Neuroscience for early childhood education: impact on virtual settings and teaching practice

Fernando Ledesma-Pérez[1], Juana Cruz-Montero[2], Jhon Holguin-Alvarez[1]
[1]Faculty of Law and Humanities, Universidad César Vallejo, Lima, Perú
[2]Postgraduate School, Universidad César Vallejo, Lima, Perú

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ABSTRACT

The research allowed us to measure the impact of neuroscience from the transfer carried out by practicing education teachers, who received university training based on neuroscience. We performed comparative inferential analyzes on 1,341 students from public and private schools in Lima who acted as an informant sample. The study sample was made up of 71 university students who worked as teachers with university training with neuroscientific content. Traceability was carried out between the macro and microprogramming of the university students and its effect on the school was calculated. Instruments were used to assess university content and measure school learning. It was found that 25% of the credits were transversal neuroscience subjects. In microplanning, more than 50% of the activities incorporated contributions from neuroscience, demonstrating significant effects on children's learning. The limitations demonstrated the low scope focused on the number of teachers evaluated, the permeability of the neuroscientific concepts that could be delivered to school students due to the time delay involved in executing this type of activities. It is concluded that the activities were moderately significant in the development of the neuroscience curriculum for university students.

Corresponding Author:

Jhon Holguin-Alvarez
Faculty of Law and Humanities, Universidad César Vallejo
Av. Alfredo Mendiola 6232, Lima, Perú
Email: jholguin@ucv.edu.pe, jhonholguinalvarez@gmail.com

1. INTRODUCTION

Neurosciences allow the interdisciplinary study of the nervous system including disciplines such as biology, neurology, psychology, physics, chemistry, medicine, ethology, linguistics, as it studies the relationship between brain activity, learning and behavior [1]. Their findings allow to explain the educational results from a multiple perspective [2]. Universities include neuroscience subjects in their curricular plan to incorporate advances in the understanding of learning and teaching programming. Therefore, it is considered necessary to investigate the impact of such knowledge on teacher training. In their training, enriched environments are considered as a group of conditioning factors for learning, from the infrastructure to the methodologies that currently seek to develop creativity and self-assessment [3], [4]. However, Latin American schools are separated from the use of this paradigm, they lack infrastructure for practical teaching from the understanding of the brain as the milestone of professional performance [5], the lack of laboratories and learning opportunities it is a declarative problem of university education.

Another of the conditioning factors of teacher training is found in social interactions and their abilities as facilitators of pedagogical work [6]. Current teaching neglects the inclusion of group work as the first form of interaction; therefore, microprogramming (learning sessions, units and projects) excludes the use of verbal information in current work developed on traditional educational platforms with which to impart a synchronous or asynchronous model. Part of the problem is explained by the limitations in connectivity and the lack of technological skills of the teacher [7]. Physical exertion activities contribute to the development of motor skills, brain oxygenation, respiratory system function, optimization of the phono articulatory structure, and in general, contribute to cognitive development [8]. However, this has been the most affected area during the COVID-19 pandemic, the dynamics and recreational games have been virtual, the exercises with breathing techniques have not been carried out, as well as the exercises to educate the phonological components.

Emotions at school are developed from experience, students experience pleasant moments, receive the trust of their teachers and from these spaces' recognition of the virtues of others is promoted, the ability to generate emotionally welcoming environments [9]. The school is also the space in which institutional identity, altruism and generosity used to develop. Neuroscience studies confirm their contribution to learning processes [10], since they favor personal development [11]. In this sense, the teacher with this basic knowledge can implement a positive pedagogy involving the participation of brain functions [12]. Research in educational neuroscience generates interdisciplinary knowledge for application in the classroom, since its perspective is indicative [13], [14].

The background shows that advances in neurosciences have generated changes in educational processes. With the use of imaging, it was found that brain activity is intense in the acquisition of mathematical knowledge in preschool infants and favors a greater assimilation of mathematical knowledge, which forms structures that allow building a scaffolding of knowledge in the later educational stage [15]. Some similar results were found in infants who had difficulties in reading acquisition in whom neuroplasticity and neural networks were used to apply an intervention program; the laboratory results demonstrated the existence of dyslexia in which both cerebral hemispheres were involved and showed progress in overcoming the disorder [16]. The relationship between disadvantaged environments and conditions of poverty with the development of brain structure and cognitive functions in preschool infants was investigated, and a strong association was found with chronic stress, regulation, and self-control. However, the affectation to learning processes can be diminished if infants have the permanent support of their parents and teachers [17].

