that the educational system has the possibility of transforming and strengthening itself based on the studies and contributions made by the disciplines that integrate neuroscience.

Neuropsychology is one of the disciplines that integrate neuroscience. Delgado (2017) mentions that neuroscience has influenced and transformed psychology in two aspects:

a) The theoretical in the way of conceptualizing the different psychological processes and phenomena that are studied by this science.
b) The modification of practice by changing the way of understanding the causes of normal and abnormal behavioral disturbances.

Another discipline of great relevance is Cognitive Neuroscience. According to Postle (2015), the tools and methods used to study the neural basis of human behavior is what distinguishes cognitive neuroscience from other disciplines, it has the methods and traditions of neuroscience and the primacy given by the understanding of the biological basis of mental phenomena.

The National University of Distance Education (UNED, 2016) publishes that Cognitive Neuroscience focuses on the study of the functioning of the neural mechanisms involved in the psychological processes that characterize human cognition, understanding that this discipline covers not only the strictly cognitive processes (attention, memory, language, etc.) but also the emotional processes that powerfully influence cognition.

Neurodidactics as a discipline of neuroscience has among its research topics according to Falconi-Tapia, Alajo-Anchatuña, Cueva, Mendoza-Poma, Ramírez-Jiménez, and Palma (2017):

- The study of brain bases,
- Teaching and learning processes,
- Methodologies used by educators in school contexts.

The authors also mention that all of these study factors are key to promoting learning.

Paniagua (2013) who explains that neurodidactics is a branch of pedagogy that is based on neuroscience, which aims to design more efficient didactic and methodological strategies that allow the promotion of greater learning in terms that educators can interpret.

Educational institutions should be aware that today's students learn differently, that they appropriate knowledge under different schemes, and that the teaching methods used should take into account that we all have the same set of systems and brain organization; however, we are all different. The factors that make us similar are the same factors that make us different, giving rise to diversity (Saavedra, 2001).

Paniagua (2013) emphasizes that all people have the same brain structure, but no two people think, decide, or act in the same way. Yhis new understanding of diversity based on knowledge of brain function should lead to a paradigm shift in the educational field, influencing all aspects of education, including curricula, for it is essential that the educator assumes a new role and prepares to exercise his profession from this new position.

To address the diversity of students referred to, educational institutions at all levels need to innovate and optimize the teaching process as well as strengthen the learning process, and to achieve this the authors Falconi-Tapia et al. (2017) point out that the following aspects should be taken into account:

- Know in greater depth the functioning of the human brain.
- Motivate students' attention and curiosity when explaining the topics studied.
- Understand that motivation is a decisive mental factor for students to generate meaningful learning.
- Diversify teaching strategies and promote positive and balanced emotional states.
- Recognize, in a timely manner, learning disabilities to support students.
- Value the different types of skills and abilities of students.

Therefore, it is necessary that the educator, as a fundamental factor in the educational process, puts into practice operational, methodological, and socio-emotional neurodidactic strategies that promote a creative, cooperative, and flexible learning environment for the construction of knowledge (Falconi-Tapia et al., 2017).

One of the most significant contributions made by neuroscience to education is the discovery that the brain constructs patterns from experiences acquired in everyday life, and that emotions, understanding, and ideas are recognized by the brain as patterns. Likewise, it was revealed that the stability or confidence of these patterns is accepted or challenged by an associative memory system that quickly retrieves memories to judge the accuracy and usefulness of those patterns in new contexts and environments (Schwartz, 2018).

Another important contribution to the construction of learning contexts is related to creativity. In this regard, Benedek and Fink (2019) highlight in their research that it is through cognitive and neuroscience research that several characteristic mechanisms of cognition have been revealed, including constructive memory processes to build novel representations and support active imagination.

While neuroscience has clarified the mechanisms that underpin learning, accurate dissemination of this knowledge to educators has been limited (Dubinsky, Guzey, Scwartz, Roehring, MacNabb, Schmied, Hinesley, Hoelscher, Michlin, Schmitt, ellingson, Cang, & Cooper, 2019).

Teachers' limited knowledge of adolescent development and the application of scientific research beyond the academic domain is one of the most obvious demonstrations of the gulf between science and educational practice; for teachers, grounding the work of education in developmental science involves understanding not only how development occurs but exactly what needs to be taught to contribute to students' holistic development (Stafford -Brizard et al., 2017).

