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The Neuroeducation Training of Students in the Degrees of Early Childhood and Primary Education: A Content Analysis of Public Universities in Andalusia

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Abstract: Educational neuroscience presents a broad view of what learning is and how and when it occurs. Consequently, neuroeducation offers improved strategies for understanding and developing the teaching–learning process. It is, therefore, essential that teachers and students are trained in neuroeducation, given the current knowledge in this field. Consequently, this study aims to reflect on the training in neuroeducation received by undergraduate students studying early childhood and primary education and to find out how the teaching of neuroeducation is approached in the universities of the eight Andalusian provinces. As methodology, a content analysis was made, which allowed us to transform qualitative data into quantitative data. The categories analysed were "Neuroeducation", "Metacognition", "Cognitive processes" and "Cognition". The study plans for the 2022/2023 academic year were considered. The analysis results of these plans showed that, despite the relevance of neuroeducation in the educational context, the study plans barely addressed this subject. This suggested that the training received by future teachers was not enough to enable them to make the most of neuroscience and neuroeducation considerations.

Keywords: neuroeducation; analysis content; teacher training; early childhood education; primary education

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1. Introduction

Neuroeducation, as it is currently known, has undergone a great evolution over the years. Authors such as Bruer [1], Cruickshank [2] and Gaddes [3], among others, have already investigated and reflected on the relationship between neuroscience and education some decades ago. Neuroscience is defined as "a set of scientific disciplines that study the nervous system with a focus on brain activity and the relationship with human behaviour" (p. 476) [4]. In relation to this, the neuroeducational paradigm is gaining more and more consideration in the current educational system, although there is still a lot of work to do. Understanding brain processes is considered essential in this respect, since teaching can be adapted to individual characteristics and needs [5]. Thus, neuroeducation is an interdisciplinary field that combines neuroscience and education with the aim of understanding how the brain works and applying this knowledge in the field of education to improve teaching–learning processes.

In recent years, interest in this topic has increased, focusing on learning, behaviour and cognition [6]. Studies about neuroscience applied to education in current research have been conducted, with many of them being found both nationally and internationally. In Spain, Fernández et al. [7] carry out a bibliometric analysis to delimit and understand the concepts of neuroscience and neurodidactics taught in higher education, with the aim of a better understanding of the different learning processes; Martínez et al. [8] analyse the prospects for intercultural teaching competence in relation to technology and neuroeducation; and

Procopio et al. [9] present a didactic experience of the application of an approach based on cooperative learning and neuroeducation.

At the international level, Coello, ref. [10] analyses the neurological and theoretical aspects that underpin early stimulation programmes for children receiving early childhood education in Ecuador; Brechet et al. [11] investigate the knowledge that French children have about brain functioning, relating this metacognitive knowledge to its neuroeducational implications; Ensuncho and Aguilar [12], in Colombia, highlight the importance of linking neuroscience and neuroeducation with emotional intelligence for its incorporation into the education system; Fragkaki et al. [13] explore, in Greece, the knowledge of neuroeducation possessed by university teachers under the premise that being a university teacher is associated with the acquisition of enough knowledge and skills to teach; Gola et al. [14] reflect, in Italy, on teacher training and knowledge, delving into neuroscience and neuroeducation; González and Montes de Oca [15] investigate the contributions of educational neuroscience for the development of new professional competencies in students in the healthcare field in Cuba; Schmied et al. [16] investigate, in Minnesota, the acceptability of neuroscience applications to educational practice in two groups of young adults: those studying bioscience who will be driving future basic neuroscience research and technology transfer, and those studying education who will be choosing among neuroscience-derived applications for their students; and Torres [17] reflect on current findings in neuroscience and their incorporation into education in Mexico.

Most of the studies mentioned are based on the reflection of concepts linked to neuroscience, such as *cognition* and *cognitive processes*: mental activities that allow us to acquire, process, store and use the information we receive from the environment. These processes are those involved in thinking, perception, attention, memory, language, problem solving and decision making as well as *metacognition*: the human capacity to think and reflect on one's own cognitive processes.

In the research that comprises the neuroeducation theoretical corpus, special attention has been paid to three aspects, focusing on teachers, students and the existing neuromyths surrounding brain function and its influence on teaching and learning. The latter is very present in current research, since a misinterpretation of cognitive processes and metacognition could influence the way in which we understand the learning process.