Enriched environments favored learning; exploration of feelings and perceptions of 11 preschool infants who participated in remote classes in the 2020 school year, collected through interviews and drawings, showed that online lessons were positive, offered enjoyable learning experiences, which is consistent with educational neuroscience in highlighting novel ways of learning, in rewarding enriched environments [18]. The culture of an infant educational environment based on education and enriched environments has been described for contemplative traditions, the results showed its usefulness in building cultural and personal identity, differentiation as an individuality and as a collective, highlighted the development of kindness and gentleness as contemplative practices in early childhood education [19]. A review of the Montessori method showed that neural networks, sensitive periods, windows of opportunity and enriched environments are proposals that coincide in the Montessori approach and in the neuroscientific approach [20]. A research on executive functions conducted with 23 three-year-old children studying with the Montessori method in public schools, showed that in the first three years of life, learning in inhibitory control and cognitive flexibility were superior to those occurring later, without evidencing differences by gender, a slight difference was recorded by the degree of implementation of the spaces, the more enriched, the better performance [21].

Social interactions are valuable activities for learning; these were observed for six months in 62 infants to determine their progress in the acquisition of writing from interactions with their teachers and peers, the results showed that the ability to produce writing is facilitated by interaction and is a predictor of literacy, having shown continuous progress in the achievement of writing skills and abilities [22]. Neuroscience, psychology and pedagogy seek an explanation for the low interest and low performance of infants in mathematics, the problem was investigated with the cultural-historical approach and activity theory, the results showed that of the three proposals used with infants: i) conceptual teaching; ii) mathematical actions performed by the teacher; and iii) interactive communication, the first proposal on conceptual-theoretical teaching was the most effective [23]. Cognitive neuroscience has reported that conversations with mathematics content in which interaction with infants is motivated, the ability to count, increased use of mathematical terms, notions of quantity and mathematical relationships are achieved. Mathematical domains are increased if mathematical notions are applied in teacher-student interactions [24].

Foti and Sidiropoulou [25] carried out a historical review in which they recorded a sustained contribution of neurosciences and psychology to the understanding of emotional, social, cognitive and linguistic processes in the first years of life, specifying that training in this stage will influence later years of life. Taylor [19] described the culture of an educational environment for infants based on contemplative education and traditions, in whose results he demonstrated the usefulness of their inclusion in the construction of cultural and personal identity and in differentiation as an individual and as a group. In the investigation by Mavrelos and Daradoumis [26], it was found that neurosciences contribute to the resolution of problems related to the pedagogical practices of Waldorf schools, multiple intelligences, however, empirical research is needed for brain-based schools human as a central objective. Benhadi and Moubtassime [27] specify that learning is a complex activity and its understanding involves understanding its processes; found that the brain responds effectively to new and challenging activities; experiences that generate awe are effective in triggering scientific inquiry skills.

Research by Brown *et al.* [28] found that their program, led by neuroscientists and educators, developed improvements in the abilities and aptitudes of students. To this can be added what Benítez [29] argues, who argues that neuropsychological factors can operate both as a theoretical and methodological foundation in initial level educators since the students in charge will always need reinforcement in the classroom for the development of the literacy and mathematics. The results in neurosciences invite the programming of achievable educational objectives, incorporation of processes for organization and analysis in the classroom, taking advantage of the possibilities of the human brain to convert sensory experience into some form of information in long-term memory and monitoring. of the teacher as a facilitator of successful performance. Learning theories allow us to understand cognition from the development of working memory, this is also evident in behavior [30], [31]. Neurosciences have confirmed the postulates of the Montessori method such as: sensitive periods, spontaneous learning, sensory education, structured environments, which confirms that the infant becomes the individual with greater independence by receiving them tangibly during his time at school [32], [33].

