COMPREHENSIVE TRAINING OF STUDENTS WITH EXTRAORDINARY APTITUDES WITHIN THE FRAMEWORK OF THE SPECIAL EDUCATION PROGRAM IN MEXICO

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Abstract

In this project there have been implemented some pedagogical innovations in the framework of the Morelos State special educational program for gifted children through the so-called "Program of integral development in the early stages of intellectual training for students of basic level with a focus on the exact sciences". This project has been supported by the Secretary of Public Education (SEP) in order to meet the specific educational needs of children with extraordinary aptitudes, and it was especially arranged for a group of children selected from the public schools (10 -12 years old). The principal objectives of the program arranged by our group have been to design activities which would stimulate intellectual development and creativity with an emphasis on the logical mathematical thinking.

One of the tasks for the group of instructors engaged in the project has been to achieve the constructions of diagrams using pencil and paper, which demonstrate the relations between the concepts of the theme on space polyhedral (important in the Curriculum), including characteristic of Euler, which furthermore lead to constructions of spatial polyhedral figures gluing colored paperboard patrons produced by children. Another theme, is concerned to combinatorial techniques related to probability concepts: here it was successful a collaborative work, where children were engaged in some game activities specially designed so that the motor and mental coordination could be developed. Also we suggest a series of experimental activities that help students to assimilate the concepts of probability through exploration and interpretations of combinatorial tree diagrams, teamwork using cards with digits, so that children could gradually develop different skills and activate cognitive resources that are necessary for problem solving.

Keywords: extraordinary aptitudes, concept' construction, problem solving, creativity.

1 INTRODUCTION

The educational system in Mexico has had remarkable achievements in recent decades. The expansion of educational coverage and increased scholar average. However there exist certain circumstances that prevent some children to have access to education that they need. Children who have outstanding skills are found in this group.

The Constitution of Mexico (Article 3) states that all individuals have the right to access to education. While article 41 of the General Education Regulations, states that a special attention should be given to pupils with extraordinary educational needs: both, with disabilities and outstanding skills. So our work addresses to the latter case with a series of activities that attend the needs of gifted children.

Different groups School level are found to be rich in diversity (cultural, religious, economic, ethnic and linguistic, etc.). In many aspects this fact is favorable: diversity helps to build a society, where there are prevalent respect, tolerance and coexistence between individuals [3]; which are fundamental for the country's development. To that extent, diversity refers not only to recognize people with disabilities, but the heterogeneity of human characteristics, such as outstanding skills [1].

In a study concerned to a group of children between 10 and 12 years with outstanding skills, identified by their schools, there have been implemented learning techniques, which are also favorable for inclusion of all children of the same grade. It has been given a personal attention to identify the individual needs of every child. Thus, the more favorable progress towards the better acquirement of knowledge (required by the syllabus published by the Institute of Basic Education of the State of Morelos -IEBEM), is found to be through a process of integration.

Educational integration, specifically directed to pupils with special educational needs, is an element that promotes inclusion, since it affects the management and organization of the schools in training and retraining of teachers, in enriching teaching practices and promoting values, among other things. It is a
process that involves removing barriers to learning and participation in learning activities, allowing to any child with outstanding skills, to take part in all learning activities according to their own style and interests and to develop skills and competencies which would lead to the ability to solve problems in their daily lives.

2 METHODOLOGY

In this article we describe the experiences of pedagogical innovations implemented within the framework of the program of the State of Morelos for gifted children in primary education (IEBEM), based on the Plan of the National Development. This program is developed under the supervision of the Council for Basic Education in Mexico (SEP Secretaria of Public Education) in order to meet the special educational needs of children with outstanding skills.

A series of experimental activities and game activities, have been suggested for children to achieve gradually a development of different capacities and enable the cognitive resources needed for problem solving. The use of manual activities and pictorial representations, with reference to everyday life, is of great help to motivate children to focus on problems’ solving and keeping their attention during the sessions.

During the work with the outstanding pupils, particularly with 5th and 6th grade, it was observed that all of them demonstrated a higher level of awareness than others in the same grade. There are considered as "outstanding students with special aptitudes" those ones who are able to stand out significantly from the educational social group to which they belong, regarding social humanistic, artistic, as well as, scientific and technological fields.

In our project, there are addressed the two types of outstanding skills: intellectual and creative. Each student was selected by his educational institution under the concept of being an "outstanding student" and under the criteria of the classroom teacher, moreover they were evaluated by IEBEM according an examination test. Most students had one or two outstanding skills detected.

The creativity of each student is variates and is expressed according to the personality of each one as well as of the context. That is, the perception of the environment varies for each of them, so that understanding of a particular situation may be achieve much later. For some pupils it is easier to understand a problem from its graphical representation; others solve problems through comparative metaphoric or fantastic thoughts; meanwhile others prefer tangible objects.