1.1. Neuroeducation and Its Relevance to Teacher and Student Education

As for teachers, there are training plans, intervention programmes and didactic experiences aimed at training teachers in this new paradigm based on the benefits of neuroscience. Caballero-Cobos and Llorent [18] developed over two years in Spain a teacher training programme in neuroeducation through the improvement of three key competences (reading, mathematics and socioemotional–moral), with the involvement of 209 participants in the field of secondary education. The results show a significant effect of the intervention on reading competence, mathematical competence and empathy (socioemotional area). These findings invite us to think about the potential of neuroeducation in schools, with clear implications for educational policies, teacher training and school practice. Chang et al. [19] implemented a course in Texas about educational neuroscience concepts with 14 science teachers. One year after the programme's implementation, they concluded that teachers renewed their pedagogical decisions, changed their organisational dynamics in the classroom and improved their attention to students and their individual characteristics. Jolles and Jolles's [6] study in the Netherlands focused on how to improve neuroscience literacy in education professionals and proposed four neuroscience content topics "that every teacher should know" (p. 1): Theme 1: The nervous system controls and responds to body functions and directs behaviour; Theme 2: Nervous system structure and function are determined by genes and environments throughout life; Theme 3: The brain is the foundation of the mind; Theme 4: Research leads to understanding that is essential for the development of therapies treating nervous system dysfunction and helps improve the circumstances under which people learn. Kara et al. [20] conduct an intensive training programme on neuroscience and mental health with 24 Liberian secondary school teachers working with students with mental health problems. Results show that within approximately two weeks, teachers understood the emotional challenges that students may be experiencing and recognised the biopsychosocial basis of these challenges. In addition, changes were noted in the help offered, both in the student–teacher relationship and in classroom discipline. Trombini et al. [21] conduct a five-week training course with 60 teachers in Brazil on neuroscience applied to education, with topics such as neuroanatomy, neurophysiology, neurobiology of learning and memory, neuroscience and education, etc. Teachers' perceptions after the training process indicated that the course was essential in the acquisition of new knowledge about neuroscience.

As far as students are concerned, research and programmes have been carried out focusing on the development of different skills based on the benefits of neuroscience. Mainly, these studies suggest that teaching processes should focus on meaningful and functional situations in which individual learning is combined with more collaborative learning through active and participatory methodologies. Coello et al. [22] implement the neuroeducation contributions in activities related to early stimulation and the development of language skills and abilities in 200 Ecuadorian children aged 3 to 5 years. The conclusions show that an adequate use and implementation of early stimulation programmes under these parameters guarantee the strengthening of linguistic–cognitive activities and contribute to the social development of children, offering security and mental progress. Guevara et al. [23] design a research project on neuroeducation in the learning of accounting and finance for Mexican children aged 7 to 10 years. The aim is to provide new teaching strategies to generate motivation, techniques and strategies in the teaching–learning process based on the development of logical–mathematical thinking together with the brain channels' functioning and activation. Gutiérrez-Fresneda and Pozo-Rico [24], through an intervention programme, have a positive impact on the learning of reading in 428 Spanish children aged 5 and 6. As mentioned by the authors, "the results highlight the potential value of the instruction and support the development of teaching models that integrate the contributions offered by neuroscience to the educational field in order to favour the process of reading acquisition" (p. 1). Pérez et al. [25] develop an early stimulation programme under the neuroeducation paradigm, focusing on the skills and abilities linked to language in 69 Ecuadorian children aged up to 6 years. The importance of neuroeducation in the development of children's learning is highlighted.

1.2. Presence of Neuromyths in Current Education

Since neuromyths began to be discussed some decades ago, studies about them have increased, with the idea of demystifying them and offering society an accurate explanation of them. A neuromyth is defined as "a misconception generated by a misunderstanding, a misreading, or a misquoting of facts scientifically established (by brain research) to make a case for the use of brain research in education and other contexts" (p. 111) [26]. A number of authors from different contexts, following the first approaches of the OECD [26], have reflected on the main neuromyths existing in society, investigating their demystification and designing scales for their evaluation among teachers and students. Dekker et al. [27] and Düvel et al. [28] in Germany, Ferrero et al. [29] in Spain, Howard-Jones [30] and Howard-Jones et al. [31] in the United Kingdom and MacDonald et al. [32] in the United States propose the following, with their corresponding clarifications:

- "There are multiple types of intelligence and each of them operates from a separate area with corresponding IQs". However, this is not scientifically proven. Neuroimaging studies do not support multiple intelligences and the opposite is true. Through the activity of its frontal cortexes, among other areas, the human brain appears to operate with general intelligence, applied to multiple areas of performance;
- "People learn best when they receive information in their preferred learning style, e.g., VAK (visual, auditory, kinesthetic) methodology". This methodology states that learners with a visual learning style learn best through pictures, pictograms, diagrams,

etc., while auditory learners are best at storing knowledge through sounds, and finally, kinaesthetic learners are most successful in their learning through action and movement. While this is interesting, to a first approximation, it raises dilemmas and doubts about each of the learning styles for the benefit of multi-sensory knowledge integration. Moreover, the advantage of categorising learners by sensory modality has not been scientifically proven. There is not even scientific evidence that they learn best by their preferred learning style, nor that children have learning styles dominated by particular senses. The best learning occurs through multi-sensory integration;

– "Students do not show preferences for how they receive information (e.g., visual, auditory, kinaesthetic)". In reality, learners do show this preference, which does not deny that the storage of information with all senses is more robust than with only one.