On the other hand, language learning is facilitated through the implementation of enriched environments in the emotional and vivid experience, considering that it can be enriched by the inclusion of native guides [34]. Self-regulated learning techniques are enhanced when they occur in enriched environments, with interactivity for discussion and the development of a critical attitude [35]. Likewise, social interactions allow attachment and guide the behavior of the infant with his caregiver, the regulation of emotions and balance depend on interactions in social relationships [36]. Neuroscientific studies allow the understanding of the processes that occur in the human brain during these social interactions, whether in the adoption of the language or in the achievement of critical thinking, it is also to be considered that social learning also converges in this perspective [37].

Other aspects in which neurosciences influence is physical activity, since it allows the achievement of skills and increases cognitive and behavioral control [38]. Evidence suggests that structured learning experiences with physical activities represent an opportunity to learn better and with planning [39]. Emotions participate in attention, memory, motivation, and their influence on learning has been proven, since emotionally stable environments with physical activity generate favorable conditions for the apprehension of knowledge [40]. Emotions and relationships provide the impetus to implement the safe emotional environment and responsive stimuli when learning [41].

Neurosciences and education should establish a closer collaboration with each other to incorporate advances in cognitive and emotional processes; on intelligent behavior [42]; the triune brain theory [43], being the ones with the greatest contribution to the understanding of brain function and its educational implications. The archicortex is a primitive or reptilian brain where primary, non-verbal experiences of acceptance or rejection are processed. Its function is survival. The paleocortex called the emotional brain by Maclean, represented by the limbic system, controls emotional life; and the neocortex, constituted by the neocortex, is responsible for higher intellectual processes. This research approaches the understanding of the pedagogical action carried out by teachers in five-year-old infants in virtual settings, given that, since the beginning of the social isolation measures, classes are held online. Thus, it is considered that the construction of knowledge is progressive and systematic, new learning is built on the scaffolding of previous skills, it is of interest to report reference data that prove the expected performance of teachers trained in neuroscience.

The literature review allows us to ask the question: What is the level of impact of neurosciences on the teaching of initial-level teachers in a Latin American city during 2021? The objective was to describe the impact of neurosciences in the programming and curricular execution in teachers of the initial education degree of a university with a training curriculum in neurosciences during their university education. Therefore, the method allowed a descriptive and inferential study to be applied.

2. METHOD

The research was developed in the quantitative approach, with a basic documentary examination of the formative curricular programming of initial education, and the estimative evaluation with a checklist on learning based on neurosciences according to standardized performances at the national level.

2.1. Participants

The sample was organized by 71 initial education teachers who were given a checklist whose score was made with the help of an estimative scale. The time cut was longitudinal, so the evaluation was carried out in two bimesters of the school year. The sampling was non-probabilistic, which implied choosing teachers with certain characteristics required by the research, since non-probabilistic convenience sampling was applied. The subjects were drawn from a population of 1,657 teachers, active practitioners in 86 public and private educational institutions. After the revision of the curricular mesh of the universities in which they were studying their last cycles; and from the observation of the units and learning sessions of the practice centers, it was possible to have 71 teachers (38 from public institutions and 33 from private institutions), who signed the informed consent and met the inclusion criteria.

The selection criteria were: i) teaching with a classroom in charge in a year of professional practice; ii) graduated from 2019 with aspirations to a degree; iii) the curricular programming of the professional career with the 20% of credits in neuroscience content; iv) school curricular schedule with proposed activities based on neuroscience; v) classroom schedule with six or more activities from Table 1; and vi) signed informed consent.

A hypothetical analysis made it possible to compare whether the activities carried out by the teachers included in the sample were sufficient to accept that the impact of neurosciences on the teaching of early childhood education teachers, so the performance of the children under the care of these teachers in their pre-professional practice centers was evaluated. This prompted the application of inferential statistics that would allow testing the differences between a pretest and a posttest evaluation in an intact group. The total number of children was 1,341 as a whole, with the range of capacity per classroom being different among the schools attended (private schools $_{(range)}$=20-15; public schools $_{(range)}$=30-25). The ages served were three to five years old by April of the school year due to enrollment by their parents.