In this regard, researcher Coch (2018) makes an important point:

Most teacher preparation programs do not address neuroscience in their curricula; this is curious since learning occurs in the brain and teachers encourage and facilitate learning; knowledge of neuroscience should be merged with teacher training programs, which will arise remarkable benefits such as:

- Deepen the knowledge of pedagogical content from multiple perspectives; understanding neuroplasticity and its educational implications;
- Recognize the power of context as a factor impacting neurobiology, learning, and development;
- A reflective and committed practice.

Therefore, the development of teacher education and training programs should include neuroscience in education, allowing them to have "holistic approaches that take into account the close interdependence of physical and intellectual well-being as well as the interactions of the emotional and cognitive, analytical and creative brain" (UNESCO, 2015, p. 28).

Despite all the obstacles that may present themselves for teacher training in neuroscience topics, Brookman-Byrne (2016) found that there is a growing expectation among educators for brain-based findings to guide their work in the classroom, and that 91% of teachers who already have this neuroscience knowledge have applied it to at least one aspect of teaching and learning; Brookman-Byrne explains that helping teachers understand neuroscience-learning-teaching issues is happening because of the emergence of the interdisciplinary field of educational neuroscience.

Educators have great optimism in the benefits that neuroscience can bring to education, this represents one more reason to continue research in these disciplines and improve the evidence base obtained in educational interventions based on neuroscience; with this, educators can be supported in the development and understanding of neuroscience and any educational intervention (Simmonds, 2014).

For Brookman-Byrne (2016) it is clear that teachers have an interest in neuroscience and want to use it to underpin their practices.

Dubinsky et al. (2019) assert that neuroscience courses for in-service teachers, offered as collaborations between scientists and teacher educators, can improve science education, pedagogy, and understanding of neuroscience.

Levitt, Carey, Ramirez, Dizrasa, and Di Luca (2016) go further by asserting that if students are trained to think deeply and creatively and encouraged to be a little more fearless, they will have what they need to succeed in an ever-changing scientific world, and that these skills are essential not only in academia but in many careers.

Globally, several countries have realized the importance of making a change in education if they are to train people with the right skills to meet the challenges of today's complex societies while recognizing the importance of neuroscience in bringing about this change. In response, they have created research centers that offer postgraduate courses that combine knowledge of neuroscience and education (Howard-Jones, 2014).

Method

Research Question

Will the understanding and acquisition of knowledge about neurosciences in education allow UACH teachers to give a favorable response to include topics from these disciplines in their training as teachers?

Target

Determine the feasibility of including in the pedagogical training of teachers at the Autonomous University of Chihuahua the knowledge inherent in the disciplines of neuroscience in education through the provision of diplomas, courses, or workshops.

Hypothesis

H_i The acquisition of knowledge of neurosciences in education will allow teachers to give a favorable opinion in order to include the topics inherent to these disciplines in their pedagogical teacher training.

Design

The research had a mixed approach, it was experimental with pre-test and post-test, exploratory and correlational. An intervention course was given and two structured surveys were applied. A structured interview was conducted to close the research.

Participants

For the selection of participants, a simple stratified random sampling was carried out. The research consisted of three study groups, one control group and two experimental groups, each group consisted of 15 teachers of the UACH, men and women, who had a postgraduate academic degree: doctorate or master's degree.

Intervention course

An Ad hoc intervention course was designed on the topic Neurobiology of learning. The course was given to two experimental groups and a control group that did not receive the course. The virtual part of the course was conducted through one of the academic platforms of the UACH and the face-to-face part in the classrooms of that institution.

Instruments and data collection procedure

An instrument adapted from the one published by Im (2015) was used to measure the level of initial knowledge about neuroscience of the teachers of the Autonomous University of Chihuahua, which was applied at the beginning of the intervention course to both the control group and the intervention groups. At the end of the course, a second instrument consisting of a selection of items taken from Herculano-Houzel (2002) was applied to the three participating groups to measure the degree of appropriation of the topics studied in the intervention course.

A structured survey adapted from Howard-Jones et al. (2007) was conducted to measure the acceptance and importance, on the part of teachers, of receiving training in neuroscience topics in education. From the two groups with intervention, the five teachers with the highest scores were selected from each group on the premise that the greater the understanding of the topics, the greater the probability of acceptance of including neuroscience topics in their training. The interviews were conducted individually at the end of the intervention course.