Despite this, the presence of neuromyths among citizens and, even more seriously, among teachers, continues to be a reality that is currently being widely researched. So much so that there are numerous studies that seek to analyse the presence of neuromyths among teachers. An example of this is the research by Ávila-Toscano et al. [33] in Colombia, in which they administered the Dekker scale [27] to 308 practising Colombian teachers, indicating that 99.36% of the participants presented neuromyths and moderate levels of brain knowledge. False beliefs about hemispheric difference, learning styles and early cognitive stimulation predominated; Bissessar and Youssef [34] in the Caribbean, through the Dekker scale [27], collected responses from 338 teachers in Trinidad and Tobago, finding that more than 65% were unable to recognise at least 50% of the myths; Flores et al. [35] administered the Dekker scale [27] to 64 university teachers in Chile and found that more than 70% had a high prevalence of neuromyths; Gülsün and Köseoğlu [36] in Turkey administered the Dekker scale [27] to 146 biology teachers and found that most of them knew one of three correct items while they had three of seven common neuromyths; and Hughes et al. [37] administered the Dekker scale [27] to 228 teachers in Australia, finding that more than 50% of them believed seven of the main neuromyths (short bouts of motor coordination exercises can improve integration of left and right hemispheric brain function; exercises that rehearse coordination of motorperception skills can improve literacy skills; individuals learn better when they receive information in their preferred learning style (e.g., auditory, visual, kinaesthetic); children are less attentive after consuming sugary drinks and/or snacks; listening to classical music increases children's reasoning ability; a common sign of dyslexia is seeing letters backwards; and some of us are "left-brained" and some are "right-brained" and this helps explain differences in how we learn).

Idrissi et al. [38], in Morocco, administer the Dekker scale [27] to 12 teachers, finding a 66.56% prevalence of neuromyths, highlighting those about knowledge of the brain; Jeyavel et al. [39] applied the Howard-Jones scale [30] to 503 teachers in India. On average, 65.5% of teachers showed their belief toward more than two of the neuromyths and 84% of the participants believed the learning style myths.

Jiménez and Calzadilla [40], in Cuba, administered the Dekker scale [27] to 40 university teachers, highlighting the prevalence of common neuromyths; Ruiz-Martín et al. [41], in Spain, administered the Dekker Scale [27] to 807 teachers and found, as in previous studies, a high prevalence rate for the most common neuromyths; Sarrasin et al. [42], in Quebec, administered the Dekker [27] and Tardif et al. [43] scales to 927 teachers, finding a lower presence of neuromyths, in contrast to previous studies, although the authors indicate that the prevalence remains high for myths related to learning style, multiple intelligence, hemispheric dominance and brain functioning; Simoes et al. [44] administered the Dekker [27] and Papadatoua-Pastou et al. [45] scales in Brazil to 1634 teachers, observing high endorsement of some key neuromyths; and Zhang et al. [46], through the Dekker et al. [27] and Howard-Jones et al. [31] scales, collected responses from 40 principals in China, finding that the most widespread neuromyths were those about learning styles, rich environments for children in early childhood education and specific *brain gym* exercises to improve brain function.

In summary, although there is a conscious effort to implement the ideals of neuroscience in the education field, there is still a lack of training for teachers on these topics. For this reason, it is essential to understand the initial training received by future early childhood and primary education teachers during their time at university in the different public education faculties in the autonomous region of Andalusia (Spain), comprising eight provinces (Huelva, Seville, Cadiz, Cordoba, Malaga, Granada, Jaen and Almeria).

The study objectives were:

1. To determine the extent to which content related to neuroeducation, metacognition, cognition and cognitive processes is addressed in early childhood and primary education degrees in the public universities of the eight Andalusia provinces;

2. To reflect on the content linked to neuroeducation in the teaching guides of early childhood and primary education degrees in the public universities of Andalusia.

For a better understanding of the Spanish education system, it should be noted that university degrees last 4 years. Bachelor's degrees in early childhood education and primary education are the only training options that qualify for the teaching profession. Throughout this training, there are basic subjects (developmental psychology, educational psychology and learning difficulties), obligatory subjects (development of language skills and didactics, didactic strategies for the development of oral and written communication and attention to diversity) and optative subjects (pedagogical aspects of cognitive and communication difficulties, developmental and educational aspects of specific educational needs and child psychopathology in classrooms).

2. Methodology

The methodology used for this study was content analysis, which according to Bardín [47] consists of "(...) a set of techniques for analysing communications aimed at obtaining indicators (quantitative or not) through systematic and objective procedures for describing the content of messages" (p. 8). To obtain the content of messages, a system of categories was established.

Miles et al. [48] describe a category as a way of classifying certain information, depending on the importance we give to a topic. This allows, according to López-Noguero [49], "analysing the ideas that inhabit the text, not the text itself" (p. 173).

This methodology is approached from the perspectives of both qualitative and quantitative paradigms, since, as Oliver [50] mentions, "when we talk about content analysis, we refer to an indirect methodology, that is, based on the analysis and interpretation of existing documentary sources, and not to the direct observation of reality, which can be exploited both in a quantitative and qualitative sense" (p. 26).

Moreover, the use of a categories system as a coding procedure allowed raw data to be transformed into units, enabling a description of content characteristics in quantitative form [51].

2.1. Procedure

Firstly, the units of analysis (sampling, context and register) were determined, and the categories (neuroeducation, metacognition, cognitive processes and cognition) were defined. For this purpose, in a meeting with the team members in which concrete definitions of the selected categories were formulated, our group's definition of categories ensured inter-rater reliability. These categories were selected based on their link to the subject matter and their presence in the studies analysed during the literature review [6,10,11]. The studies selected to establish the categories of analysis formed the *corpus* to carry out our analysis.