Only the results of children who met this condition were considered, since the traditional classrooms of the initial level of Regular Basic Education are divided into classrooms according to the fulfillment of the regular enrollment: three, four, and five years of age. We did not see fit to use averages to indicate the adequacy of the central data extracted from the sample. However, the male gender was the most prevalent in the three-year classrooms (76%). The female gender prevailed in the classrooms with four-year-old girls (65%) and five-year-old female (61%). At the university where the professionals completed their training, they took subjects (curricular experiences) with a neuroscientific approach from the beginning (cycle I) to the last cycle of training by specialty (cycle VIII) as shown in Table 1. A total of 13 courses of the 55 offered by the initial education career (23.63%) are taught in which advances in neuroscientific research are incorporated, which is equivalent to 51 credits of the 201 credits of the total career (25.37%).

Table 1. Curricular experiences of the initial education career

Cycle	Subject	Credits*
I	Developmental psychology Creativity and plastic graphic expression	8
II	Neurosciences in education Creativity and corporal expression	8.5
III	Psychology of learning Nutrition in the infant stage	8
IV	Early education I Inclusive education and interculturality	7.5
V	Strategies for attention to diversity Early education II	7.5
VI	The game in child development	4
VII	Didactics of psychomotricity	4
VIII	Pedagogical accompaniment in the crib	3.5

Note. *Total=51 credits.

2.2. Techniques e-instruments

The technique that was initially used for data collection was observation and documentary analysis. It was found that the subjects taken by the teachers meet a minimum of 20% of cross-cutting content from neuroscience content, so that activities proposed in the development of classes based on this approach were included in the school's programming. Regarding the variable neurosciences in teaching, it was operationalized as the scientific and didactic training of the teacher on the application of the contributions of neurosciences to the teaching processes in the classroom as shown in Table 2, which must be incorporated into their microprogramming (units, projects and learning sessions). Four dimensions were considered: i) enriched environments; ii) social interactions; iii) physical activities; and iv) emotions. The response scale is dichotomous for all the items raised.

Table 2. Operationalization of the neuroscience variable

Dimensions	Indicators	Sub-indicators
Enriched environments	For science For arts For sports	Experiments Laboratories Mapping (2L) Narrative. Drawing and painting Music, Dances, Creativity Athletics, Gym Martial Arts, Ball Swimming Lifesaving
Social interactions	Group curricular work Classroom discussions Directed conversations in small rooms	Social staff area. Communication area. Area of reasoning (verbal calculation) Alternate positions Opposing positions (controversial) Emergency actions
Physical activities	Motors skills Active pauses with guided breathing or with hyperventilation	Group dynamics. Recreational games Laugh fairs Breathing exercises Stretching exercises Blown. Gestures. Emission of sounds.
Emotions	Basics Higher	…of bestowal …of reception …of generation Jealousy, revenge, pride, altruism, generosity, shared identity.

Note. Extracted from Araya-Pizarro & Espinoza Pastén [10], Contributions from neurosciences for the understanding of learning processes in educational contexts.

Finally, three instruments were used: i) Checklist for curricular programming with which the teachers were trained; ii) Checklist for school curricular programming; and iii) checklist to measure the impact of neurosciences on teaching. In order to evaluate the impact of neuroscience transferred from teachers to children through teaching based on this approach, performance rubrics were applied for reading performance, mathematical operations, and knowledge about the body and the environment. This evaluation was collected by each evaluated teacher belonging to his or her home university during the stage of his or her professional teaching practices. The overall assessment was configured using 30 items to measure basic student skills and knowledge (reading achievement 10 items, mathematical operations 10 items, and knowledge about the body and the environment 10 items). Scoring was open-ended with item assignment rated at three points: 3 (expected achievement), 2 (to be improved), and 1 (no logical solution). This type of evaluation was used to facilitate the recording of the operations and activities to be performed during the performance tests. This made it easier to analyze each item in detail, without leaving free or uncompleted data. The review by five experts made it possible to achieve reliability indexes between 0.80 and 0.91 points in Cronbach's alpha formula.

