ADULT MEDIATION AS PART OF THE LEARNING PROCESSES IN CHILDREN WITH LANGUAGE DISORDERS: A CASE STUDY BASED ON PIENSA INFINITO

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Abstract

Fostering the development of mathematical skills is important in itself and beneficial for the academic development of children. While mathematics education researchers and curriculum designers have emphasized the importance of representations in fostering students' mathematical learning, there is limited research on actual pedagogical practices in special education, and on how teachers integrate representations in regular classroom activities. This qualitative study illustrates specific ways in which educators may utilize multiple representations to teach numeracy, thereby showing how theoretical ideas can be applied into practice. We analyzed data from two semi-structured problem-solving sessions that were conducted in a Special Education center specialized in language disorders, as well as classroom observations data that were collected between those two sessions. Participants were 3 male and 2 female students between 8 and 15 years old and their main teachers. The two sessions took place 5 months apart, during which the educators were trained on the implementation of Piensa Infinito, a pedagogical program based on the Singapore methodology. We analyzed the verbal prompts and pedagogical strategies employed by the teachers to achieve the intended learning objectives, with special emphasis on the mediation of representations as learning tools. Our ultimate goal is to encourage teachers to use this methodological approach in a strategic manner, in order to face the particular challenges and specific attention that these educational contexts require.

Keywords: Learning, special education, mathematics, mediation, Singapore methodology.

1 INTRODUCTION

In recent decades, several technical and pedagogical resources have been developed aiming at a greater and better explanation of early childhood developmental processes. Advances in neuroscience have opened an important debate about current understanding of how the human brain works. Besides the clear advantages that this entails for the progress of scientific knowledge, a more precise definition of cognitive processes has favored the generation of integrative approaches in which various disciplines converge, such as neuroscience and education. Pairing these two fields stands out for a solid empirical foundation that combines the most avant-garde knowledge about how the brain learns and what types of stimuli favor its development [1]. It also helps to identify their implications for teaching methods, the design of psycho-pedagogical interventions and their implementation, in which educational psychology plays a key role.

In a previous work, we obtained empirical evidence that supports the idea that the development of reading comprehension and mathematical competence could benefit from a balanced combination of cognitive elements. Both skills act as two fundamental levers for children's learning, contributing to more complex abilities that arise later in development [2]. The present paper deepens into the development of mathematical thinking in children, while extending the prior hypothesis to a new school context that is particularly challenging: a classroom in a special education center with children with language disorders.

Our aim is to analyze the impact of using a specific teaching methodology on the learning progress of children with special needs. For this purpose, we used Piensa Infinito program, which is based on the Singapore Method for mathematical learning. We examined pre- and post-intervention mathematical thinking strategies of the participants, as well as their ability to solve problems. Piensa Infinito is based on children's prior mathematical knowledge, allowing for the development of mathematical thinking even when there are neurological disorders or difficulties for abstraction understanding.

In short, based on the conviction that all students are capable, we aim to find evidence-based examples within classroom observations that contribute to identify the most appropriate ways for providing these children with relevant support, so we could significantly improve the teaching and education processes.

1.1 The psycho-educational intervention in mathematical learning

Today, we have an advanced knowledge and understanding about the cognitive mechanisms that allow children's language acquisition and development. Moreover, how these processes are organized has been a powerful tool for planning interventions when there are language difficulties. For instance, the brain regions that are associated with auditory perception (which is crucial for communicative development) develop exponentially during the infant's first months of life [3][4]. In these studies, typically developing babies were able to solve simple phonological recognition tasks by the end of the first year, and they quickly expand their repertoire and its complexity throughout the following months. Moreover, this rapid linguistic specialization is greater marked when the sound stimulus came from a real person, rather than from a videoclip or an audio recording [5].

From the premise of educating each brain in a unique way, the neuro-educational approach has allowed for the identification of relevant learning activators of children development and learning through systems such as music, movement, challenging tasks, emotions and spaces or environments. An excellent example is the enacted learning, as it stimulates children's imagination by recreating stories that combine the real world with fictional scenarios, in which motor activity favors children performance at several tasks such as sequencing and sorting. Interestingly, the area of the brain that is responsible for the most basic motor movements is the same region in charge of more complex sequencing processes the are present in many other activities, both formal and non-formal education related.

In this sense, a good educational mediation should be aligned with the level of executive functions development of the student, considering his/her abilities to initiate the activity, what does motivate him/her, or his/her capacity for planning and self-regulation [6][7]. This fact becomes crucial especially during early childhood, or when there are cognitive and behavioral difficulties that associates with certain clinical profiles [8], given the close relationship among several developmental factors such as mental flexibility, information monitoring, planning and cognitive skills and processing [9].

Executive functions have gradually become a differentiating and explanatory element of different processes associated with neurodevelopment and other learning factors [10][11]. For example, a specific training in working memory, a systematic and frequent reconstruction of what has been learned, or providing with a study guide through questions and oral examination, have proven to be very effective strategies for activating brain mechanisms that strengthen the memorization and improve the conditions of learning [12]. The cognitive and socio-emotional nature of executive functions emphasizes the need to consider them within our analytical framework for the study of specific educational practices that take place within the classroom. Both attention and memory elements are present in all learning processes, but especially when students face new situations and/or difficulties in facing them [13].

