Neuroeducation and teaching perception: a systematic review from the qualitative approach

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Article Info

ABSTRACT

Neuroeducation is a discipline that considers aspects contributed by the natural sciences, including cognitive abilities, brain functioning, and the emotional system, among others, as topics derived from knowledge in fields such as neuroscience, cognitive science and psychology, and which are articulated in the social domain. The aim of the present review was to learn about teachers' perceptions of neuroeducation and to determine which qualitative methods are most commonly used in this field of research. The review followed the guidelines of the preferred reporting items for systematic reviews and meta-analyses (PRISMA) method, searching the databases with the highest impact between 2015-2023. The selection process yielded nine eligible studies and they were analyzed in terms of the type of knowledge studied and the methods used in neuroeducational research. The results discuss the most frequently developed qualitative methodologies in the neuroeducational discipline, offering recommendations from the methodological cluster to strengthen future research in the discipline. Therefore, this study promotes neuroeducational research from a qualitative approach will improve the resonance between neuroeducation experts and teachers. Furthermore, it highlights the importance of proposing situated research, using descriptive methodologies in the field, which communicate in a language appropriate to educators and their context.

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1. INTRODUCTION

Over the past few decades, there has been an interest in brain research findings, particularly in human cognition, behavior, and learning [1]. From this encouragement, several authors have highlighted the importance of understanding brain functioning as a starting point for improving teaching and learning [2]. The attractive power of this concern has lead communication between neuroscience and education to promote strategies based on empirical scientific research through a linkage titled neuroeducation [3]. Neuroeducation is a discipline that articulates the areas of cognitive neuroscience, cognitive psychology, education and its raises, from its theoretical basis, knowledge through research located in the classroom context [4]. The transdisciplinary research developed by neuroeducation studies documents the motivation of teachers to learn about this scientific field, highlighting from the discipline to the scientific interest in reducing the existing gap between science and teaching practice and also in helping to avoid misconceptions about neuroeducation, known as 'neuromyths' [5], [6]. The erroneous beliefs regarding certain myths present in education have caused teachers not to apply neuroeducational information correctly in their work, sometimes reducing the neuroeducational discipline to these misconceptions [7].

To date, previous studies developed to reduce this breach have evidenced a clear preference for the investigation of learning processes (e.g., motivation, self-esteem, and memory), frequently focusing on quantifiable analyses of the results from the implementation of neuroeducational programs and strategies in the classroom [8], [9]. The limitation of this kind of study focused on analyzing students' academic performance which lies in the consequently scarce that knowledge has provided regarding the teaching thought process linked to the subject. In this context, there have been efforts to demonstrate the neuroeducational knowledge of teachers prior to pedagogical implementations [10]–[12]; those investigations have also sought to address the issue from the positivist perspective, which despite its apparent contributions to the construction of scientific knowledge on the subject, present recognized limitations regarding its reductionist nature concerning the understanding of teaching processes, and a situated vision of teachers' perceptions [13].

Therefore, research that qualitatively, interpretatively, and in-depth assesses teachers' thinking about neuroeducation and analyzes their perceptions in a descriptive manner is observed in a lesser proportion and a scattered manner. In this sense, Vasalou *et al*. [14] states that empirical research developed in classroom climate should seek to know teachers' perceptions, defined as attitudes, beliefs, or social values that have been subjectively elaborated from reality [15], since these are as fundamental as students' learning and working on them in the classroom might have a positive impact on the teaching task [16], [17]. This aspect is fundamental and highlights the need to synthesize qualitative research from the teachers' perspective to formulate concrete proposals that support the development of this field of research.

Accordingly, the present study assumes this task and proposes to contribute to the discipline with systematic research that brings together and analyzes teachers' perceptions from the pedagogical point of view based on the analysis of exclusively qualitative research. In this regard, the qualitative vision aims to examine how individuals perceive the phenomena that surrounds them, deepening from the analysis in their interpretations and allowing categorizing and classifying the main conceptual assets analyzing them together with the participants of the study. In this framework, the present study attempts to learn about teachers' perceptions of neuroeducation and its implementation in the classroom and to determine which qualitative methods are most (or least) used in this field of neuroeducational research in order to reflect on their contributions and future challenges.

