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THE EFFECT OF SCHEMA-BASED INSTRUCTION ON THE RESOLUTION OF ADDITION PROBLEMS BY A STUDENT WITH AUTISM SPECTRUM DISORDER

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In this study, the effectiveness of a SBI instructional approach to improve the mathematical word-problem-solving performance of a student with autism spectrum disorder (ASD) was examined using a case-study design. After seven intervention sessions, adapted to the student's educational needs, he improved his problem-solving performance of one-step change additive word problems in two dimensions: the comprehension of the problem statement and the attainment of the correct numeric solution. In particular, the student abandoned his first strategies based on the situation model of the problem and showed evidence of having developed the mathematical model. Additionally, the student generalized the acquired skills to two-steps word problems and the achievements remained 4 weeks after instruction. The implications of these findings for teaching problem-solving skills to students with ASD are discussed.

INTRODUCTION

Students diagnosed with Autism Spectrum Disorders (ASD) often show difficulties in solving mathematical problems due to their executive functioning deficits (Hart & Cleary, 2015; Polo-Blanco, González & Bruno, 2019). The teaching methodology *Schema-Based Instruction* (SBI) has proven useful in helping these students overcome some of these difficulties (Kasap & Ergenekon, 2017; Rockwell, Griffin & Jones, 2011; Jitendra, DiPipi & Perron-Jones, 2002).

This work contributes to deepening the manner in which students with ASD develop strategies for solving arithmetic word problems. We adopt the model of solving word problems of Verschaffel, Greer and Corte (2000), according to which the subjects develop a *situation model* from the verbal statement of a problem that sustains their resolution strategies, and this model interacts with the *mathematical model*.

Before receiving formal instruction, students can solve a variety of problems through *strategies associated with the situation model*, based on counting (Brissiaud and Sander, 2010). To be efficient in solving problems, though, they must develop other types of strategies, called *arithmetic strategies*, associated with the *mathematical model*, directly related to the use of mathematical properties and the recognition and execution of the arithmetic operations that solve each problem.

The study we present is part of a larger ongoing project to get primary and middle school students with learning disabilities to develop arithmetic strategies for solving arithmetic word problems. The instruction is carried out individually for each student and, based on the schema-based instruction, and it adapts to the specific needs of each student. We present in this paper the case of a student diagnosed with ASD who, after following an instruction based on schemes for 7 sessions, has developed arithmetic strategies to solve change addition problems.

METHODOLOGY

The methodology followed in the global project is a multiple probe design across students. The objective is to evaluate the effectiveness of schema-based instruction for the students to develop arithmetic strategies. In this work, the performance of one of these subjects, a 13-year-old male diagnosed with ASD, is considered. The student presents a level of affection characterized by severe symptoms with disruption of social and school activity, and presents a wide repertoire of stereotyped behaviours. He has a full IQ of 54, measured by the Wechsler intelligence scale for children WISCV.

INSTRUCTION

The study took place during the 2018-19 school year, in weekly sessions. A teacher with experience with students with learning difficulties carried out the instruction. The following process phases were included: baseline (7 sessions prior to the instruction), instruction (7 sessions), evaluation (7 sessions, at the end of each instructional session), generalization to problems of two operations (1 post-test), and maintenance (1 post-test 4 weeks after instruction).

One-step change addition word problems were used, varying the place of the unknown in the three possible configurations. An example with the unknown in the final position is the following problem: "I have 15 candies and I eat 8, how many candies do I have at the end?" A schema-based instruction was followed, instructing the participant to carry out the following steps: (1) place data in schema, (2) place the interrogation, (3) surround the larger amount, (4) raise the operation, (5) solve the operation and (6) interpret the solution. An example of the use of the schema for the previous problem is shown in Figure 1.

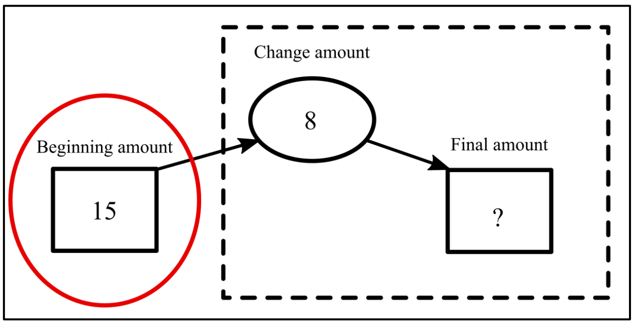

Figure 1: Use of the schema for a problem with the unknown in the final position.

The problems were introduced by placing the unknown in the following positions: Final amount (sessions 1 and 2), change amount (sessions 3 and 4) and initial amount (sessions 5 and 6). Session 7 mixed all types of problems. Each instructional session lasted approximately 50 minutes. At the end of each session, the participant was evaluated in the types of problems introduced up to that moment by means of a 6-problem test.

