



PSYCHO-PEDAGOGICAL INTERVENTIONS IN THE PREVENTION AND THE THERAPY OF LEARNING DIFFICULTIES IN THE FIELD OF MATHEMATICS

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Abstract: In the given study dyscalculia is approached in the context of learning difficulties, but also in relation with damaged psychic processes and functions. The practical part of the study describes intervention models from the perspective of dyscalculia prevention and therapy-materialized in personalized intervention programs.

Key words: dyscalculia, learning difficulties, calculus difficulties, prevention and therapy

1. Introduction

Dyscalculia, acalculia and arithmastenia are terms which can be found in works which are already considered classic in the field of learning difficulties, and which are used by authors like Kreindler and Fradis (1970), Borel-Maisonny (1971) or Myklebust (1960). However, the history of the interest in the mathematics related disorders is connected to the clinical research studies in the field of aphasia. S. Henschen was among the first researchers to use the term of acalculia in 1920, in a study concerning the aphasia disorders. Most of the times, these works are limited to the relationship between the acalculia symptoms and focus brain damage (Dugas, 1970). By analogy, the aforementioned author suggests that students with disorders in the formation of elementary arithmetic abilities also display such minor brain damage. In the psycho-pedagogical approaches, dyscalculia is often associated with dyslexia and dysgraphia. Significant correlations have been established between spatial dyscalculia, spatial amnesia and apraxia.

2. Definitions and Conceptual Fundamentals

Currently, the majority of definitions given to learning difficulties encompass references to mathematics related difficulties or disorders.

A classic definition of learning difficulties (Kirk, 1962, quoted by Ungureanu, 1998, p. 263) refers to a delay, a disorder, a slow development of the speech, language, reading, writing, arithmetic or of other school subjects, which results in a psychic disfunction caused by a possible brain disfunction, emotional or behavioral disorders. The learning disorder is not the result of a mental disability, sensory deficiencies or cultural and instructional factors.

Crealock and Kronik (1993) quoted by Vrăsmaș (2007) indicate that when defining learning difficulties, at least three criteria are considered: discrepancy, exclusion and etiology.

Kulcsar (1978) points out that the following can be affected by learning difficulties: language processing, visual-spatial processing, phonologic processing, the speed of information processing, memory, attention and the executive functions.

One of the definitions from a psycho-pedagogical perspective is provided by Borel-Maisonny in 1965, quoted by Păunescu and Mușu (1981, p. 159): "Dyscalculia is comprised of all the difficulties related

to the acquisition of the concept of number, of arithmetic calculation and mathematical reasoning”. Another comprehensive definition, which is based on the exclusion criterion, but also leads the way to the differential diagnosis, is to be found in DSM IV TR (2003, p.53):

” The essential element of this disorder is a significant impairment in the development of arithmetic skills and which cannot be accounted for by mental retardation, improper education or auditory or visual deficiency; the diagnosis is given only if this impairment significantly affects academic performance or daily activities which require arithmetic skills.” In the case of normal mental development, the point of reference to be considered are the mathematical abilities considered normal for a certain age. Thus, curricular points of references will also be taken into account. Additionally, with children, dyscalculia is a progressive disorder, different from the forms of dyscalculia which are manifest in adulthood.

3. Taxonomies

In an attempt to achieve systematization, obviously incomplete, of the manifestations in this field, Myklebust (1960) describes three forms of the dyscalculia:

1. Difficulties in the visual or auditory perception and discrimination of numbers, often accompanied by difficulties in number writing;
2. Difficulties in the acquisition of mathematical principles which form the basis of problem and exercise solving ;
3. Difficulties in the acquisition and usage of symbols for the arithmetic operations.

Some taxonomies have as a starting point the association of calculation abilities with other cognitive abilities such as : verbal abilities, perceptual, spatial and memory abilities; other taxonomies are based on the description of various inabilities in dyscalculia, and a third category refers to the association between dyscalculia and other learning related disorders.