The purpose of this study was to analyze research on teachers' perceptions of neuroeducation and to determine which qualitative methods are commonly used in this field of study. Therefore, the research questions were the following:
− What are teachers' appraisals of neuroeducational implementations?
− What behavioral, emotional and/or social changes do neuroeducational implementations bring about in students?
− What are the main qualitative research designs used in neuroeducational studies?

In this review, we can find the main research that has sought to understand the perceptions of educators regarding neuroeducation, in addition to bringing together the various strategies developed in the neuroeducational implementations analyzed. Also, different strategies and qualitative tools are proposed that deepen the analysis of empirical implementations in an educational context. In addition, the review mobilized a theoretical/empirical support from the analyzed findings to inform public policy to reorient the focus from the academic, to the transversal aspects that education also entails, in order to stop considering social and affective principles from a compensatory point of view, and to intend them from the importance they have in the integral life of students and educators.

2.   METHOD

The methodological framework uses a systematic literature review procedure. Systematic reviews are integrative investigations that allow synthesizing the validity of the results of studies on a given topic that comes from a structured research question and are characterized by being developed based on a reproducible methodology [18]. This reproducible method allows synthesizing and analyzing the studies researched in the investigation, generating relevant concepts that identify the voids in the field of research and organize them in a systematic way. The search was conducted between July and August 2023, and the methodology was carried out in two stages, as seen in Figure 1.

First, an advanced search was carried out in English in the electronic databases: Web of Science (WoS), EBSCO, and Scopus. At this stage, the search equation was entered: neuroscience AND education AND teacher perception. The exploration was then refined to the years 2015-2023, as this period has seen a sustained growth of the literature in the field of study. Afterwards, the search was limited to the title, key descriptors, and abstract. Likewise, a search was carried out in the Scielo database in order to give a broader scope to the research, but no results were obtained for the defined criteria.
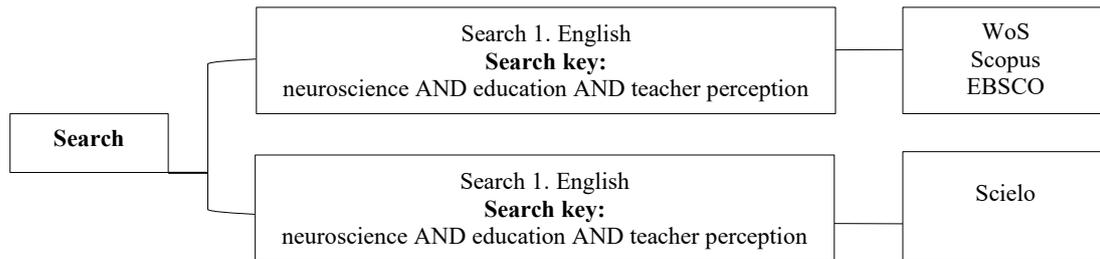
Figure 1. Search keys in databases

2.1. Eligibility criteria

In order to be included in the review, given the objective of this study, the articles had to be primary scientific articles, a systematic review, written in English or Spanish, have education as the area of study, and present neuroscience and education, neuroeducation or neuro-didactics as theoretical support. Therefore, for both stages, we included research that met the following criteria: qualitative or mixed-method research (so as not to discard any qualitative pretension), the participants had to be teachers or student teachers, the research had to be empirical, and the theoretical constructs mentioned (neuroscience and education, educational neuroscience, neuroeducation, neuroscience, and learning, or neuro-didactics) had to be used. Systematic reviews, letters to the editor, reflective articles, graduate theses, journal articles, and book reviews were excluded at both stages.