Data analysis

Quantitative

In the first study, the variables that were included are acquisition of knowledge inherent to neuroscience in education by teachers (independent) and acceptance of receiving training in neuroscience in education for teaching practice. The covariate used was the initial knowledge, i.e. the first qualification obtained with the application of the initial questionnaire and the knowledge achieved.

The statistical analysis was performed using general linear mixed models in the software R Version 1.3.959. The model was tested with all variables and one covariate, it was found that the academic postgraduate variable was not significant ($p= 0.7166$) as well as its interaction ($p=0.2144$), so they were eliminated from the model.

The model complied with the assumptions of independence, homogeneity of variance, and normality, thus proving that the conclusions obtained with the model used in this research are true.

The LMM statistical model was formulated as follows:

$$y_{ij} = \mu + S_i + \beta x_{ij} + e_{ij}$$

Where:

- y_{ij} = corresponds to the jth observation of the response variable taken under the ith treatment of the single factor (gain in teacher knowledge).
- μ= overall average.
- S_i = effect of the ith treatment (teacher's sex, i=F, M.)
- β= is the linear regression coefficient indicating the dependence of y_{ij} on x_{ij} (linear relationship between initial knowledge and final gain in teacher knowledge).
- x_{ij} = is the measurement made of the covariate corresponding to y_{ij} (the ijth run, teacher's knowledge of the topic at the beginning of the course).
- e_{ij} = random error component.

Qualitative

A thematic analysis was carried out using Atlas.ti software for the analysis of qualitative data. A Hermeneutic Unit (HU) was created to store the primary documents that were used to generate the quotes, codes, and memos (see Figure 1). For analysis, the interview data were organized into two categories: a) Importance attributed by teachers to the understanding of the cognitive functions of learning and the factors that promote or inhibit it, and b) Teachers' agreement to receive training in neuroscience. For the first data reduction, quotations were formulated with the answers given by teachers to each item in each category. For the second level of data reduction, codes were generated with concepts considered useful for the analysis. Annotations considered relevant for consultation were stored in the memos. For the creation of the thematic network, a code-code link was established in order to determine the relationship between them, as well as to identify the levels in which they are related.

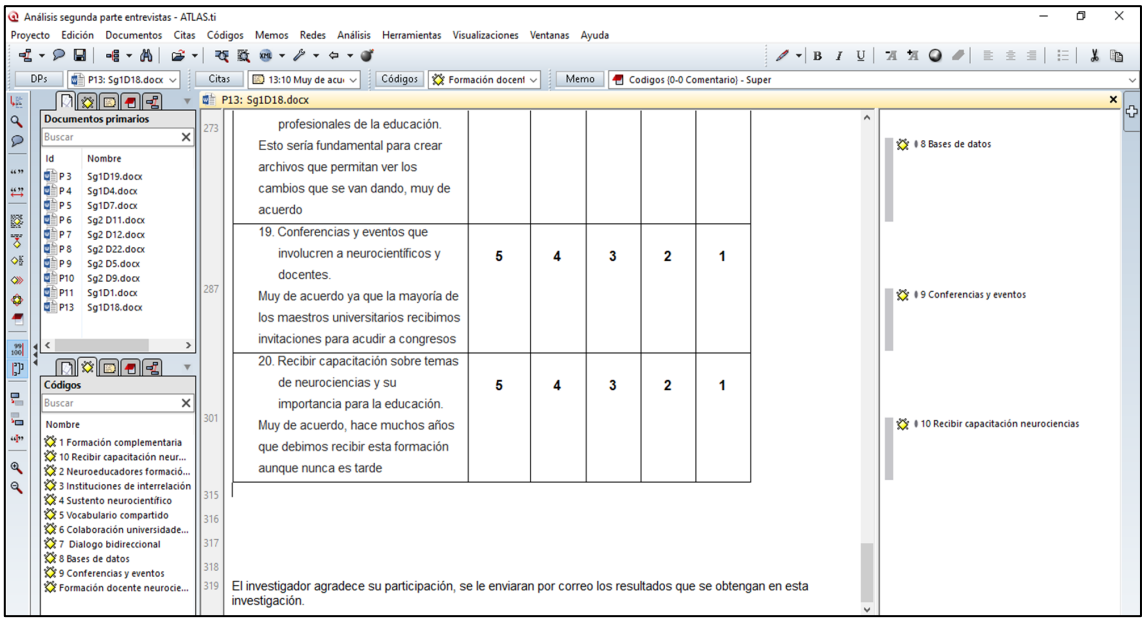

Figure 1. Data coding process in Atlas. ti

According to Braun and Clarke (2006), thematic analysis facilitates the identification, organization, and analysis of patterns and themes based on a reading, allowing inferences to be made as well as understanding and interpreting the phenomenon under study.