The instruments intended for the evaluation of university students were validated by 12 experts and reliability was calculated with Cronbach's alpha reliability coefficient, yielding indices in the range of 0.90-0.902. Descriptive statistics were used for data analysis, and inferential statistics were used for comparisons, based on the type of zonal management (urbanized or non-urbanized). The research was developed applying the ethical criteria of the APA, the Declaration of Helsinki insofar as it is applicable; what is regulated in the Resolution of the University Council of the university of origin, and its code of ethics implemented during the university training stage.

3. RESULTS

3.1. Incorporation of pedagogical activities that include neuroscientific principles

In the macro and micro planning of classes taught by the teachers (units, projects, learning sessions, and modules), more than 50% of the activities contained were related to the incorporation of the contributions of neuroscience as shown in Table 3. The rest of the student body was between 25% and 35% for the negative range. On the other hand, unitary responses were obtained in some cases, representing less than 5% of the total.

Table 3. Inclusion of activities with a neuroscientific perspective

Activities		F	%
Scientific inquiry in science	No	6	8.5%
	Yes	65	91.5%
Change of state in water	No	19	26.8%
	Yes	52	73.2%
Use of cartography with Google Maps or Google Earth	No	19	26.8%
	Yes	52	73.2%
Use of second language	No	28	39.4%
	Yes	43	60.6%
Practice of physical exertion exercises	No	1	1.4%
	Yes	70	98.6%
Discussions about the environment	No	6	8.5%
	Yes	65	91.5%
Exercise of the phonoarticulatory structure	No	21	29.6%
	Yes	50	70.4%
Use of dynamic or playful	No	10	14.1%
	Yes	61	85.9%
Exercises to recognize and express emotions	No	2	2.8%
	Yes	69	97.2%
Experimentation, discovery and presentations	No	22	31.0%
	Yes	49	69.0%

Of the total activities scheduled by each of the 71 teachers, "Yes" represents those that incorporate neuroscientific principles, and "No", their absence. In the case of science inquiry, 65 teachers did have it in their schedule, and six teachers did not. However, these six teachers had at least six of the following nine activities in their schedule.

3.2. Involvement of neurosciences in the development of teacher activities

For the interpretation of the results, a high-level impact was considered when 9 or 10 activities with neuroscientific principles were considered; medium impact: 7 or 8 activities; and low impact: 6 activities. High impact allowed consideration of indicators with trait scores greater than 10. Medium impact was greater than 6. According to Table 4, it can be inferred that the neurosciences generated a high impact on the majority of the participants, practically, in a quarter of the total, a medium impact was generated. In turn, a dimensional analysis of the impact of neuroscience on the virtual activities carried out by preschool teachers was carried out as presented in Table 5. Similarly, the high, medium and low traits were retained, although the average could be placed at the high impact level.

Table 4. Impact on neuroscience-based teaching

		Frequency	Percentage	Valid percentage	Accumulated percentage
Valid	Low level	1	1.4	1.4	1.4
	Medium level	19	26.8	26.8	28.2
	High level	51	71.8	71.8	100.0
	Total	71	100.0	100.0	

Table 5. Impact on neuroscience by dimensions

Dimensions	Levels	F	%
Enriched environments	Low	4	5.6
	Medium	38	53.5
	High	29	40.8
Social interactions	Low	4	5.6
	Medium	18	25.4
	High	49	69.0
Physical activities	Low	3	4.2
	Medium	15	21.1
	High	53	74.6
Emotionally stable environments	Low	3	4.2
	Medium	9	12.7
	High	59	83.1

As for the enriched environments, more than half developed medium impact on their students. It is noteworthy that a large percentage had a high impact according to this dimension. On the other hand, approximately 70% of the subjects received a high impact from neuroscience in relation to social interactions, while, according to the interactions of physical activities developed by the teachers, less than 20% generated low impact. Finally, more than 80% generate high impact by preparing emotionally friendly environments for the student, although 5% generate low impact in this case.

3.3. Impact of applied neuroscience on early childhood education teaching

To interpret the data on the impact of neurosciences transferred through teaching in early education of the group of teachers evaluated, the data submitted on the skills and knowledge in the education of the 1341 children in charge were also studied. In this sense, we proceeded to confirm whether the data came from a normal distribution. Therefore, when the absence of this normality was verified and in favor of the type of data obtained, we proceeded to apply non-parametric tests for the calculation of base statistical differences as shown in Table 6. This would help to endorse the extent of the impact within the group of students learning with neuroscientific bases.