Regarding the first stage, the search in English came up with 117 articles, while phase 2 was not fruitful with the search equation in the Scielo database, as seen in Figure 2. Subsequently, an exhaustive analysis of the total research was carried out by reading the abstract and key descriptors of the identified studies. A total of nine articles that met the inclusion criteria were included in the review, excluding duplicate texts and those that did not meet the stated criteria. Subsequently, the selected articles were analyzed in a collection created for the present systematic review, organizing them according to their database and categorizing them from the methodology, which allowed the identification of duplicate research or those that did not meet the criteria indicated.
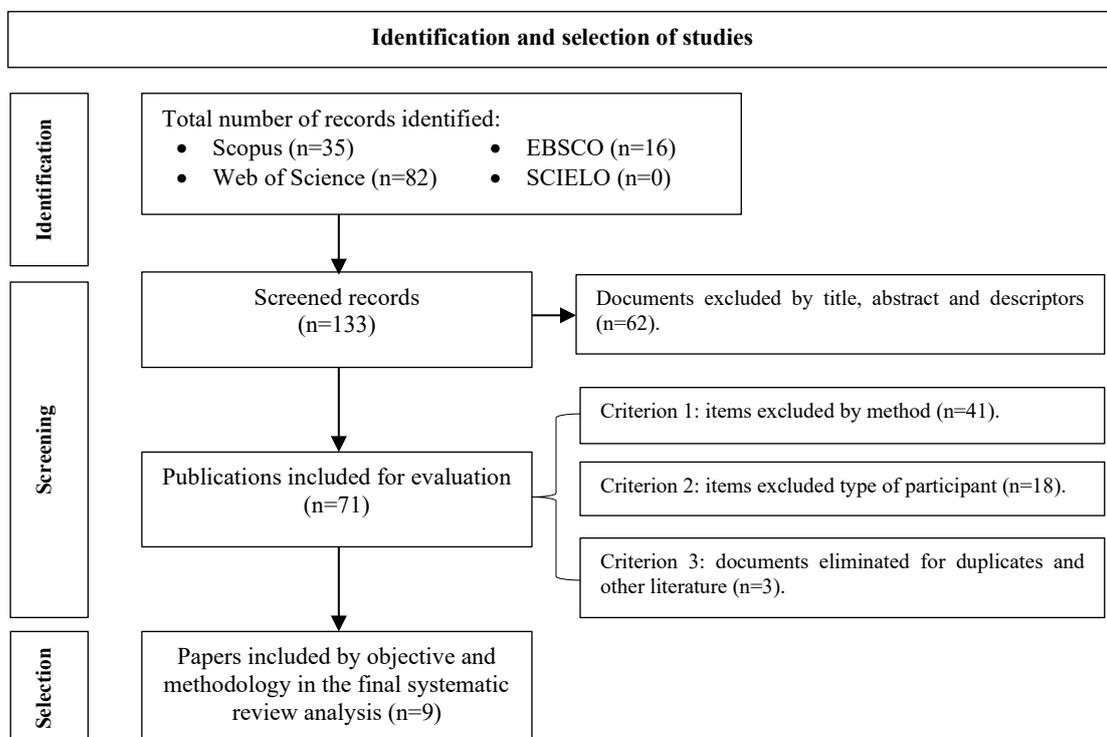

Figure 2. Systematic review flowchart

2.2. Extraction and synthesis

The extraction work was performed on a template, which adapted the work of Valdés-Villalobos and Lazzaro-Salazar [19] regarding the following aspects: basic information (e.g., year of publication, author, title), objective, qualitative or mixed methodology, participants, theoretical and conceptual foundations (e.g., neuroscience and education, neuroeducation or neuro-didactics), and main results. Subsequently, the nine selected investigations were read in full text, and the studies were analyzed and summarized descriptively independently by both authors. Although mixed studies were considered in the screening of the research, the analysis followed the interpretive logic of the study objective following the focus of this review, which centered on qualitative methodologies that studied teachers' perceptions of neuroeducational theory.

2.3. PRISMA method screening

Figure 2 presents the selection process from the identification of the total number of initial investigations N=133 to the N=9 articles that met the inclusion criteria. The preferred reporting items for systematic reviews and meta-analyses (PRISMA) diagram design of Urrútia and Bonfill [20] was adapted.

3. RESULTS

In honor of the object of study, Table 1 presents the identification of the descriptive results analyzed in honor of the object of study [21]–[29]. Based on the analysis of these articles, teacher perceptions and methodologies analyzed in the selected research are described and discussed.

3.1. Teachers' perceptions of neuroeducation

Research has the challenge of contributing to and modifying educational practices for constant improvement. Undoubtedly, imbuing the scientific community with new neuroeducational knowledge that contributes to knowing the opinions of the primary agents of education is fundamental and, therefore, an excellent challenge for educational researchers [24]. In this regard, the articles analyzed show that teachers' perceptions of neuroeducation were approached from the following perspectives:

i) Teacher evaluation of neuroeducation courses: to learn about teachers' opinions and experiences on a neuroeducation course after having taken it [22], [25], [29]. These courses were intended to make teachers literate in theoretical aspects of learning from the view of neuroeducational principles and in applying these in the classroom.

ii) Neuromyths: to investigate teachers' neuroeducational knowledge in isolation, without any teacher literacy activities or neuroeducational pedagogical implementation [26].

iii) Teacher literacy and pedagogical implementation: to learn about teachers' perceptions of the usefulness of neuroeducational teacher literacy workshops and to learn about the changes and challenges that teachers' knowledge of neuroeducational principles have generated in their teaching practice since the training [23], [24], [27], [28].

iv) Neurodidactic assessment of trainee teacher evaluation: to learn about the opinions of trainee teachers on the presence of neurodidactic elements in evaluations at higher-level institutions [21].