Results

The quantitative results of this research were obtained through the analysis of 90 surveys, the qualitative results were obtained through 10 interviews answered by teachers from various faculties of the Autonomous University of Chihuahua in order to answer the research questions and test the hypothesis.

On the other hand, within the exploratory part of the research, it was found that the Autonomous University of Chihuahua has not included courses, diplomas or workshops on neuroscience topics, being established that the intervention course taught by the author of this research is the first in this subject (see table 1).

Table 1
Courses, diplomas, and workshops given by the University Center for the Development of Teachers (CUDD) of the UACH.

Name of course, workshop, or diploma course
Training Projects
Training in Lean Startup Methodology
Moodle Basics for Teachers
Learning Communities
Portfolio of Evidence
Healthy Stress Management
Workshop on Publications and Digital Tools for Higher Education and Research
Burnout in the University Teacher
Diploma in Tutoring with a Focus on Inclusion
Design of Analytical Programs by Competences
Technology Transfer
Management for School Administration
Information Resources and Anti-Plagiarism Tools
Social Responsibility
Virtual Modality. Moodle Platform
Workshop for the Filling out of the PRODEP Teacher Improvement Program
Use and Management of Oral History Techniques
Ethics
Basic Statistics with Excel
UACH Educational Model
Data and Document Protection
Search for Journals in Digital Media for Publication in the Social Sciences, Arts, and Humanities
Training of Social Service Advisors
The Intellectual Property of Educational Materials
Workshop on Multiculturalism in the Classroom
Document Organization Systems
Name of course, workshop, or diploma course
Basic Mexican Sign Language Course
Strategic Planning
Relevance of Mentoring, Commitments, and Challenges of its Stakeholders
Instructional and Graphic Design for Online Courses
Using Google + (G+) and Slack as a Platform for One-on-One Online Collaborative Projects
Public Sources of Information
Instructional Design for Virtual Learning Environments
Podcast Creation, a Powerful Tool for Digital Marketing Applied to Teaching
Fundraising
Diploma in Human Rights and Gender Equality
Curriculum Design by Competencies from Socio-training (part 1)

Curriculum Design by Competences from Socio-training (part 2)
Human Rights and University Social Responsibility
Technological Updating Tools. Management of Smart Boards, Proyectors, and Computers.
Design for All: Use of Free Platforms for Graphic Design of Didactic Material
Tools to Support the Use of Online Courses, Using Assessments from Mobile Devices
Great Teachers. UNAM. Language, Culture, and World Vision. The Identity of the Spanish of Mexico, Human Rights. Inter-American System of Protection
Multimedia Material Production
One-Factor Anova and Non-Parametric Tests
Designing an App to Support my Classroom
Creating Blogs as Teaching Opinion Forums and Using Online Project Management Platforms
Competency Assessment through the Objective Structured Clinical Examination
Live Coding
Cloud Tools for Teaching Management

Note: Adapted from the catalog of 2019 courses, diplomas, workshops, and projects provided by the CUDD through its academic liaison, Ms. María de Lourdes Parada Olivas.

Adjustments to the statistical model

The value found for the Akaike Information Criterion (AIC), in the different models run in the R software, yielded 475.99 as the final result of the research with the selected model having the lowest value and best fit to the data (see table 2).

Table 2
Fit to the statistical model

N	AIC	BIC	logLik	Sigma	R2 0	R2 1
225	475.99	493.01	-233	0.66	0.49	0.54

Note. Lower AIC and BIC implies better results.

Analysis of variance

Marginal hypothesis testing

Table 4 shows that the covariate initial knowledge and the knowledge achieved, that is, the survey applied at the beginning of the intervention course was significant ($p<0.0001$), so it is important to highlight in this study that the gain in knowledge regarding the topics is due to the previous knowledge that teachers have about the topic at the beginning of the research. This same result was obtained and corroborated with the analysis of separate groups. The gender variable was significant ($p=0.0320$), so the difference in knowledge gain between men and women is different (see table 4).