Secondly, coding of the study plans of degrees of early childhood education and primary education of the public universities of Andalusia for the 2022/2023 academic year [52–67] was conducted. These documents are in the public domain and can be found on the websites of the Andalusian public universities. The coding was conducted according to two criteria: the presence or absence in the text of the register units and the weighting frequency with which units appear in the teaching guides.

Based on these two criteria, the weighting was carried out by considering its appearance in obligatory courses to be of greater value than others that could be taken as optative courses. Therefore, the following values were distributed: basic courses (B): value 3; obligatory (OB): value 2; and optative (OP): value 1. For this process of coding and weighting the obtained data, Excel 2016 (16.0) software was used.

2.2. Categories and Analysis Units

The unit of analysis is understood to be the representative entity chosen as the object of study, in this case, the established categories. In relation to these categories of analysis, Table 1 describes the categories using the definitions drafted by our research group.

Table 1. Categories of analysis.

Categories	Definition	Examples
Neuroeducation (NE)	This category included all content related to the brain processes that take place when a person carries out teaching and learning processes.	"Compression of Learning Process" "Errors in the construction of mathematical thinking"
Metacognition (MC)	Human capacity for thinking and reflecting on one's own cognitive processes.	"Self-learning"
Cognition (C)	Content related to the human capacity to know through perception and the brain organs.	"Teaching, Learning and Knowledge" "Teaching-learning process"
Cognitive processes (CP)	All contents related to the mental operations performed by the brain to process information were included.	"Information processing" "Scientific thinking and reasoning" "Cognitive development"

In the present content analysis, there was an additional category of analysis, "Neuromyths", as the literature review highlighted the importance of this category being considered in the study plans. However, the category did not occur in any of the teaching guides analysed. For this reason, it was not considered in the methodology and discussion sections.

According to Krippendorff [50], because of the categories, sampling units were established, understood as the basic entities through which the unit of analysis is accessed. For this study, the sampling units were the basic, obligatory and optative training courses in the study plans of early childhood education and primary education degrees currently taught in the public universities of Andalusia, for the 2022/2023 academic year. The teaching guides for these subjects were in the public domain.

Finally, we understood the recording unit as the group of words that contained information on the category of analysis, in this case, those contents that appeared in the teaching guides of the subjects related to the established categories of analysis.

3. Results

3.1. Results Obtained in Primary Education Degrees

Table 2 shows the weightings obtained in primary education degrees in Andalusia. Of the 360 teaching guides analysed belonging to the curricula of primary education degrees of Andalusian public universities, 28 subjects (7.8%) contained at least one of the categories analysed. Of the 28 subjects, the majority belonged to basic education.

The most common category was "cognitive processes", as it appeared in 24 teaching guides. The categories "metacognition" and "cognition" appeared in nine teaching guides, while the category "neuroeducation" was the least present, appearing in only eight teaching guides.

Table 2. Weightings obtained in Primary Education Degrees.

University	Number of Courses	Number of Courses That Have Categories	Categories				Weighting	Total
			NE	MC	CP	C		
University of Almeria	B = 10 OB = 14 OP = 30	B = 2 OB = 3 OP = 1	0 0 1	1 1 0	2 2 0	1 0 0	4 × 3 = 12 3 × 2 = 6 1 × 1 = 1	19
University of Cadiz	B = 10 OB = 17 OP = 24	B = 2 OB = 1 OP = 0	0 0 0	1 1 0	2 1 0	0 0 0	3 × 3 = 9 2 × 2 = 4 0 × 1 = 0	13
University of Cordoba	B = 10 OB = 21 OP = 24	B = 1 OB = 0 OP = 1	1 0 0	0 0 0	1 0 1	0 0 0	2 × 3 = 6 0 × 2 = 0 1 × 1 = 1	7
University of Granada	B = 10 OB = 15 OP = 23	B = 2 OB = 0 OP = 0	1 0 0	1 0 0	2 0 0	2 0 0	6 × 3 = 18 0 × 2 = 0 0 × 1 = 0	18
University of Jaen	B = 10 OB = 12 OP = 18	B = 3 OB = 0 OP = 1	2 0 0	2 0 1	2 0 1	1 0 0	7 × 3 = 21 0 × 2 = 0 2 × 1 = 2	23
University of Huelva	B = 10 OB = 28 OP = 24	B = 3 OB = 0 OP = 1	1 0 0	0 0 0	2 0 1	3 0 0	6 × 3 = 18 0 × 2 = 0 1 × 1 = 1	19
University of Seville	B = 10 OB = 17 OP = 20	B = 3 OB = 1 OP = 1	1 0 0	1 0 0	3 1 1	1 0 0	6 × 3 = 18 1 × 2 = 2 1 × 1 = 1	21
University of Malaga	B = 10 OB = 19 OP = 29	B = 1 OB = 1 OP = 0	1 0 0	0 0 0	1 1 0	1 0 0	3 × 3 = 9 1 × 2 = 2 0 × 1 = 0	11
Total	**360**	**28**	**8**	**9**	**24**	**9**		**131**

Note: *B* = "basic"; *OB* = "obligatory"; *OP* = "optative"; *NE* = "Neuroeducation"; *MC* = "Metacognition"; *CP* = "Cognitive procedures" *C* = "Cognition".