Likewise, the articles analyzed show the various contributions made by the qualitative approach to teachers' perception of neuroeducation. In the first instance, it should be mentioned that teachers perceive the neuroeducational discipline as a strategy that allows them to make their teaching more holistic and highlights the importance for teachers to make pedagogical and didactic constructions that lead them to include neuroscience advances in their content and knowledge [26]. This would support them in providing updated teaching that is conducive to the development of skills in their students [22]. In this regard, teachers perceive that neuroeducational conceptual management should be presented more understandably, reinforcing and linking concepts with ideas and strategies previously known from their teacher training process, which can give theoretical robustness to decision-making in the classroom [22], [27], [28].

More precisely, Brick *et al.* [23] described three insights teachers recurrently expressed in their field notes after becoming neuroscience and learning literate and developing their understanding of students' mental health problems. These three insights reference understanding adolescent development and the causes of problems, establishing positive relationships with students to address social and emotional problems, and abandoning harsh disciplinary practices. As a first point, understanding adolescent development allowed teachers to understand the importance of brain plasticity, recognizing that this organ continues to grow in adulthood and that, therefore, although students are adolescents, they have not yet completed their development process. In this regard, teachers indicated that they never knew "the difference between adult and child brain development" [23]. This information laid the foundation for greater awareness of the psychological and cognitive developmental problems of students; therefore, teachers commented that this helped them in increasing pedagogical tools and being a better teacher from empathic development [22].

Table 1. Information on each selected article

Study	Aim	Methodology and analysis	Participants	Main results
[21]	To analyze the perceptions of university students about how they have been evaluated in their years of schooling.	Open-ended questionnaire, and frequency and thematic analysis.	240 first year students of Teacher Training Degree in Spain.	Redesigning the evaluation instruments from a neuroeducational vision facilitates students' learning and maximizes their capabilities, using error as a source of learning.
[22]	To explore elementary teachers' perceptions of a professional development course on neuroscience and learning.	Interviews, a focus group and case study observations. Analysis was conducted through content coding, pattern matching and descriptive narratives.	12 first grade teachers from a private school in California, USA.	The results reinforce the idea that teachers benefit from knowing the science behind learning.
[23]	To determine whether a program combining neuroscience with mental health literacy content could increase teachers' awareness of students' mental health issues and produce changes in teacher attitudes and classroom practices.	Individual structured interviews and field notes. The analysis was conducted through NVivo 12. In addition, a codebook was developed after an iterative reading of the interviews to generate codes.	Workshop I: 15 high school science teachers, one university-level teacher, and eight staff from the Ministry of Education. Workshop II: 92 teachers, and 10 teachers (Liberia).	After the neuroscience training, teachers understood adolescent development and the causes of student problems. Teachers strived to build positive relationships with students to address social and emotional problems, as well as to abandon harsh disciplinary practices.
[24]	To examine the relationship between curricular implementation strategies following an inquiry-based neuroscience PD and student learning.	Field note and observation were used. Coding and thematic grouping were performed. Teachers were then ranked according to their responses.	Suburban district: 12 secondary school teachers. Urban district: 13 secondary school teachers, in the US.	The availability of quality curricular materials is vital for the implementation of neuroscience lessons in secondary school classrooms.
[25]	To examine teachers' perceptions of the impact of the TCM program.	Focus groups and interviews with teachers after completing the TCM program. Thematic analysis was used.	44 elementary school teachers from the United Kingdom.	The impact on the teacher included a positive change in his ethos.
[26]	To describe aspects of the teaching of the nervous system and the perceptions of neuromyths held by teachers of Natural Sciences in elementary education.	Online survey of open-ended questions regarding the teaching of the nervous system, and the use of the machine-brain analogy; opinions regarding neuromyths. A content analysis was performed.	20 teachers of natural sciences working in basic education in Colombia.	The need for initial training programs to open spaces for critical reflection that allow teachers to access information related to scientific and technological advances of neuroeducation is highlighted.
[27]	To examine the perceptions of teachers and school staff who participated in the PD program in educational neuroscience.	In-depth interviews were conducted, and analyzed thematically with NVivo.	Seven high school teachers from Canada.	Teachers indicate that knowledge of educational neuroscience must be present in lesson planning, lesson delivery, assessment, student engagement, and the two-way teacher-student relationship.
[28]	To train higher education teachers in innovative neuroscience methods through an online platform created to facilitate the development of transversal communication competencies.	Design of six-module course on educational neuroscience. Online survey included closed-ended and open-ended questions. Data analysis included descriptive and inferential statistics and grounded theory.	32 scholars	The results highlight the importance of addressing in a technical and quality manner the components that are developed in the translation of neuroeducational programs in order to ensure their operation and effectiveness.
[29]	To verify that educational neuroscience training programs can promote teachers' understanding of neuroscience-related knowledge.	Survey; descriptive statistics and reliability analysis were used for each subscale.	216 in-service teachers (male=71, female=145) from China.	Educational neuroscience is a new and underexplored field for most teachers. How to explain the views on educational neuroscience to teachers may be more important than the discipline itself.

