



ELECTRONIC JOURNAL OF  
RESEARCH IN  
EDUCATIONAL PSYCHOLOGY

No. 1 (2) 2003. ISSN: 1696-2095

# Problem-solving: Evaluative study of three pedagogical approaches in Mexican schools

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## ABSTRACT

**Introduction.** One of the most important goals of the Mexican educational system is that students, from primary education onward, acquire complex thinking skills such as "problem solving" and "creativity", among others. This paper describes how problem solving finds expression in three different pedagogical approaches in Mexico.

**Method.** The design used is not an experimental type, since variables are observed in an existing situation without being deliberately manipulated. The design is also descriptive cross-sectional or transversal, since measurement is taken on a single occasion, obtaining the incidence of values manifest by the variable under study. Additionally it is performed with a mixed design type 6 X 1.

**Results.** Results show how children from the Freinet school obtain the highest scores in both groups, and that the lowest scores correspond to the traditional public school. There are significant statistical differences between the different pedagogical approaches in regard to problem solving in their basic educational process.

**Discussion.** A new educational model is required, one that takes into account all human potentialities in its programs, adapting human resources and necessary materials responsible for the educational process. It is indispensable to include educational content where problem-solving skills are exercised, taught and developed.

**Keywords:** Problem solving, Pedagogical approaches, Traditional education, Montessori, Freinet, Primary Education.

## Introduction

In the Mexican educational reform, *Program for Educational Modernization* (SEP, 1989-1994), one of the fundamental objectives established for Primary Education is “learning to solve problems”. At this time, however, there exists no formal, systematic evaluation process that would allow us to know whether this higher-level thinking skill is being achieved at the desired level. It is important to state, then, that the research presented here evaluates "problem-solving", one of the most complex cognitive processes, in the three pedagogical approaches that are prevalent in our society. We consider this research to be relevant to both educational and social aspects of our country, since evaluating problem-solving in students from three different approaches will allow us to understand which of these favors such processes, as well as to establish a way to evaluate this cognitive process.

"Problem-solving" is the highest form of learning (Klausmeier and Goodwin, 1993), since the individual defines new ideas based on this process. Likewise, it is well known that when faced with a problem one needs knowledge of rules, on the one hand, and the capacity to use them, on the other, thus achieving transfers of learning. Being able to solve problems, then, enables persons to adapt to their environment and to modify it in part.

To speak of problem-solving is to speak of “thinking skills”, these being among the the human being's highest and most complex skills; problem solving involves not only higher mental processes, but simpler processes such as memory, attention, representation, comprehension, etc. In thought, one engages in mental activities such as the articulation of symbols and concepts, which lead us to the creation of new forms that culminate in "problem-solving". Throughout this paper, problem solving will be referred to as *PS*.

For De Vega (1986, p. 494), the definition of a problem involves: “...those tasks which demand relatively complex reasoning processes, and not merely an associative or routine activity.” In this way, the process performed in *PS* can be managed as a goal-directed activity, which is sometimes routine, using what already exists (reproduction), or sometimes creative, generating new procedures (production).

For Pozo (Pozo, Pérez, Domínguez, Gómez and Postigo, 1994; p. 9), “Problem solving is based on the posing of open, suggestive situations that require from students an active

attitude and an effort to find their own answers, their own knowledge". *PS* in itself is a process where external elements (problems to be solved) are interrelated with ones already existing in the subject (memory, simple rules, complex rules, etc.), so-called cognoscitive strategies (intellectual skills), in order to obtain from this interaction the adequate solution to the problem in question, and the modification of the person's intellectual capacity, given that once the problem is solved, one obtains a "higher order rule", added on to and remaining in the individual's repertoire. Teaching how to solve problems encourages in students the capacity of learning how to learn. Students need to acquire skills and strategies that will allow them to learn new knowledge on their own (Pozo et al., 1994).

It is then that one can speak of "learning" when speaking of "problem-solving" and of abilities involved in it, namely: intellectual skills, organized verbal information and cognoscitive strategies which a person is able to articulate in this process.

Thus, for purposes of this research, we define *PS* as follows: "Problem solving is a higher mental process where attitudes, prior knowledge, and heuristic or algorithmic rules intervene in order to provide the best of possible answers to a problem, where one did not exist" (Esquivias, 1997).

Acuña and Batllori (1988) explain, when referring to such authors as Wylie, Samson, De Bono, Maier, Dunker, Polya, Krulik and Rudnik, and Anderson and Barry, that they all concur in problem solving as a process that requires four steps: 1) problem identification, 2) problem formulation, 3) applying data to each solution, and 4) selecting the best alternative.

On the other hand, some research within the educational field shows that the student does not follow a consistent sequence in a problem-solving process, since he or she lacks the habit of applying logic and reasoning (Sánchez, 1996).

*PS* should be understood as a fundamental part of any educational process, such that at the end of any developmental or training program, be it professional, technical, etc., we are all problem solvers, in one way or another, to a greater or lesser degree, and that having elements and/or skills of logical thinking or reasoning will allow us to adequately practice our profession or other activity.