In any way, the objective of this work under the project of linking with the Department of Special Education, the Institute of Basic Education of the State of Morelos (IEBEM), was to ensure the complete assimilation of the fundamental concepts of the educational program not only in mathematics but in other areas, in order to achieve comprehensive training approach to science, programmed in the "comprehensive development program in the early stages of intellectual training for students in basic level of education, with a natural approach to the exact sciences and computation".

It was not easy to establish an appropriate language to make children transmit into words what they have in mind. When they start with arguments, they showed feelings of rejection of their own proposals, although those were not entirely wrong. As well, on several occasions it was observed that a pupil noticed his mistakes at a moment of the presentation of the arguments; making corrections immediately.

For some pupils, some of the factors that facilitated this process were the constant coexistence with people with similar point of views, i.e., classmates with whom to discuss their results with equivalent arguments, obtaining feedback that had previously failed. For other group members it was sufficiently only to listen to others to express their arguments, to generate a proper conclusion. They sought the slightest verbal interaction with peers. However, their results were reviewed in writing form.

3 RESULTS

The project has been realized in two stages. The first stage with children of 8 and 9 years old and the second stage with children of 10 and 11 years, several of whom has been from the same group as in the first stage.
3.1 Description of some activities during solutions of mathematical tasks.

At the first stage, some preliminaries activities with children were organized in order to develop their logical-mathematical thinking for the study of the topics corresponding to grades 3 and 4 of primary (8 and 9 years old), (figure 1).

During the second stage there were performed some of the same type of activities, resolving them now with the new strategy learned from their previous experiences.

3.1.1 Labyrinths.

During the first stage of the project, the pupils approached problems concerned to different types of labyrinth in order to promote the development of fine skills [5]. To solve problems with labyrinths stimulates the logical-mathematical processes in children, also helps to develop their curiosity to manipulate and explore patterns; use visual spatial skills, as well as to count, to plan and to remember roads used, identifying forms and shapes.

During the second phase of the project, students were encouraged to find the right path without drawing with pencil the preliminaries routes, with the aim of optimizing the solution time and to avoid drawing and erasing the wrong ways. What we reality wish, was that children construct the solution mentally. This process was accompanied with the use of basic geometric figures, identifying those that had names (Figure 2).

One of the objectives was to introduce the group of outstanding students of primary school to counting techniques, to manipulate two and three dimensional figures, to create their own ideas to approach some problems. Children made practices with mental images to help them understand a specific problem situation, as well as realizing the possible rotations of geometric shapes in his mind.

3.2 Geometry of plane figures and spatial bodies.

This activity gave a brief revision of elementary geometry that should be covered in the curriculum of basic level indicated by SEP, this time covering certain theoretical aspects of plane figures and spatial shapes usually presented in syllabus of basic mathematics; such as round geometric bodies: these
bodies contain at least one face of a curved shape. Among the best known are spheres, cylinders, cones and toroids or just torus.

3.2.1 Plane figures: Classification and general aspects

In this section a polygon (figure whose sides are formed by straight segments) has been introduced in an intuitive fashion, by giving illustrations of such sort of figures. The pupils were surprised and yet pleased, because they noticed that some of these examples were already known, although not in a formal manner. So that these complemented their knowledge about those objects.

Thus they immediately proceeded to a classification of these objects as shown below:

1 Regular Polygons: polygons whose sides have the same magnitude, i.e., all sides are equal.
2 Irregular polygons: Polygons whose sides have different magnitudes, i.e., at least one side is different.
3 Simple polygons: polygons whose sides do not intersect.
4 Complex polygons: polygon that do not have an intersection with itself.

The pupils showed great interest to new knowledge and their classification was illustrated with examples such as square, equilateral triangle, the pentagon, in the case of regular polygons, and the diamond, parallelogram, etc. in the case of irregular polygons. Regular and irregular polygons fall under the classification of simple polygon, meanwhile five-pointed star was shown as an example of a complex polygon.

As an application of the polygons, it was shown that in nature there are animals and plants that possess shapes geometric figures, for example, flowers, insects and spiral shells (serving this as an opportunity to mention the golden ratio).

Pupils were amazed with these relations, it was great surprise that they did not have notice before these relations which were always around.

3.2.2 Spatial bodies: polyhedra and Euler characteristic

This section describes some examples of studying polyhedra, in addition to spatial bodies that have been considered before: the sphere, cone, cylinder caps, cube, torus, etc.

Thus we introduce the known platonic solids, requiring to establish their characteristics, and to find out why these figures are so peculiar. These solids are cube, tetrahedron, the octahedron, dodecahedron and icosahedron. Since this was a completely new issue for them, they showed curiosity and interest.

Then they were guided to discover the Euler characteristic, which is a remarkable mathematical expression that leads us to a classification for these abstract objects. For example, establishing Euler characteristic of the Platonic solids, they find the corresponding mathematical in general case.