Another essential point teachers report concerning educational development is the awareness of the student's social and material environments. This point identified external factors that disrupt learning: poverty, family environment, psychological alterations, lack of family support, fatigue, and social and emotional problems [23]. Urrútia and Bonfill [20] indicates that neuroeducationally literate teachers focused on developing students' emotional regulation, focusing on meaningful learning rather than grades. Thus, they established secure relationships with students and improved self-regulation [23]. In addition, teachers

reported that the neuroscience learning training enabled them to control their adverse emotional reactions for the benefit of establishing supportive relationships with their students [23]. The articles show that this self-reflective capacity allows teachers to have a critical perspective on their work [26] and presents a holistic approach that successfully mobilizes the union between neuroscience and education not only as an optimistic projection of the academic performance of students but also as a self-regulatory factor for teachers.

As a third point, teachers' perceptions fostered a positive change in the abandonment of harsh disciplinary practices described as culturally appropriate in some educational contexts [23]. This aspect is of fundamental importance for teachers' work since it shows an attitudinal change in teachers' attitudes towards their students, expressing that they were able to understand the repercussions of stress caused by physical punishment and other harmful behaviors on their students' neurophysiology and the traumatic impact that this generates on the cerebral, psychological, emotional and social levels on students' learning and self-esteem. These teachers expressed that after the neuroeducational training, they abandoned these practices to improve trust between teachers and students, thus propitiating more adequate well-being spaces for learning [23]. In this regard, educators commented that "by suspending harsh disciplinary practices, teachers claimed to have changed power dynamics and created safer environments," making it known that the combination of fundamental neuroscience and learning can produce changes among secondary school teachers in such vital aspects as physical punishment [21]. Emphasizes the importance of continuous training of these teachers since scientific advances in the discipline of study evolve considerably in short periods [26].

Neuroeducational learning from the interpretive viewpoint has incorporated opportunities for teachers to reflect on their practices and the new knowledge acquired to the benefit of modifying and improving their work. This impacts a change of mindset and ethical perspective that mobilizes the development of teacher empathy [25], [24]. This change in mindset of a more empathetic nature made teachers feel more confident and have more positive perceptions of their levels of self-efficacy in job performance, as modifications in their behavior created positive reinforcement cycles from their modeling with their students, which then contributed to improved behavior in students [25], [26]. Nevertheless, for this learning to be effective, teachers stated that it must have a structure and curricular components that allow for flexibility and adaptability, as well as time to be able to work on this curricular flexibility [22], [23], [27]. Furthermore, teachers' perceptions report the importance of having quality materials to support classroom implementation [24]. In addition, teachers emphasized a fundamental aspect of neuroeducational interventions face-to-face, thus mobilizing active dialogue and collaboration between neuroscientists and educators, explaining that such communication is essential to maintain a feedback spiral [27], [28]. Consistent with this, the importance of neuroeducational feedback was also evidenced as a relevant component in the relationship between teachers and students. Accordingly, Calatayud [21] exposes the perceptions of a group of student teachers regarding the neuroeducational evaluative process as "a grade that embodies a final result" and shreds of evidence that advances in neuroeducation have enabled a paradigm shift that has positively permeated the forms of evaluation. Therefore, it is necessary to promote neuroeducation training programs for teachers, establishing expert teams in the area that promote activities that increase the use of neuroeducation in the classroom by teachers highlighting the importance of making teachers literate in this subject [29].