Table 6. Statistical differences of comparison between pretest and posttest measurement in infants

Pretest-Posttest*	N	Average rank	Sum of ranks
Negative ranks	27	28.53	781.32
Positive ranks	1262	69.48	423.60
Ties	52		

Note. Z=3,401; *p<0.05.

Table 6 shows more prominent positive ranges in the comparison of the pretest and posttest evaluations in contrast to the ties obtained (diff.=1210), the median remained in a range of 27.9 and 29.1 points. Similarly, the effectiveness of the data can be corroborated with significant differences of less than 5% margin of error. This index supported the difference between the pretest and posttest evaluation moments, after the university students applied the neuroscientific activities to the children they were in charge of during the academic year of their pre-professional practice.

4. DISCUSSION

Due to the purpose of the study, the curricular program of the initial education career of the university in which the teachers obtained their training, considers a total of 55 subjects, of which 13 represent 23.63%; which incorporate neuroscientific content. The degree requires the approval of 201 credits, of which 25.37% manage said content, clearly incorporating advances based on scientific evidence into its content. This curricular proposal is consistent with the current demands on the professional skills required by these implications in neuroscientific training, which from research recognize that this knowledge allows a better understanding of evolutionary processes, improves the quality of teaching and learning achievements, and consequently favor the development of the person [10]–[12], [14], [26], [27].

In addition to this, in the results on class planning, 10 activities that involve the incorporation of contributions from neuroscience were evaluated. It was found that of the total number of activities programmed by each of the 71 teachers who received transversal university training from the neurosciences, these incorporated six or more activities to strengthen cognitive pedagogies favorable to child development. This agrees with the proposal of Redcay and Schilbach [35] who argued that the advances in neuroscience in terms of cognitive and emotional processes; collects the proposals of the triune brain of MacLean [42]; which need to be incorporated both in the university training curriculum and in the school training curriculum. Given this, it is considered that neurosciences facilitate higher intellectual processes [38], as the goal for biological and emotional development. Part of these results have evidenced that teachers who used learning processes at university with diverse strategies managed to include their creativity, techniques for behavioral adaptation, and constant metacognition [1], [3], [4], which may also have been transmitted to their students in charge in the development of professional practices in the centers where they programmed and applied neuroscientific activities. However, difficulties in understanding brain structures and their activation in the face of various stimuli may have generated limitations in university students to learn, which is a common educational problem in Latin American universities that resort only to constructionist paradigms, even knowing the relationships between the brain and free activities that dissipate stress and emotional dysregulation [5], [17]; moreover this usually occurs in vulnerable contexts to learn in a neuroscientific way. In this sense, universities follow educational policies based on social cognition with full dependence on socialist government policies. Thus, this research focuses on recognizing the impact and investigating its transfer to another group of learners through the transfer of neuroscientific learning from university education to school education.

Regarding the impact of neurosciences in teaching, it was determined that in 72% of the pedagogical teaching actions, a high level of impact was generated and in 26.8% its effects were medium level. These results are consistent with the findings of Foti and Sidiropoulou [25], who found that in the last 30 years these contents have been incorporated into curricular plans and educational policies, so neuroscience is the discipline with the best contributions to the understanding of neuroscience. the emotional, social, cognitive and linguistic processes in the first years of life and how they influence the person's later life, maturity and life perspective. In the same sense, in the research carried out by Taylor [19] regarding contemplative traditions, he found that these contributions favor the construction of cultural and personal identity, individual and collective differentiation, from which the student develops kindness and amiability. From the theoretical point of view, it is considered that the contributions in neuroscience for teaching imply the interest in learning, the stimulation of curiosity, the improvement of memorization, and motivation; to convert the classroom experience into spaces for experiences that involve the development of long-term memory whose construction and use transcend the school environment [33], considering the learner as in his total complexity [34], so the teacher, especially in this time of virtuality, can take advantage of sensitive periods for learning in highly favorable environments [35], [36].