Table 3
Marginal hypothesis testing (SC Type III)

	numDF	denDF	F-value	p-value
(Intercept)	1	220	241.70	<0.0001 0.0320
Sex	1	220	4.66	
Initial	1	220	251.05	<0.0001

Interview results

The analysis of the thematic network of the first category shows that the application of neuroscience in education is due to the importance that neuroscience has gained for teaching practice (see figure 2).

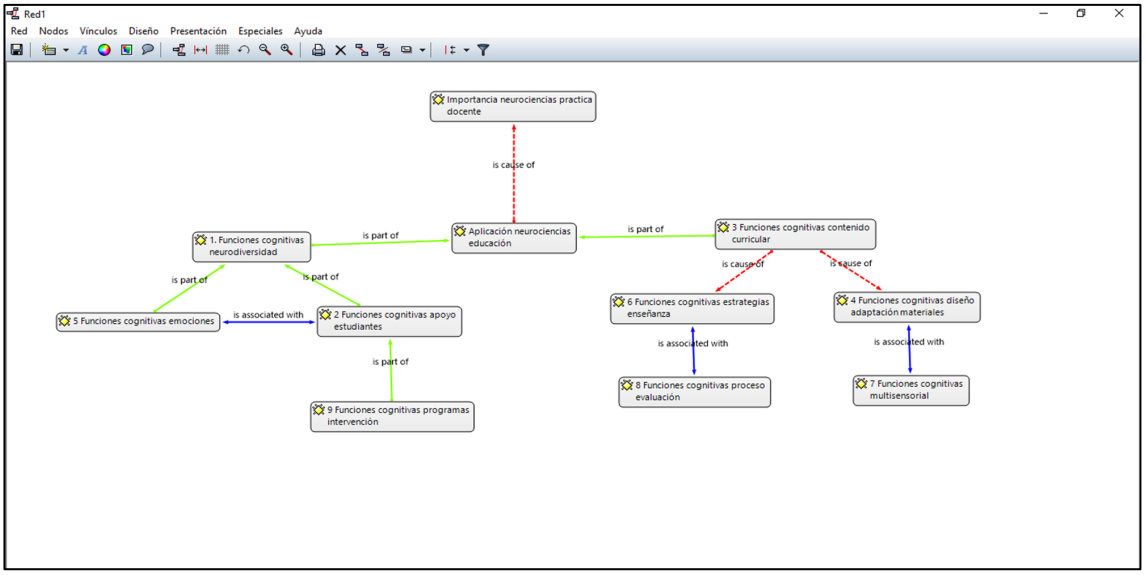

Figure 2. Thematic network of the category importance of neurosciences in teaching practice

In this same category, it was found that all teachers considered that neuroscience is very important to understand the neurodiversity of their students' learning (see figure 3).

> "Please indicate the importance that attributes.... Very important, international organizations are asking us to provide inclusive education for all..."[Sg2D11]