3.2. Qualitative methods

The qualitative approach allows for exploring and understanding the nature of teachers' perceptions, revealing the most successful strategies from the neuroscience and learning theory [24]. Qualitative analysis has an interpretative purpose that seeks to make sense of phenomena according to the meanings that teachers give, so this type of approach is appropriate in the investigation of teachers' perceptions of neuroeducation [26]. In this regard, the third column of Table 1 summarizes the methodological information available for each article. There, it is observed that most of the analyzed articles prefer a plurality of data collection methodologies, in particular through the use of in-depth interviews and focus groups among the most privileged techniques [25], [22]. Interviews were primarily semi-structured, only conducted in structured form by Brick *et al.* [23]. The interview is the most frequently used method of self-reporting in qualitative studies. For this reason, the dimensions of the phenomenon studied and the questions that make up the semi-structured script become vitally important when determining dimensions of the teacher's perception that should be studied in depth in the research work. Table 2 presents this information for each study.

Following on from the design and data collection methods, it is worth noting that only one of the studies followed a case study design [20], two studies presented a mixed design [27], [28]. Likewise, only the use of field notes was reported by Brick *et al.* [23], while two studies reported conducting direct classroom observations [22], [24] and using an open-ended questionnaire [21], [26]. For data analysis, thematic coding through codebooks, patterns, and descriptive narratives was used for illustration [20], [23], while most of these studies followed an inductive analytic approach and supported their analyses through the use of qualitative software, such as NVivo11/12 [23], [25], [27].

Table 2. Questions and dimensions addressed in the interviews

Article	Questions or dimensions address
[21]	– Meaning of the lived evaluation. – Mental processes involved in the evaluation. – Instruments with which they have been evaluated.
[22]	– Focus on content. – Active learning. – Sustained duration. – Collective participation. – Coherence. – With respect to active and effective learning professional development, the following questions were asked: How effective was the professional development course?
[23]	-
[24]	-
[25]	-
[26]	How do you approach the topic of the nervous system in your Natural Science classes? Are the methodologies used in the textbook contents to approach the topic of the nervous system adequate for elementary school students? Explain your answer? What aspects do you emphasize when dealing with contents related to the nervous system? Many teachers use analogies of the functioning of a computer or a machine with that of the brain. What is your opinion about this strategy?
[27]	What had they found beneficial in the educational neuroscience sessions? How had the sessions influenced their knowledge and views on educational neuroscience? How had they applied what they had learned in their teaching practice? How had the sessions influenced their students? What did they think about the educator-researcher relationship?
[28]	What does neuropedagogy bring to the teaching profession? What is a neuromyth? Why do neuromyths persist in schools and universities? Where do emotions come from? From the emotional brain. What is associative memory?
[29]	-

Note: Questions were included as available in the article. For those cases in which the questions were not available in the articles, the reported dimensions or categories of question formulation were included.
- represents those cases in which no information was available on either the questions or the dimensions addressed.

4. DISCUSSION

The scarce number of articles that investigate teachers' perceptions of neuroeducation from a qualitative approach (N=9) makes evident the need to develop research in this field of study. Therefore, it would be interesting to expand knowledge in the area to understand teachers' perceptions of implementing neuroeducational strategies and how these generate new conceptions about education that contribute to learning based on theoretical-empirical foundations of the neuroeducational discipline from the teaching practice.

This is particularly relevant for the Latin American context, in which only one study was found in Colombia [26] based on the databases surveyed. Possibly for this reason, 71% of the articles analyzed were published in English, which is consistent with other research that analyzes this discipline [19]. This is evidence that research on neuroeducation and teacher perception is incipient in Spanish-language journals indexed in the databases of the most significant scientific impact in the social sciences. In this regard, Arévalo *et al*. [26] discuss that few works perform an exhaustive analysis from a qualitative view of teaching practices that link the advances of neuroeducation in implementations with teachers' perceptions and highlight the need to develop this field for the construction of spaces for critical reflection that contribute in offering quality education.