The university with the highest weighting was the University of Jaen with a value of 23. This was followed by the University of Seville with a weighting value of 21, the University of Huelva and Almeria with a value of 19 and the University of Granada with a value of 18. The universities that obtained a lower weighting were the University of Cadiz with a value of 13, the University of Malaga with a value of 11 and the University of Cordoba with a value of 7.

Table 3 shows the 28 subjects that contained at least one of the analysis categories in their teaching guides. The universities that contained the most subjects with categories were the University of Almeria and the University of Seville.

Most of the subjects belonged to the psychology area, with the subjects "Developmental Psychology" and "Educational Psychology" being present in all teaching plans as basic training subjects. There were also subjects belonging to the area of didactics of experimental sciences such as "Didactics of Experimental Sciences" (University of Almeria) and to the area of didactics of mathematics: "Mathematical knowledge in Primary Education" (University of Cadiz).

There were also subjects belonging to the area of special education such as "Developmental and Educational Aspects of Specific Educational Needs" (University of Cordoba) and "Intervention and Developmental Aspects of Specific Educational Needs" (University of Seville).

Table 3. Courses that contained any of the categories in Primary Education Degrees.

Course	University	Type	Categories			
			NE	MC	PC	C
Developmental psychology	University of Almeria	B			X	
Educational psychology	University of Almeria	B		X	X	X
Didactics of experimental sciences I	University of Almeria	OB			X	
Didactics of experimental sciences II	University of Almeria	OB		X		
Problem solving and mathematical connections	University of Almeria	OB			X	
Learning difficulties in mathematics	University of Almeria	OP	X			
Developmental psychology	University of Seville	B	X		X	
Educational psychology	University of Seville	B		X	X	X
Developmental and Learning Difficulties	University of Seville	B			X	
Development of language skills and didactics in Primary Education	University of Seville	OB			X	
Intervention and developmental aspects in specific educational needs	University of Seville	OP			X	
Developmental psychology	University of Huelva	B			X	X
Educational psychology	University of Huelva	B	X			X
Psychological bases of special education	University of Huelva	B			X	X
Child Psychopathology in classroom	University of Huelva	OP			X	
Psychopedagogical bases of Special Education	University of Jaen	B	X		X	
Developmental psychology	University of Jaen	B	X	X		X
Educational psychology	University of Jaen	B		X	X	
Pedagogical aspects of cognitive and communication difficulties	University of Jaen	OP			X	
Developmental psychology	University of Cadiz	B			X	
Educational psychology	University of Cadiz	B		X	X	
Mathematical knowledge in Primary Education	University of Cadiz	OB	X		X	
Educational and developmental psychology	University of Cordoba	B	X		X	
Developmental and educational aspects of specific educational needs	University of Cordoba	OP			X	
Developmental psychology	University of Granada	B			X	X
Educational psychology	University of Granada	B	X	X	X	X
Developmental and educational psychology at school age	University of Malaga	B	X		X	X
Didactic strategies for the development of oral and written communication	University of Malaga	OB			X	

Note: *B* = "basic"; *OB* = "obligatory"; *OP* = "optative", *NE* = "Neuroeducation"; *MC* = "Metacognition"; *CP* = "Cognitive procedures" *C* = "Cognition".

3.2. Results Obtained in Early Childhood Education Degrees

Table 4 shows the weightings obtained in each early childhood education degree from Andalusian public universities. Out of a total of 325 teaching guides analysed, 32 subjects (9.8%) contained at least one of the categories analysed; most of these subjects were basic training subjects.

In terms of the presence of the categories, the category with the highest presence was "cognitive processes" which appeared in 28 teaching guides. The category "cognition" appeared in 14 teaching guides, followed by the category "neuroeducation" which appeared in 12 teaching guides. The category with the least presence was "metacognition" which appeared in only six teaching guides.

The universities that obtained the highest weighting were the University of Granada and the University of Cadiz, both with a weighting value of 25. The University of Malaga obtained a weighting of 21, followed by the University of Seville which obtained a value of 20. The universities of Huelva, Cordoba and Jaen obtained a weighting of 18, with the University of Almeria obtaining the lowest weighting with a value of 16.

Table 5 shows 32 subjects that contained at least one of the analysis categories. The universities with the highest number of subjects with categories were the University of Cadiz and the University of Cordoba.

Table 4. Weightings obtained in Early Childhood Education Degrees.