Regarding the impact of neurosciences in the generation of enriched environments, it was found that 53.5% generated medium impact, and 40.8% high impact. In the analysis of these results, it was considered that the research was carried out in virtual scenarios in which the generation of the enriched environment corresponded to the setting that was materially possible to carry out in the home. For this reason, as it is a dimension whose management was not in charge of the teaching staff, the highest results were located at the medium level. The findings of this research are comparable to those of Benhadi and Moubtassime [27], who state that learning has both cognitive and emotional value, these being necessary for development and learning. The best response of the brain is executed before new and challenging activities, the experiences that generate astonishment in the students are effective, allow them to think and discover, trigger learning processes and induce inquiry to find answers to problematic situations. From the theoretical point of view, it is argued that the usefulness of enriched environments is valid, as in the cases of teaching a second language, through which the student's interaction with native characters of the language is generated, and in cases where the student also self-regulates due to guided learning with synchronous and asynchronous teaching methods [37], [38].

In the impact dimension of neurosciences in social interactions, it was found that 69% generated high impact and 25.4% medium impact. These results are consistent with the findings of the Mavrelos and Daradoumis [26] research, which reports a correlation between the pedagogical practices of Waldorf schools, neurosciences, and multiple intelligences; It should be noted that Walford school focuses on hands-on activities, creative play, artistic expression, and social skills, all of which require interpersonal interactions. University students have mostly managed to obtain a didactic concept development based on the development of neurosciences, many times they will face certain programmatic and didactic difficulties to attend groups with learning problems, socialization problems and economic problems. Current research has shown that work with children with these characteristics can be developed using techniques of neuroplasticity, cognitive regulation, socio-cognitive regulation and exploratory methods of emotional control with respect to meta-learning and behavioral development [15]–[18]. Here, it should be noted that a large proportion of university students came from economic strata of poverty [17], as well as a large percentage of school students, especially those from public institutions. Given this characteristic, it can be accepted that the techniques used provide rich characteristics for the contextualization of the didactics applied both in the university and in the school. The transfer of neuroscientific strategies had an impact on the development of university curricula and on the development of school programming. The theory on social interactions allow attachment, guide the infant's behavior, regulate emotions and achieve a healthy balance; this event generates synaptic networks that record the interactions of the infant and configure the neuronal structure in patterns of connectivity between the cognitive and emotional, in that sense, they are a source of security and protection [39], to which is increased than the social observation of replicable behavior of others in which the individual is not in a position to intervene if there is no intermediary security of the social environment [40].

Regarding the impact of neurosciences in the execution of physical activities, it was determined that in 74.6% it generated high impact, and in 21.1% medium level impact. In this dimension, the intervention of household members was decisive because the classes were virtual during the development of this research. These results are consistent with the observations of Benítez [29], since neurosciences and neuropsychological factors can operate both as a theoretical and methodological foundation, since these allow inserting objectives, content, activities until evaluation. In addition, stimulation with physical activities allows better development of literacy and mental processes of calculation if they are used from the first years of life, as well as in formal learning, so that pedagogy applied to children's groups improves behavioral control as a basis for opening efficient cognitive learning [41], [42]. This is perceived in the group of teachers who developed practical and theoretical lessons with parallel evaluation activities, which allowed teachers in training to reflect during their professional practice.

The results on the impact dimension of neuroscience in the generation of emotionally stable environments made it possible to determine that 83.1% generated high impact and 12.7% medium impact. The results of this part are similar to the research that indicates that participatory work can cause positive environments for interaction and affective neuronal development [31]. Therefore, they also improve attention, memory and motivation; when the student manages to feel in a safe emotional environment to live and learn [43]. In the same way, emotions and relationships offer a boost to learning and favor the development of the brain, the safe and cognitively stimulating emotional environment predisposes the brain to apprehend from social experiences, in sensitive periods, it is essential to offer favorable learning opportunities from neuroscientific principles.