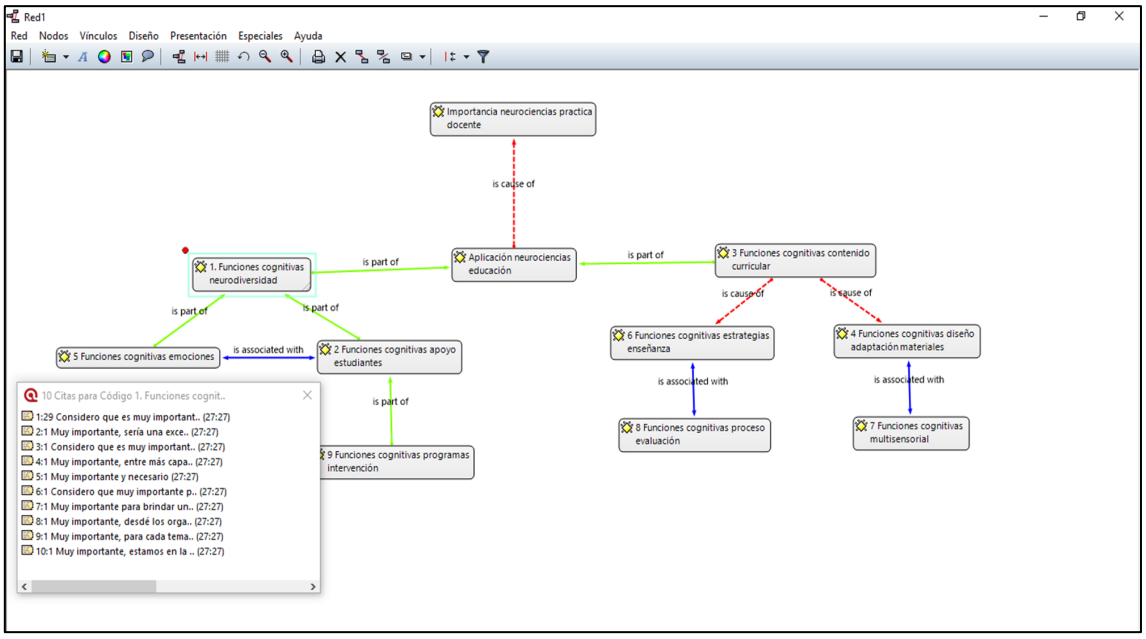

Figure 3. Importance of understanding neurodiversity in learning

In the second category referring to teachers' agreement to receive training in neuroscience, the thematic analysis yielded the following results: for the complementary training code, all teachers expressed strong agreement (see Figure 4), and the same result was obtained for the code to receive training in neuroscience since all teachers expressed strong agreement (see Figure 5).