1.2 The origin of the educational experience: neuroeducational aims and agents involved

One of the most relevant discoveries in the field of neuroscience has been the great capacity for adaptation and restructuring of the brain throughout the entire life cycle, also known as brain plasticity. In this sense, structural changes in the brain will be more efficient if they occur in the first years of development, as they are considered a particularly sensitive period for children's learning. Through proper stimulation, largely mediated by emotions, the brain is able to strengthen or weaken the synapses that connect neurons and to promote brain plasticity and, consequently, learning. From the educational perspective, these particular advances are of great importance as they open the possibility of providing personalized, and even compensatory support in cases of specific alterations,. Also, it offers greater and better tools for developing strategies that aim to overcome children's difficulties and to enhance their learning.

In this sense, the learning process based on the Singapore Method for mathematical learning is rooted on a sequence of three core aspects: manipulative, pictorial and abstract. It connects with the natural way of learning mathematics, thus serving as a solid basis for the acquisition of more complex mathematical concepts. The Piensa Infinito program that we used in this particular case study, adds to

the Singapore Method an additional perspective, from the neuroeducational paradigm, that provides a more natural approach to mathematical learning through evidence-based active dynamics and classroom management strategies. This results in a different organization of the work in the classroom, in which the students often verbalize the process that they following when facing problematic situations, while also share their proposals to solve it. There are only a few moments during which they actually "read" maths in their books. We consider that this approach contributes to generating positive expectations and to developing a comprehensive mathematical mentality in all students. With this program, we intend to contribute to a better and easier alignment between the teacher's expectations and those of the student, two of the three factors that make the greatest impact on student learning [14] and that reduces the stereotypes about the students' capacity.

2 METHODOLOGY

The present case study was conducted in a special education center located in the Community of Madrid (Spain), during the first half of 2019. We selected one classroom of Educación Básica Obligatoria (EBO) that attends five students (three boys and two girls) of 8, 9, 11, 13 and 15 years old. Although the five students have diverse developmental profiles, all of them have language production and comprehension difficulties, which impacts in their performance on different tasks and activities of their school routines and daily life (especially on those that may involve abstract knowledge).

In order to analyze the impact that using Piensa Infinito methodology has on the learning progress of students with special needs, we designed a semi-structured mathematical task that children resolved together with their respective educator. We examined the skills that children used before and after the implementation of the program as part of the center's pedagogical routine, in order to discuss whether they improved their resolution time and abilities.

For measuring children's competency level, we devised a qualitative rubric that helped to identify any potential progress in children's mathematical thinking skills. The observations were recorded in two sessions, leaving a period of 5 months between the pre and post stages. Between the two sessions, some external educators who are specialized instructors on the program Piensa Infinito, trained and guided the children's teachers on how to implement the program within their classroom.

3 RESULTS

Data analysis conducted for this study show significant improvements in all children who have participated in the educational experience. On the one hand, all students applied reasoned strategies to solve problems in the post-intervention session, and they all showed more security and confidence while solving the task. They also identified what they are supposed to do in less time, and made the relevant decisions with less teacher intervention than in the pre-intervention session. They evidenced they knew the mathematical symbols involved, and they gave symbols of different representational nature some significance by themselves. In addition, all participants were able to rectify on numerous occasions without the intervention or guidance of the educator.

On the other hand, teachers consider that the manipulation of different materials not just facilitates the student's acquisition of the contents, but also helps them to internalize the symbolic codes, closely related to certain positive consequences that we observed regarding children's communicative abilities. A key element for the follow-up throughout the implementation of the program has been the children's workbooks where, based on a continuous process of metacognition that is reflected on their annotations and comments, we clearly observed the maturation process of children's mathematical thinking.

Notwithstanding, we consider that the contribution of the teachers has been the most relevant component in this progression, especially in relation to their expectations about the potential for improvement of the participating children. Teachers were the ones that better knew their students, occupying a privileged place for guiding their cognitive processes of reflection and self-regulation. And Precisely in these circumstances of communicative difficulties, in which the situations of frustration towards certain academic domains, such as mathematics, are manifested through denial, impulsivity, non-reflection during the activities, or the loss of attention and interest during the task. In the observations that we conducted of this study, we have identified specific needs in those students who, in one way or another, were guided by their educators while helping them organize and plan a task,. They led their thinking towards the objectives that were previously set, refreshing the information repeatedly in order to overcome short-term memory difficulties, and inhibiting any distractions when

required [15]. All these strategies act as an extra aid for the student to be able to stop, evaluate, analyze the task and, where appropriate, reorganize, start over and rethink the activity. This strategies were observed when guiding students in tasks of cognitive nature, but also in others of a social and emotional nature [7].

4 CONCLUSIONS

Results from this study could help for a better design of teaching methods, that tightly link the curriculum, instances of better practices and educational policies. The implication, motivation, and consequent attention of the children necessarily make them active agents in their own learning process. Continuous practice is an excellent way to improve the children's analytical skills, as well as their attentional and focus capacities. All this would have direct and positive consequences on children's cognitive development. The brain is in continuous reorganization due to daily and varied experiences and interactions. So, the promotion of challenging spaces and those that rely on positive emotions greatly contribute to develop the particular potential of each child. We hope this experience would contribute to strengthen the learning capacity of each participating child, broadening the focus to the mere addition of -often decontextualized- abstract contents.

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