RESULTS

We carried out a coding of the student's responses, taking into account two dimensions for each problem: The comprehension of the problem statement and the attainment of the correct numeric solution. The former is considered correct when the student explicitly selects the arithmetic operation that solves the problem; in that case, 1 point is assigned. The latter is considered correct when the student provides the correct numerical value; in that case, 1 point is assigned. Thus, each problem has an allocation of a maximum of 2 points. To each session, we assign the percentage of the student's success in the session, defined as the ratio between the points obtained by the student in the session problems and the maximum possible points of that session.

Figure 2 depicts one of the four problems solved in Baseline 3. It can be seen that the student uses the situation model through an informal strategy based on counting. Furthermore, he does not recognize the operation (subtraction) but achieves the correct numerical result, thus obtaining 1 point in this problem.

Raúl had 9 pencils, he lost some and now he has 3. How many pencils did he lose?

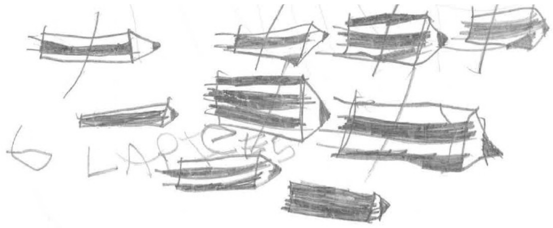

Figure 2. Use of the situation model to solve a Baseline 3 problem.

Figure 3 shows the results obtained during all the sessions of the study. Notwithstanding certain fluctuations, the student accepted and incorporated the use of the schema from the beginning, which led him to correctly solve all the problems with unknown in the final position. In the problems with change unknown and initial amount unknown, he experienced difficulties in the identification of the operation, although this dimension improved significantly from session 5.

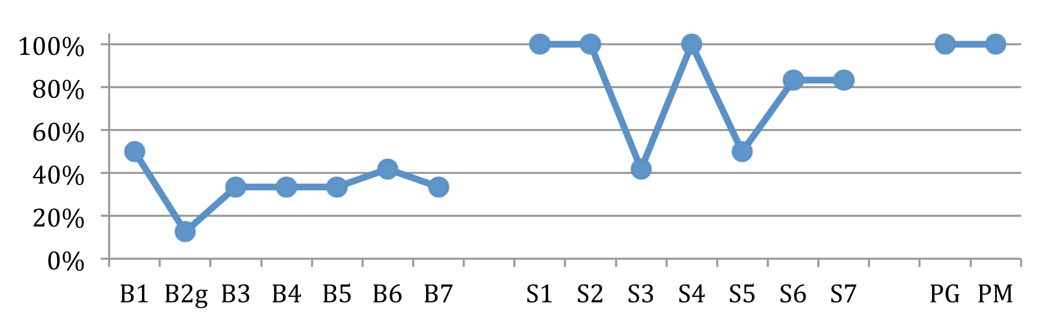

Figure 3: Percentage of correct problems in each session.

In Figure 4 we show an example of a resolution of a problem in session 6. It is observed that the student has abandoned the situation model and informal strategies, in favour of the mathematical model. In effect, he explicitly recognizes and executes the arithmetic operation of subtraction, even in this case where the verb of the problem implies an increase (a situation he had previously identified with addition).

"Carmelo had some chocolates. He has been given 3 chocolates and now he is 11. How many chocolates did he have at the beginning?"

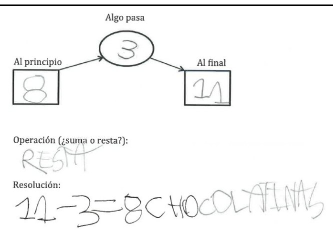

Figure 4. Use of the mathematical model to solve a problem of the fifth evaluation session.

CONCLUSIONS

The SBI methodology has been effective in helping the student to progress from informal strategies based on the situation model to arithmetic strategies associated with the mathematical model. The position where the unknown is placed in a change problem has had an important role in the process.

The specific characteristics of the student have been essential to guide the process, so that, while maintaining the SBI philosophy, modifications have been incorporated depending on the difficulties that were being detected. For instance, it has become necessary to use large numbers to get the student to abandon informal strategies; it has also been necessary to explicitly request that the student reviewed the statement in cases where the verb of the problem involved an increase of the initial amount but required a subtraction for its resolution. Returning to the general framework in which this work is formulated, we observe that these adaptations are distinct for different students, even if they share the same diagnosis (ASD). Due to the great variability of the learning characteristics of the students, the attention should be as individualized as possible to achieve the planned objectives.

As a line of future work, we intend to focus on the learning of the resolution of problems that involve combined arithmetic operations, following a similar methodology in students with ASD.

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