According Strang and Rourke (1985) quoted by Ardila and Rosselli (2002) the errors done by the children with dyscalculia can be classified in the following categories:

- a) spatial organization of quantities errors;
- b) visual attention errors;
- c) mathematical operations errors;
- d) graphic-motor errors in the writing of quantities;
- e) counting and reasoning errors;
- f) quantity memorization errors;
- g) avoiding problem and exercise solving.

Geary (1993) groups the various types of errors identified by other authors in three categories only: visual-spatial, pertaining to the semantic memory and procedural. Thus, he operates these taxonomies much more efficiently, which facilitates the diagnosis and the orientation of the psycho-pedagogical intervention.

From the perspective of the association with other forms of learning difficulties, Rourke (1993), quoted by Ardila and Rosselli (2002) mentions the following:

- a) dyscalculia associated with speech disorders or dyslexia (deficits in the understanding of instructions, in deciphering the text of the problem and difficulties related to the verbal memory);

- b) dyscalculia associated with spatial-temporal difficulties (for instance problems related to number sequencing).

Ungureanu (1998) describes intuitively the way learning difficulties manifest themselves in the field of mathematics: multiplication difficulties; problems in identifying the multiples, the factors etc, errors in elementary mathematical calculations; poor understanding and operation of mathematical concepts; poor visual-spatial abilities.

3. Diagnosing Dyscalculia

There is a series of programs which aim at identifying children with dyscalculia. One of the approaches is the didactic one, which makes use of the school curriculum requirements based on the educational levels. It includes number dictation, copying numbers and exercise and problem solving. From the psycho-pedagogical perspective, there are tests which investigate mental functioning through the psychic processes and functions involved in the acquisition and usage of arithmetical calculation: memory, auditory and visual memory, visual and auditory perception, temporal-spatial orientation. Special attention is paid to the components of psycho-motricity, like corporal scheme, right-left orientation.

Certain dyscalculia symptoms (difficulties in the creation of the concept of number, in counting, in associating the number with the quantity etc.) can manifest themselves in the context of certain requirements specific to the kindergarten or first grade activities, but diagnosis becomes possible during second grade.

Tests are used in order to determine the conceptual space in which the pupils have to orientate themselves in close vicinity, to estimate distances (e.g. using feet as unit measure), to find their way following drawings, diagrams, maps. The perception of temporal succession is frequently assessed based on rhythm reproduction tests. In order to determine laterality, a number of tasks are used, which refer to the manual laterality (single and bimanual), ocular, auditory and pedestrian laterality. The visual memory tasks based on the reproduction of complex figures (A. Rey's Complex Figure Task) or similar figures Borel-Maisonny (1971) indicate the possible difficulties in the acquisition or in accessing the visual image of the number and often the correlations related to the performance in this task are checked.

The diagnosis criteria from DSM IV R (p.54) prove to be extremely useful in identification and diagnosis:

- A. The capacity of arithmetical calculation, measured through standardized tests, is significantly below the expected level, considering the chronological age of the person, the measured intelligence level and the education corresponding to the person's age.
- B. The perturbation from the A criterion interferes significantly with academic performance or with the daily activities which require mathematical skills.
- C. If a sensory deficit is present; the difficulties in the mathematical skills are excessive, compared to those which are usually associated with it.

4. Interventions in the Prevention and the Therapy of Dyscalculia

As previously shown, both in taxonomies and symptomatic or etiological descriptions, dyscalculia is most often associated with language disorders or with spatial-temporal abilities disorders. This is why the prevention or therapeutic models are dependent on these associations.

A series of recommendations for *the prevention of calculation disorders and of dyscalculia* in particular have been formulated. Thus, Lemel (2000) quoted by Meljac (2001) suggests the following methods:

- searching for several ways to solve a problem, and analyzing the advantages and disadvantages of each solution;
- verbalizing the problematic situations and the resolution reasoning;
- identifying and analyzing the errors.