Regarding teachers' perceptions, an exciting plurality of perceptions was investigated, ranging from conceptualizing neuromyths to opinions of neuroeducational literacy courses for teachers and teachers' perceptions of their implementation of neuroeducational principles in their classes. Nevertheless, it is crucial to instill the need to share interview protocols in the report on the design of qualitative studies to contribute to transparency and credibility in the research. A priori, it would not be possible to determine with certainty the gaps in knowledge regarding teachers' perceptions of neuroeducation due to the scarce information presented in the studies on the questions asked to the participants, as shown in Table 2. That is why it is essential to comment on the numerous advantages of publishing interview protocols, among which: i) it enables the comparability of data and findings between studies; ii) it facilitates the replicability of studies; iii) it allows the continuous improvement of the quality of qualitative data collection protocols; and iv) it contributes to identifying previously unaddressed knowledge niches [30]–[33].

Furthermore, the studies address teachers' perceptions in homogeneous and monocultural contexts. However, the school reality of the globalized world is more complex and dynamic, so it is interesting to

investigate teachers' perceptions of the success of neuroeducational principles and strategies in intercultural school contexts. For example, in Chile, classrooms in the public system are increasingly intercultural in their sociodemographic composition, not only because of the presence of schoolchildren of indigenous origin [34], but also because of the growing waves of migration from Latin American countries, such as Venezuela and Colombia [35]. In this context, future studies could investigate whether there are different perceptions among teachers when applying neuroeducational principles in intercultural classrooms with different characteristics and analyze how this influences teacher decision-making. Therefore, tertiary education institutions and policy makers must recognize the potential of training teachers in neuroeducation to foster professional growth [28].

Concerning the methodological approach to teachers' perceptions of neuroeducation, although the inclination towards using a combination of data collection methodologies in most articles is positively highlighted, the type of techniques is limited. In this regard, it is suggested to explore innovative methodologies in the field of qualitative inquiry in neuroeducation. This does not necessarily imply creating new techniques or methodologies [36]. But rather, it is proposed to adapt techniques and methods used to gather information in other fields of educational research (e.g., teacher logs, photovoice and dyadic interviews, among others) [37], or used in other areas (e.g., see adaptations of typology matrices in the field of neuroeducational research). See adaptations of matrices of nonverbal behavioral typologies from the neurocultural model in or scientific disciplines e.g., written interviews, stimulated recall interviews. Several of the techniques suggested foster enriching reflection processes in the participants and allow us to study their perceptions from a complementary perspective to traditional interviews [38]–[40].

It is also proposed to systematize the study of teachers' perceptions through observing non-verbal behavior/communication in the classroom as an indicator of emotions and attitudes towards the various practical aspects of neuroeducational teaching [41]. This would also support building comparable knowledge with that collected through other techniques (e.g., interviews) to triangulate teachers' perceptions. However, for this to be possible, future research should partially abandon data collection based, for example, on interviews or focus groups, and gain greater access to natural data where nonverbal behaviors can be observed in their natural context. In this sense, the efforts of two studies to conduct direct classroom observations stand out; however, it is necessary to make a more tremendous effort in a cross-sectional manner (that is, in research in diverse contexts) to collect natural data to triangulate the perceptions reported by teachers with observable behaviors that support these perceptions and help to deepen them (consider the differences between requested and spontaneous primary data [42]. Consequently, in addition to classroom observations, we also suggest going to the teachers' lounge during recess and participating in teacher training planned by the school, which are spaces for sharing and pedagogical debate among teachers.

It should also be emphasized that all 7 articles have used thematic analysis to explore the data. Thematic analysis is a type of content analysis that analyzes the frequency of key terms or concepts to create analytical categories. In this sense, there are several limitations that from different disciplines, are recognized concerning the exclusive use of thematic analysis in a research area. These limitations are aimed at discussing: i) the dangers of reducing a text and extracting it from a whole for analysis; ii) the reductionist nature of qualitative software analysis (when it is the only form of analysis presented); iii) the fact that many times articles state the type of analysis performed, but do not detail the analytical steps gone through; and iv) the risk of falling into analytical superficiality by only reproducing the participant's message without basing it on theoretical and empirical assumptions that support problematizing the message and understanding it from different perspectives [43]–[45].