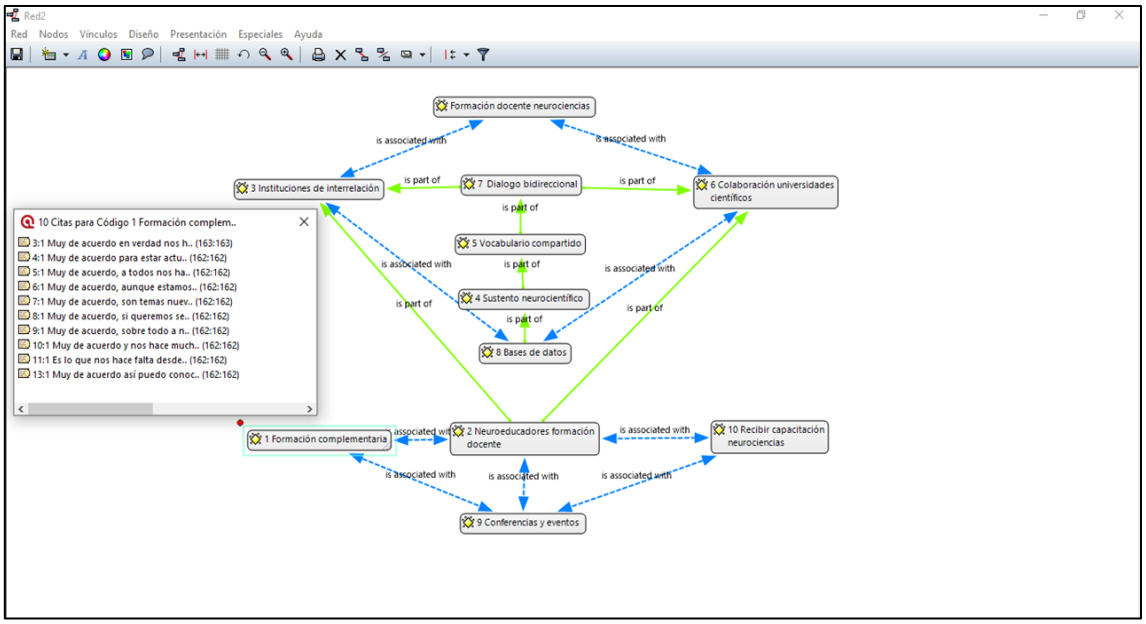

Figure 4. Agreement to receive further training in neurosciences

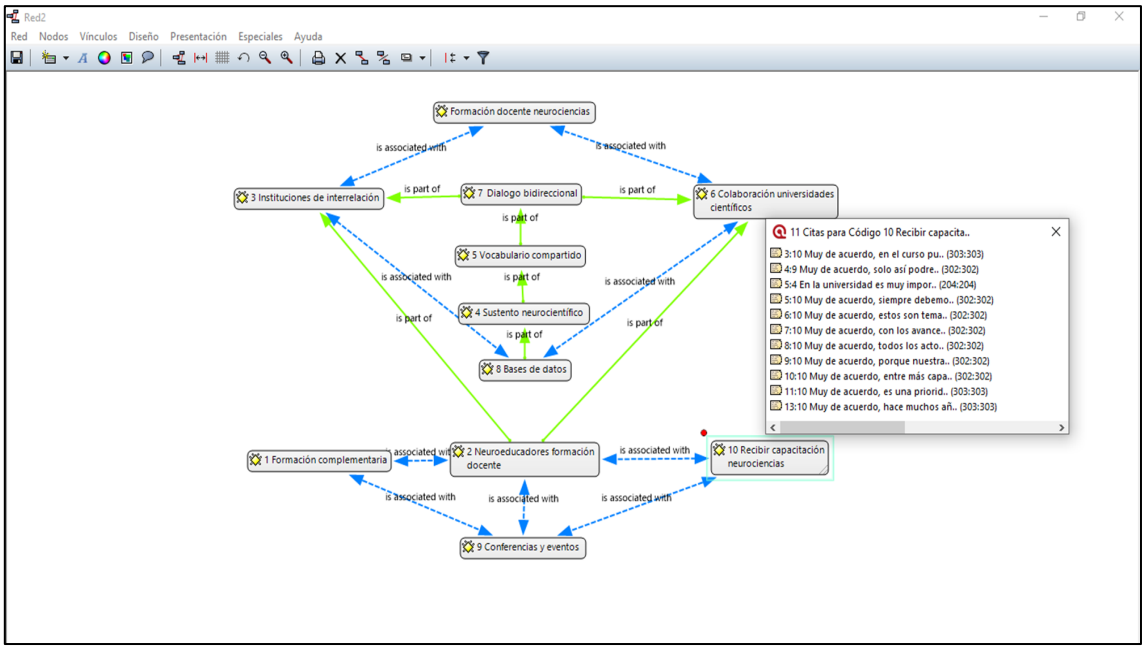

Figure 5. Agreement to receive neuroscience training

The analysis of the thematic network allowed to establish a detailed relationship between codes, highlighting that teacher training in neuroscience is directly associated with networking institutions and collaboration between universities and scientists. It was identified that the bidirectional dialogue is part of the collaboration between universities and scientists as well as with institutions of interrelation, and it also shows that the neuroeducator is associated with complementary education and teacher training. Another important relationship that was found is that teachers associate scientific conferences and events with their training in neuroscience topics (see Figure 6).