University	Number of Courses	Number of Courses That Have Categories	Categories				Weighting	Total
			NE	MC	CP	C		
University of Almeria	B = 16 OB = 9 OP = 8	B = 2 OB = 2 OP = 0	1 0 0	1 0 0	1 2 0	1 0 0	4 × 3 = 12 2 × 2 = 4 0 × 1 = 0	16
University of Cadiz	B = 15 OB = 10 OP = 15	B = 4 OB = 0 OP = 1	3 0 0	1 0 0	2 0 1	2 0 0	8 × 3 = 24 0 × 2 = 0 1 × 1 = 1	25
University of Cordoba	B = 17 OB = 11 OP = 14	B = 2 OB = 2 OP = 2	1 0 1	0 0 0	2 2 1	1 0 0	4 × 3 = 12 2 × 2 = 4 2 × 1 = 2	18
University of Granada	B = 15 OB = 10 OP = 15	B = 2 OB = 1 OP = 0	1 0 0	2 0 0	2 1 0	2 1 0	7 × 3 = 21 2 × 2 = 4 0 × 1 = 0	25
University of Jaen	B = 17 OB = 14 OP = 14	B = 2 OB = 0 OP = 2	2 0 1	0 0 0	2 0 2	1 0 0	5 × 3 = 15 0 × 2 = 0 3 × 1 = 3	18
University of Huelva	B = 18 OB = 12 OP = 17	B = 3 OB = 0 OP = 0	1 0 0	0 0 0	3 0 0	2 0 0	6 × 3 = 18 0 × 2 = 0 0 × 1 = 0	18
University of Seville	B = 15 OB = 10 OP = 14	B = 3 OB = 1 OP = 0	1 0 0	1 0 0	3 1 0	1 0 0	6 × 3 = 18 1 × 2 = 2 0 × 1 = 0	20
University of Malaga	B = 16 OB = 10 OP = 13	B = 3 OB = 0 OP = 0	0 0 0	1 0 0	3 0 0	3 0 0	7 × 3 = 21 0 × 2 = 0 0 × 1 = 0	21
Total	**325**	**32**	**12**	**6**	**28**	**14**		**161**

Note: *B* = "basic"; *OB* = "obligatory"; *OP* = "optative"; *NE* = "Neuroeducation"; *MC* = "Metacognition"; *CP* = "Cognitive procedures" *C* = "Cognition".

Table 5. Courses that contained any of the categories in Early Childhood Education Degrees.

Course	University	Type	Categories			
			NE	MC	PC	C
Developmental psychology	University of Almeria	B			X	X
Educational psychology	University of Almeria	B	X	X		
Development of mathematical thinking in Early Childhood Education	University of Almeria	OB			X	
Development of written communicative skills and their didactics	University of Almeria	OB			X	
Developmental psychology	University of Cadiz	B	X	X	X	
Educational psychology	University of Cadiz	B	X		X	X
Educational processes in Early Childhood Education	University of Cadiz	B				X
Learning difficulties and developmental disorders	University of Cadiz	B	X			
Socio-emotional skills and peer relations in Early Childhood Education	University of Cadiz	OP			X	
Developmental psychology	University of Cordoba	B			X	X
Educational psychology	University of Cordoba	B	X		X	

Table 5. *Cont.*

Course	University	Type	Categories			
			NE	MC	PC	C
Development of mathematical thinking	University of Cordoba	OB			X	
Acquisition and development of sexual and gender identity and coeducation	University of Cordoba	OP			X	
Psychological, social and emotional effects of music therapy	University of Cordoba	OP	X			
Developmental psychology	University of Granada	B	X	X	X	X
Educational psychology	University of Granada	B		X	X	X
Development of children's mathematical thinking	University of Granada	OB			X	X
Educational psychology	University of Jaen	B	X		X	
Developmental psychology	University of Jaen	B	X		X	X
Pedagogical aspects of cognitive and communication difficulties	University of Jaen	OP			X	
Instructional psychology in Early Childhood Education	University of Jaen	OP		X	X	
Developmental psychology from 0 to 6 years of age	University of Huelva	B			X	X
Developmental Psychology	University of Huelva	B	X		X	X
Psychological foundations of special education	University of Huelva	B			X	
Educational psychology	University of Seville	B	X		X	
Developmental psychology	University of Seville	B		X	X	X
Developmental and learning difficulties	University of Seville	B			X	
Development of language skills and their didactics	University of Seville	OB			X	
Developmental psychology from 0 to 6 years of age	University of Malaga	B			X	X
Educational Psychology of Early Childhood Education	University of Malaga	B		X	X	X
Psychological well-being of children	University of Malaga	B			X	X

Note: *B* = "basic"; *OB* = "obligatory"; *OP* = "optative" *NE* = "Neuroeducation"; *MC* = "Metacognition"; *CP* = "Cognitive procedures" *C* = "Cognition".

It is worth noting that most of the subjects belonged to the area of psychology, with the subjects "Developmental Psychology" and "Educational Psychology" being present in all curricula as basic training subjects. There were also subjects belonging to the area of didactics of mathematics, such as "Development of Mathematical Thinking" (University of Cordoba).

There were also subjects from the area of special education, such as "Learning Difficulties and Developmental Disorders" (University of Cadiz), and from the area of music didactics, such as "Psychological, Social and Emotional Effects of Music Therapy" (University of Cordoba).

4. Discussion

Neuroscience—more specifically, neuroeducation—has become very relevant in the educational field, at least on a theoretical level. It offers teachers a deeper understanding of how the brain learns and how this knowledge can be applied to improve teaching and educational performance. By using neuroscience-based approaches, more effective teaching strategies can be developed, learning can be adapted to individual learners' needs and cognitive skill development and emotional well-being in the learning environment can be promoted.