In this sense, the proposal here is to complement thematic analysis with other types of analysis, such as textual analysis, narrative analysis, and discourse analysis [46]–[48]. Particularly concerning the latter, quantitative discourse analysis software is reductionist and limits the analysis to evaluate the presence or absence of a category and does not examine the discursive complexity involved in teacher perception. Future research in this field of study could incorporate a detailed linguistic-discursive analysis of teachers' perceptions, as this favors an in-depth exploration of the data beyond the participant's explicit message to analyze the intentionality behind the message, the discursive forms of construction of reality, and the construction of identity positions that contribute to a holistic understanding of teachers' perceptions of neuroeducation. When contrasting the background obtained in this review with current empirical work, it is evident that a qualitative vision fosters critical and creative thinking in educators, which contributes to their pedagogical work [49], [50]. Likewise, neuroeducation researched from a qualitative approach allows for greater dynamism in the professional development of teachers through the development of strategies agreed upon by educators, contextualizing the neuroeducational study proposals to their classrooms [51], [52].

In this regard, qualitative neuroeducational research allows for the development of professional competences that improve didactics, which has been evidenced in descriptive approaches through a self-critical and reflective vision of professional work [53]. Therefore, the neuroeducational discipline applied in an empirical context and investigated qualitatively contributes to a restructuring of the current educational system by eradicating teaching centered on the transmission of a series of decontextualized concepts that

have no practical applications [54], [55]. In the context of a world that increasingly recognizes diversity in schools as a challenge, educational research should contribute to this new challenge by incorporating more complex, in-depth and multivariate analyses of the factors that potentially intervene in the educational environment [56], [57]. For this reason, the analysis of research through the voices of teachers is essential, because educators must adapt to the needs of students and design their pedagogical practices based on the heterogeneity of the classroom, so that adopting an ecological approach from neuroeducation can be useful by facilitating with its contributions situated strategies to the teaching and learning process [58], [59].

Last but not least, the contribution of qualitative neuroeducational research to informing educational policy resides in its potential to provide contextually-situated and relevant considerations from the practitioners themselves. This may work to mobilize much needed efforts to adjust educational policies to reflect the reality and diversity of classrooms, in order to improve not only the teaching-learning experience and outcomes, but also human relations among teachers and students.

5. CONCLUSION

The purpose of the systematic review was to analyze qualitative studies that investigated the principal teachers' perceptions of neuroeducation. This made possible to learn about the growing interest on the part of neuroeducational researchers in identifying what teachers think about the implementations and, in addition, to learn about the assessment of the teachers themselves concerning the contribution of neuroeducation and the positive behavioral changes that it can generate in the pedagogical task. Therefore, from the pedagogical point of view, the studies analyzed emphasize the need to design a neuroeducational literacy and implementation plan for teachers. Concerning the scientific development of the topic, it is concluded that promoting neuroeducational research from a qualitative approach will enhance the resonance between neuroeducation experts and teachers in favor of strengthening bidirectional communication between both agents. The core of this point lies in proposing situated research, using innovative qualitative methodologies in the field that communicate in a language appropriate to educators and their context. This will generate empirical evidence of relevance and viable scientific support for replicability in future research in the field and in the classroom.

Concerning the limitations of a systematic review, the exclusive use of the Scielo, WoS, EBSCO, and Scopus databases stands out, avoiding scientific literature not indexed in these databases. This methodological decision may have limited the potentially relevant documents from other digital spaces of scientific dissemination, identifying only primary scientific articles indexed in the mentioned databases. It is, therefore, relevant to install the ethical debate on how systematic review methodologies are developed and validated in order to value the inclusion of research from scientific spaces that are frequently invisible to promote the democratization of knowledge.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualization	I : **I**nvestigation	Vi : **Vi**sualization
M : **M**ethodology	R : **R**esources	Su : **Su**pervision
So : **So**ftware	D : **D**ata Curation	P : **P**roject administration
Va : **Va**lidation	O : Writing - **O**riginal Draft	Fu : **Fu**nding acquisition
Fo : **Fo**rmal analysis	E : Writing - Review & **E**diting	

CONFLICT OF INTEREST STATEMENT
Authors state no conflict of interest.

INFORMED CONSENT
We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL
The research related to human use has been complied with all the relevant national regulations and institutional policies in accordance with the tenets of the Helsinki Declaration and has been approved by the authors' institutional review board or equivalent committee.

DATA AVAILABILITY
Derived data supporting the findings of this study are available from the corresponding author, [BV-V] on request.

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