It was observed that the students were more interested in mathematical topics involving drawings and/or illustrations showing them the beauty and the beautiful but curious balance between simplicity and complexity of mathematics, which is well exemplified in the flat and spatial geometry.

During the project, recreational activities allowed motor coordination and mental coordination during peer to peer work performed.
3.2.3 3 dimensional puzzles.

Assembling puzzles in two and three dimensions was conducted by instructors, using the two-dimensional rectangular (Figure 3a) and three dimensional spherical shapes (Figure 3b) and three cubic shapes (Figure 3c).

These activities were designed so that pupils could develop their mental processes to reconstruct structures. To visualize correctly every possible ensemble and to get the goal in the shortest possible time.

The similar case is the goal achieve with the labyrinths of different stages, only now the entrance to the labyrinths needs to have separate pieces, knowing how they have to be linked properly, and their goal is to recover that figure.

3.3 Activities to develop the theme of combinatorial counting

The topic of counting is included within the syllabuses corresponding to grades 5 and 6 of primary school.

In the activities designed for the group of outstanding students, the techniques have been proposed to improve the understanding of the different forms to realized counting.

![Image of a cubic puzzle] Figure 3c. Cubic puzzle.

![Image of a problem count diagram] Figure 4. Problem count. Solution by using tally charts.
3.4 Tree diagram and multiplicative principle.

The process started with identifying of the variety of possibilities to have two or more events. The structure of the tree diagram was shown for various situations, in order that the pupils arrive at the multiplicative principle, which in the institutional definition is formulated as:

"If an event A can be realized in m ways and event B can be done in n ways, then there are m × n possibilities to obtained A and then to perform B, simultaneously".

In addition, pupils were able to generalize this case to more than two events.

The material used to introduce pupils to these subjects were some sheets that raised the problem of choosing how many different cakes can be formed with a certain amount ingredients (Figure 4).

First, it was requested to resolve the issue by analyzing the information shown in the tables that they answered by their own. Subsequently, they were provided with a tree diagram patron and some labels with illustrations of each ingredient available for the problem (Figure 5).

The results obtained with the construction of the tree were favorable. Most managed to build the tree diagram correctly (figure 6). Those who did not succeed happened to leave too much space between some branch. By the end they had ingredients left over and they had spare space in their worksheet.

![Tree diagram and combinations](image)

**Figure 5. Patron provided for construction diagram corresponding to the problem tree.**

3.5 Combinations from \( n \) by 2

The activities started with a simple question: if there are three persons, how many shaking hands will there be performed, if everyone greets each other? This introduces a particular case of the technique of combinations that says: "to calculate the number of ways to combine \( k \) items from a set of \( n \) (with \( n ≥ k \)): No matter the order; and the elements are not repeated ".

![Combinations](image)

**Figure 6. Base provided for construction diagram corresponding to the problem tree.**
Then the dynamic was as follows: the children made teams of four and began to count their greetings. When the correct result was obtained, they increased the number of team members one by one and retold the greetings. The response of the children was favorable since they themselves realized that the amount of greetings given by a certain number of persons, say n persons is equal to the sum of the n-1 numbers, and then they themselves deduced the way to optimize that amount by a multiplication and a division

\[ Saludos = \frac{(\text{núm. personas})(\text{núm. personas} - 1)}{2} \]

Mathematically, the combinations from n by 2 are equivalent to the sum of the first n-1 numbers. That is to say \( nC2 = \frac{n(n-1)}{2} \).

### 3.6 Permutations and factorial number

The last counting technique was permutations without repetition, which is formulated as: "Permutations of n elements without repetition, are the different groups of n distinct elements that can be made, so that two groups differ only by the way in which the elements are placed ".

For the pupils to assimilate the concept there were given cards with the digits from zero to nine and cards with the letters of the alphabet. They were asked to count the number of three-digit numbers that they can form using three specific digits. In the same way the questions was posed for the letters, that is to count the amount of words that can be formed using three given letters (calling word to any order of the letters). Then the same was done for four-digit numbers, four-letter words, combination of letters and numbers to form auto plates. The children realized that they could count the total ways of ordering letters and numbers by simply multiplying the number of digits or letters we wanted the word or quantity to have by their predecessors until they reached the one. In this way, the pupils were able to discover the concept of factorial number: The factorial number (represented as n!) Is defined as the multiplication of a number by all its descendants. The notation n! was used to optimize the results obtained in the permutations without repetition.

The children accepted the new operation and named it as "anticipations"; because they multiplied a number by all their previous ones till 1. They understood that the factorial of a number can be a very large number.

### 4 CONCLUSIONS

In conclusion, it has been observed that the children prefer problems with attractive visual elements: colors, drawings, figures, textures. Final evaluations demonstrated that children developed their intellectual abilities and performed the problems of Mathematical Olympiad (Kangaroo) even those of a higher school grade.

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### REFERENCES