The results obtained in the school have allowed corroborating the impact of neurosciences in the group of university students due to the evidence obtained in the pretest and posttest evaluations, the impact has been measured through the transfer of teaching didactics and directed learning in the professional practice. As part of the activities developed, the student practitioners applied playful activities in specific places to learn with school children, enriching them with motivational strategies from individual and collective play, as has also been achieved in other similar studies [12], [13], [20]. On the other hand, physical activities and self-regulation techniques applied in the areas of science and environment and mathematics learning dissipated some of the stress that young children have when they feel that new activities overwhelm them, and even when negative emotions appear in social interaction [8], [15], [18], [23]. The phono articulatory dynamics, the physical effort exercises and the scientific inquiry applied to the schoolchildren should be taken into account, since they were taught with a neuroscientific approach at the university and transferred to the school from the execution of the teaching at the school. The didactic transfer was positive and significant and was evidenced in the final statistics of the study.

This research is novel because of the usefulness of the strategies applied in two specific fields: the university and the school; and thus, the impact of neurosciences on early childhood education student teachers through the transfer of neuroscience-based knowledge has been sought. The research was born to fill the gap in the literature on transferable knowledge from neuroscientific didactics with specific populations, since usually, direct influences on the target populations are evidenced. We identify the impact indirectly, seeking to develop learning among intrinsically connected populations through educational practice. The evidence is insufficient, so it is recommended to use phases or stages of research to develop neuroscience practices with groups of initiated teachers versus expert teachers, as well as to investigate the didactic transfer between neuroscience-based teaching guided by expert teachers to novice teachers. This would make it possible to locate shortcomings in the process in a qualitative way and to extend the results to other areas of the school curriculum. The future research that we are seeking to carry out in subsequent studies aims to clarify how effective the neuroscientific techniques directed and implemented in universities in vulnerable contexts can be on school populations with certain social and economic problems.

5. CONCLUSION

The impact of neurosciences was moderately significant in most of the teachers specialized in early education, affecting the dimensions of social interactions, physical activities and self-regulation in emotionally stable environments. Although it is true that the data collected allowed us to conclude that many university students acquired effective neuroscientific concepts and strategies, a small group is still in a situation of support, since their pedagogical cultural background is far from this perspective, which places them in the spectrum of constructionist teachers. Our findings seek to develop new evidence that compares the curriculum from a constructivist approach to discern whether neuroscientific strategies support its development in the school, however, the experience has shown greater agility for learning with neuroscientific didactics. On the other hand, the results obtained have allowed us to find that didactic transfer makes mathematical knowledge, reading learning and knowledge of nature effective in young children. The results formulate indirect evidences to determine the impact achieved in the university, as well as the impact achieved in the school, complementing each other from the neuroscientific didactic transfer.

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BIOGRAPHIES OF AUTHORS

Fernando Ledesma-Pérez is a teacher at the School of Initial Education, Faculty of Law and Humanities of the César Vallejo University in the city of Lima, Peru. Renacyt Researcher qualified by the National Council of Science, Technology and Technological Innovation of Peru (Concytec). He is a Doctor of Education and researches various topics in the area of psychology, educational psychology, and in the processes of human development; In turn, he is a member of the Culture and Development Research Group. He is also a member of the CIBRAMEP Group of the Universidad César Vallejo. He can be contacted at email: fledesma@ucv.edu.pe.

Juana Cruz-Montero is a professor at the Graduate School of the César Vallejo University in Piura, Peru. Renacyt Researcher qualified by the National Council of Science, Technology and Technological Innovation of Peru (Concytec). She is a Doctor in Education and researches various topics in education and psychopedagogy in early childhood. She is a member of the Research Group on Culture and Development; and is a member of the CIBRAMEP Group of the César Vallejo University. She can be contacted at email: jcruzmo@ucv.edu.pe.

Jhon Holguin-Alvarez is a researcher in the areas of education, postgraduate studies, and the research institute of the César Vallejo University, in the city of Lima (Peru). He is leader and coordinator of the CIBRAMEP Research Group. Renacyt Researcher qualified by the National Council of Science, Technology and Technological Innovation of Peru (Concytec). He is a Doctor of Education and researches topics related to gamified learning, and the development of humanistic skills, proactivity and prosociality. He can be contacted at email: jholguin@ucv.edu.pe, jhonholguinalvarez@gmail.com.