The presence of concepts linked to neuroeducation, as defined, is lacking in the teaching guides of early childhood and primary education degrees of the different Andalusian universities. Out of a total of 685 guides, only 60 contained any of the categories evaluated (cognitive processes, metacognition, cognition and neuroeducation). Likewise, it should be noted that the category "Neuromyths" was not present in any revised guide. In this way, it is shown how, despite the efforts of neuroscience to offer great contributions to the teaching–learning process, the training offered in the field of university education still has great room for improvement. This has negative repercussions on the initial training of future Andalusian teachers, since neuroeducation is a topic shown to be increasingly present in the future of society, according to previous studies [7–17]. To safeguard these training deficits, there are intervention programmes and training plans, with the aim of promoting knowledge about neuroscience and its applicability in education [6,18–21].

The categories evaluated had a notable presence in the subjects of "Developmental Psychology" and "Educational Psychology" in the eight Andalusian universities studied, in both degrees of early childhood education and primary education. This is logical, as it is one of the most important basic subjects for the development of educational professionals. These subjects allow us to understand human development, the evolutionary characteristics of each age and, consequently, the adaptation of teaching methods according to each stage of development [68]. They also identify individual needs and the influence of biological, cognitive, social and emotional factors on children's progress, allowing teachers to provide additional support and resources to help students overcome challenges and reach their full potential. In addition, developmental and educational psychology provides valuable insights into how learning occurs and how effective learning environments can be created [20]. This knowledge contributes to dispelling the most common neuromyths among teachers [27–31]. Some of these are: "There are multiple intelligences that make each student more capable for certain tasks", "There are separate brain areas for emotions, rationality and cognition", "Each student has a preferred learning style (visual, auditory, kinaesthetic), which explains the differences in their learning abilities" and "There are critical learning periods, after which it is possible that certain skills cannot be acquired", among others. Based on this, it is worth noting that neuroimaging studies do not support multiple intelligences. Through the activity of its frontal cortexes, among other areas, the human brain appears to operate with general intelligence, applied to multiple areas of performance [30]. It is also suggested that the cerebral hemispheres work together.

In exchange, the categories of analysis were present in the area of mathematics in both degrees, but with a very low percentage (0.43%). They only stood out in three subjects at three universities (Almeria, Cadiz and Cordoba). This fact is noteworthy, because in the mathematical field, having basic notions about this allows teachers to identify and address learning difficulties such as dyscalculia and, thus, improve their teaching strategies [69,70]. Also, knowing about the different cognitive processes and their development in childhood will influence the presence of teaching neuromyths in this area, such as "Boys are better at mathematics and spatial skills than girls", "Generally, boys' brains are more rational, and girls' brains are more emotional" and "The left hemisphere generates actions linked to logic, planning and analysis (rational and analytical zone)", among others [27–31]. In consideration of these neuromyths, it should be said that those linked to sex have no scientific basis. Moreover, the hemispheres of the brain work as one and in an interconnected way. It would be incorrect to think that there is hemispheric dominance and that the two hemispheres are separate and, therefore, perform completely different and independent functions. It has been found that both hemispheres are united by the corpus callosum and that performing a task requires the use and functioning of both hemispheres [71]. Moreover, in the event that one hemisphere is damaged, the other is able to assume its functions [71,72].

The presence of the different categories of analysis could also be seen in special education, but with an equally low percentage (0.43%). These categories were detected in three subjects in three universities (Cordoba, Seville and Cadiz). These findings are surprising, since with so many students with special educational needs [73], and a society that is increasingly aware of the need to pay attention to diversity, it is unacceptable that higher education does not pay sufficient attention to these terms and to the contributions of neuroeducation. The knowledge provided by neuroscience in this field allows teachers to understand neurocognitive differences, the influence of different disabilities and disorders on the teaching–learning process [74] and the development of flexible teaching methods adapted to the socioemotional development of students with more specific needs and difficulties. Around this theme, there are also numerous neuromyths that are unlikely to disappear if initial teacher training has these shortcomings. Some of them, according to Dekker et al. [27], Düvel et al. [28], Ferrero et al. [29], Howard-Jones [30] and

Howard-Jones et al. [31], are: "The designation of students with functional diversity is due to the fact that their brain functioning is different from that of their peers", "The brains of children with Attention Deficit Hyperactivity Disorder (ADHD) are overexcited", "A common sign of dyslexia is that letters are perceived backwards in the brain" and "Specific diet can help to overcome certain disorders, such as Attention Deficit Hyperactivity Disorder, dyslexia and Autism Spectrum Disorders", among others. To understand these neuromyths, it should be noted that nutrition has no influence on overcoming a disorder, as this is a lifelong condition. Likewise, dyslexia do not imply that the brain sees letters backwards or that the ADHD child has an overexcited brain, as the scientific basis does not indicate this.