In the course of several applied research cases, developed under the umbrella of a type A CNCSIS project, developed among 2007-2009, preventive and therapy actions have been undertaken for learning difficulties pertaining to mathematics. One of the applications was developed according to the curricular requirements for the Mathematics academic subject in third grade. The attempts at preventing mathematical learning difficulties aimed adapting the contents by enlarging upon certain themes, selecting and applying customized intervention programs. In this research, the intervention was focused on problem solving, starting from the difficulties in verbal comprehension which are reflected in successful problem solving.

While teaching, several elements were taken into account: the degree of difficulty in the task, the suitability of the methods, suitable task duration timing and identifying the need for support.

For the finalization of the solving acts, the activities aimed at: discussion and writing of resolution plan, assessing the clarity of verbal/ written expressions, checking the conciseness of verbal/ written expressions, checking the results and other developmental activities.

In another application within the project, pupils from the fourth grade were assessed, using "Learning Disabilities Checklist", suggested by the National Center for Learning Disabilities from New York (posted on www.LD.org). With the help of this instrument, the teachers were guided in their attempts to observe students with learning disabilities. Starting from the observations conducted over a period of 6 months, educational intervention plans were elaborated for the pupils who took part in the research. The guiding of the recovery interventions was done based on these plans. An instance of one of these plans is presented in the following, which was applied by the psycho-pedagogue Andras Kinga on a fourth grade pupil diagnosed with mathematical learning difficulties.

Table 1. -PEI Mathematics participant V.N.

<i>Nr. crt.</i>	<i>Learning Unit</i>	<i>Reference objectives</i>	<i>Strategies methods and action means</i>	<i>Minimal criteria for progress assessing</i>	<i>Methods and assessing tools</i>
1.	Addition of natural numbers smaller or equal with 1000000	To solve addition exercises with and without crossing over order. To use properties for mentally solving calculations.	Explanation Brainstorming I know/I would like to know/I learned Demonstration Exercise Working sheets Students' book Writing tools	To solve calculation exercises. To associate the mathematic symbol with mathematic operation. To know operation properties.	Working sheets Observation and appreciation Direct products Oral examination
2.	Subtraction of natural numbers smaller or equal with 1000000	To solve subtractions with and without loaning. To analyze the component parts of a problem that includes subtraction.	Explanation Exercises Quadrant Method Working sheets Students' book Writing tools	To solve subtractions with and without crossing over order. Correctly solve the given problem.	Direct assessing of the products. Working sheets Observation
3.	Multiplying the natural numbers smaller or equal with 1000.	To do multiplications in various numerical contexts. To solve and to compound problems.	Exercises Explanation Cube Working sheets Students' book	Observes the connections between context and operation. Analyzes and	Working sheets Oral evaluation Assessing the products

			Writing tools	solve the problems.	
4.	Dividing the natural numbers smaller or equal with 1000.	To know the corresponding terms. To recognize the concrete situations or the expressions that implies division operations.	Exercises Explanation Demonstration Cluster Method I know/I would like to know/I learned Brainstorming Working sheets Exercise book	Names the terms correspondent to the mathematic operation. Establishes connection between operation solving and concrete situations.	Working sheets Written evaluation Oral evaluation
5.	The order in which the operations are done.	To do the operations following the correct order. To check the obtained results.	Explanation Demonstration R.A.I. Method Students' book Writing tools	Solve the exercises following the correct order. Checks the obtained results by using other methods.	Oral evaluation Observing the products

5. Conclusion

Within the methods of global therapy of calculation disorders and of dyscalculia in particular, Lemel (2000) and Perradeau (1996), quoted by Meljac (2001) identify three categories:

- methods based on the construction of mental operations;
- methods pertaining to learning;
- methods which take into account the pupils' personal characteristics.

Following the psychopedagogical interventions based on customized interventions, through this research it is underlined an increased efficiency in the case of combined application of methods which aim at learning with the methods that take into account the pupils' personal traits.

That's is why through this research we underlined the efficiency and the necessity to work by using PEI in the case of the children with learning difficulties in mathematics field. This research also has an important impact in establishing direction for organizing and reorganizing the curriculum for the children with learning difficulties in the field of mathematics as in Romanian psycho-pedagogical field there is an acute lack of this type of adapted materials.

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