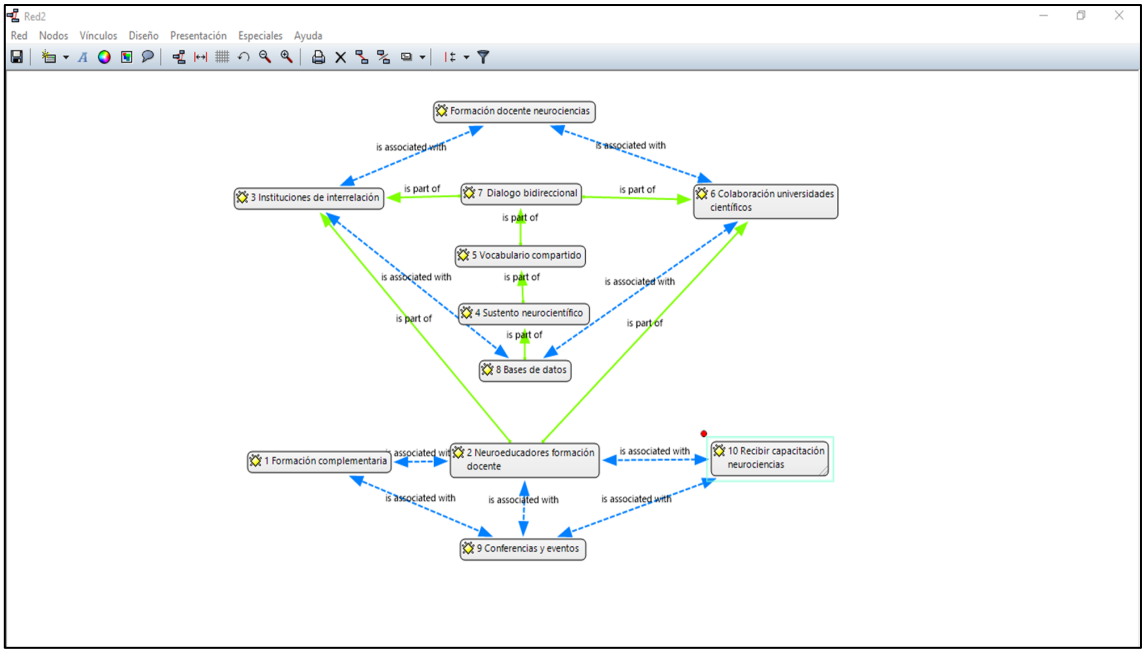

Figure 6. Thematic map showing the relationship between the different codes analyzed

Discussion and conclusions

Great progress has been made by neuroscience in understanding the processes involved in the neurobiology of learning. These discoveries and contributions of neuroscience aroused a deep and exponential interest in the educational community at the international level. The results obtained in the present research show that teachers do not receive training by the Autonomous University of Chihuahua in neuroscience topics. This finding agrees with what was published by Román and Poentis (2018) who explain that in the training of teachers neurosciences have not been contemplated as generators of knowledge about their practice. It was also found that teachers who had previous knowledge to the intervention course about neuroscience obtained a gain in knowledge greater than teachers who had no previous knowledge. This gain in knowledge was reflected in the score obtained in the questionnaire applied at the end of the intervention course. This result agrees with that published by Martínez-González, Manzano-Patiño, García-Minjares, Herrera-Penilla, Buzo-Casanova and Sánchez-Mendiola (2018) who found that prior knowledge acquired facilitates learning since a platform is created composed of a system of interconnected knowledge, patterns, images, and ideas that were acquired which makes it possible to understand new information and integrate it with existing ideas to achieve meaningful learning. Likewise, the University of Valencia (2017) publishes that the information that is obtained "fits" in relation schemes and, in addition, the new knowledge is "linked" with what is already known resulting in deep learning. The results also showed that women acquired greater knowledge about the topics taught in the intervention course which was reflected in the results obtained in the final questionnaire. This finding is consistent with the results obtained by Martinez et al. (2018) who found that in the evaluation exams women obtained a marked increase in the number of correct answers obtained than in the case of men; they also found that women have a higher academic performance than men.

The first category of the interviews gave as a result that the total of teachers considered very important neurosciences to understand the neurodiversity of learning of their students; these results agree with what was published by Yavorosky and Santos-e Campos (2019) who found that in the institutions investigated there are students with specific learning difficulties, and that teachers seek to know new methodologies that help their students during the teaching and learning processes.

Another significant result is the relationship between the application of neuroscience in education and teaching practice. This finding is consistent with that published by Basurto-Vélez and Zambrano-Mendoza (2020) whose result indicates that neuroscience influences the teaching-learning process; likewise, Acta-Caraballo (2019) found that all of the teachers evaluated consider that knowledge about how the brain works can help them improve their academic practice.

The analysis of the second category showed that all of the teachers expressed that they strongly agree with receiving complementary training in neuroscience, and the same result was obtained for the code receiving training in neuroscience since all of the teachers interviewed expressed that they strongly agree. These results are consistent with those obtained by the Wellcome Trust (Simmonds, 2014) where they show that most teachers are interested in knowing and understanding how the brain works. Similar results were obtained by Luque-Rojas and García-Ortigosa (2018) who indicate that a significant number of the educators surveyed expressed the need to incorporate and add neuroscience to their training.

It is concluded that the objective of the research was achieved since the data analysis showed that teachers have a great willingness to be trained in neuroscience topics to improve their teaching practice and to understand the neurodiversity of learning, educational institutions must take responsibility to train, educate, and update their teachers in neuroscience topics to be able to change the traditional way of teaching and move to a teaching based on the neurobiological principles of learning. The hypothesis formulated is verified since the greater the acquisition and understanding of neuroscience topics in education, the greater the interest and willingness of teachers to receive education and training in these disciplines. Finally, the answer to the research question posed is positive since the topics addressed in the intervention course allowed teachers to dimension the importance of acquiring and understanding the topics of neuroscience in education and thus issue a favorable response to include these topics in their training as teachers.

For future research, it is recommended that undergraduate and postgraduate students be included in order to broaden the dissemination of neuroscience topics.

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