On the other hand, it was found that the subject "Psychological, social and emotional effects of music therapy", as part of the degree of early childhood education at the University of Cordoba, presented the categories of analysis established in this study. This area of knowledge, like the previous ones, is highly relevant in the field of neuroeducation [75], as it provides a deep understanding of how the brain processes musical skills, fosters auditory and perceptual skills, stimulates cognitive and emotional development and encourages artistic expression. Equally, it is incomprehensible that these concepts are so scarcely present in transversal but crucial subjects in children's development. Equally, there are some neuromyths with a strong presence in today's society and widespread among teachers, such as: "Listening to classical music improves children's cognitive skills", "We learn better when we receive information in the preferred learning style (visual, auditory, kinaesthetic)" and "Students do not show their preferences for the way they receive information (visual, auditory, kinaesthetic)", among others [27–31].

After reviewing the teaching guides of Andalusian universities, it was found that many essential areas of knowledge in initial teacher training and determining factors in the development of pre-primary and primary school pupils were left out. No link has been found between neuroeducation and linguistic competence or the field of artistic expression and physical activity, despite the diversity of studies that show their link and relevance [22,76,77]. Also, the presence of neuromyths associated with these terms has been studied by several authors [27–31]. Some of these neuromyths in the field of linguistics are as follows: "Children should learn their mother tongue before learning a second language", "The earlier one learns to read, the better", "Our handwriting reveals our personality", "Doing basic *Brain Gym* exercises helps pupils learn to read and use language better" and "Exercises to coordinate motor perception skills improve reading and writing". As for neuromyths linked to brain functionality optimisation and physical activity, examples include the following: "Motor coordination exercises improve the integration of the functions of both brain hemispheres", "After an intense session of physical activity, attention and morale decrease due to fatigue" and "Physical exercise improves the body, and mental exercise improves the brain. One does not influence the other". In relation to the above, the understanding of declarative and procedural learning systems as children mature is of enormous importance for early childhood education. In fact, several studies have reflected on this and on second-language learning [78–80].

In consideration of these neuromyths, it is convenient to indicate that to teach reading and writing, students should be stimulated through multi-sensory learning, hence the need to reinforce, repeat and update concepts through memory. It has been proven that the ideal age to start reading is the last year of infant education (at approximately 5 years of age), as this is the time when pupils have acquired pre-reading skills and are more easily able to master reading [24]. Consequently, learning to read should not be forced at ages before 5 years old.

Certain beliefs that were considered true in past decades have been disproved, which implies that educators should be aware of these facts to prevent myths from influencing their educational practice [81].

After determining how neuroeducation is approached in Andalusian universities, the study of teaching guides of other autonomous communities of Spain (Aragon, Balearic

Islands, Canary Islands, Cantabria, Castilla-La Mancha, Castilla y León, Catalonia, Community of Madrid, Community of Navarre, Community of Valencia, Extremadura, Galicia, Basque Country, Principality of Asturias, Region of Murcia and La Rioja), as well as of other European cities, is proposed as a prospective research project. In this way, comparative and inferential analyses can be established between the different universities of Europe. At the same time, it would be interesting to investigate the teaching guides of other university degrees linked to education, such as those of pedagogy or social education, as the training of these professionals is also relevant in the academic and social panorama. Another continuation of this research would be a reflection on the role of technology in the development of metacognition, as some authors have already started [82].

5. Conclusions

Neuroeducation has a fundamental role in the teaching–learning processes and, therefore, in the training of future teachers. As for the conclusions obtained, they were based on the following research objectives:

Objective 1: To determine the extent to which content related to neuroeducation, metacognition, cognition and cognitive processes is addressed in the degrees of early childhood and primary education in the public universities of the eight Andalusia provinces.

Neuroeducation was scarcely addressed in the study plans of Andalusian public universities, although the universities that most addressed the subject were the University of Cadiz and the University of Granada. This fact made it possible to observe that, despite its importance, future teachers did not receive sufficient training to be able to apply it in their teaching practice in the future.

Objective 2: To reflect on the content linked to neuroeducation in the teaching guides of early childhood and primary education degrees in the public universities of Andalusia.

Most of the subjects that contained the categories of analysis were related to the area of psychology, with "cognitive processes" being the most present category in the curricula and "neuroeducation" and "metacognition" the least present. This suggests that training in the neuroeducation of future teachers of early childhood education and primary school education was scarce.

As a main limitation, it is worth highlighting the fact that it was possible to know whether the teaching guides addressed the subject matter but impossible to know the quality of the training in neuroeducation in the subjects that did contain the categories of analysis.

As a limitation, the category neuroeducation did not appear in any of the teaching guides analysed; for this reason, its analysis was more complex when determining what was considered neuroeducation content and what was not, added to the complexity of the definition of the term itself.

Another limitation was the absence of the category "neuromyths" in the teaching guides, as the literature review indicated this concept's importance in the neuroeducation field.

In terms of contextual limitations, it is worth highlighting the size of the sample, since due to the novelty of this study, only a single autonomous community in Spain was considered. However, this creates the possibility of a future study analysing training in all the regions that comprise Spain.

It is also worth highlighting the fact that university degree structures vary from country to country, which makes it difficult to replicate this study in countries with university systems very different from those in Spain.

Given the novelty of the topic and the advances in neuroscience and neuroeducation, it is understandable that teachers and educational staff are updated on these aspects. For this reason, there is a multitude of material and online courses that can help solve this situation [83].

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