Piaget and García (1983; quoted in Pozo,1999), show that new concepts generally rise from the integration of other more simple ones, emphasizing that from the reorganization of ideas one acquires new meanings, such that the role assigned to the student is crucial in the construction of his or her own knowledge. For Ausubel (Ausubel et al, 1998), “the ability to solve problems is the primary goal of education”, this proposition being known as the fifth in the thesis of learning by discovery, thus upholding the importance of this process in students. Vygotsky's pertinent contributions seek to emphasize cooperation in group work, a principle which is derived from the theoretical postulates of this author's sociocultural paradigm. Thus the cognitive and constructivist positions in educational psychology consider as one of their propositions that problem-solving is a crucial ability in the formative process of any individual.

### **Pedagogical approaches**

Regarding the pedagogical approaches surveyed, we find that they are distinguishable by characteristics specific to each. Differences include those of philosophy, methodology, materials used, and other aspects. We will summarize them briefly.

#### 1) Traditional

This is what is being taught at the majority of schools in our country. It centers on the transmission of knowledge of a declarative type, encouraging learning by reception-repetition, and where the main role is played by the teacher as the unique authority in the group. The teacher is the speaker, transmitter of knowledge, and the student is the hearer, passive receptor of said knowledge. Democracy can hardly be favored here, the teacher is the one who makes the decisions on behalf of the group in general.

#### 2) Montessori

This school is classified as what was once considered Scientific Pedagogy, where the concept of education springs from "the nature and laws of childhood development, aside from traditional habits, including tradition itself, and any metaphysical consideration" (Monés i Pujol-Busquets, 2000).

The educational principles of this method are as follows:

- “Encourage dextrous activity and sensorial perception as principal sources of learning and for the child's development.

- Give importance to artistic education as a means of expressing one's inner world and of communicating with external reality.
- Create a reading/writing method based on logic and which avoids mechanical learning.
- Familiarize the child with mathematics, make him feel that it forms part of his world, is nearby, accessible.
- Help the child to experience, observe, and classify what he perceives as his physical and social surroundings.” (Vallet, 2000; p.33).

Here the student is the protagonist in the teaching-learning process, working at his own pace in a free environment with specialized materials, developed specifically for this purpose, and where furniture corresponds to his stage of physical and mental development. The teacher's role is mainly as a guide and adviser to the children.

### 3) Freinet

One of the central characteristics of this type of pedagogy is precisely "socialism". Here Freinet contributes a concept with important implications, calling the class a "social cell" and converting it into a democratic and cooperative institution, where experimental trials allow the student to face and address difficulties, these leading to interaction and cooperation (Freinet, 1985). “The concept of functionalism acquires an extraordinary dimension in Freinet: all his techniques are at the service of the children's capacity for experimentation and expression, for the solution of their immediate needs” (Vilaplana, 2000; p.72).

In this approach, students are the protagonists in the classroom. Here, students together with the teacher, in democratic fashion, make decisions about what they are going to learn and in some cases on how they will go about it. Socialization is a fundamental factor in the Freinet classroom; social consciousness generated in this environment provides elements for better living with others.

### **Objectives**

The purpose of this research is expressed in the following objectives:

- 1) obtain real data that provides information about the way "problem solving" is manifest in different pedagogical approaches.

- 2) determine which approach best encourages this process, try to understand what elements or characteristics representative of each approach contribute toward the development of this ability in students.
- 3) emphasize the importance of including content, strategies and methodologies in general that are directed toward the development of these abilities in students, seeking to create awareness, provoking thought and attention, thus encouraging a reconceptualization of education in our country.
- 4) establish relationships between theory and educational practice, based on proposals from the official documents that govern education in our country.

## **Methodology**

### *Sample*

The sample is not probabilistic of an intentional type (usefulness), since elements were selected that were considered representative for the purpose of this study (Salkind, 1998). It is made up of 259 boys and girls enrolled in either third grade (formative evaluation) or sixth grade (summational evaluation) of primary education. The sample was selected according to the following:

- 1) Being the most representative of each of the approaches being studied (prestige).
- 2) Socioeconomic level (controlled by location and by correspondence to an economic bracket from 10 to 12 minimum salaries).
- 3) At most schools, groups were assigned by the school administrators, who stated that they were the best groups (verbal report).
- 4) 5 schools were selected, with two groups per school for a total of 10 groups. Here we may mention that the choice of a school from the North (different from the rest of the schools located in the South), was made intentionally for the purpose of comparing results. Thus the population under study was distributed as shown in Table 1.

**Table 1**  
**Sample Population Studied**

School	3rd Girls	6th Girls	3° Boys	6° Boys	Total
Freinet	18	13	11	20	62
Montessori	13	13	5	4	35
Private Traditional	4	12	16	19	51
Public Traditional (North)	12	11	8	10	41
Public Traditional (South)	19	16	22	13	70
<b>Total</b>	<b>66</b>	<b>65</b>	<b>62</b>	<b>66</b>	<b>259</b>

### Setting

The setting consisted of classrooms from the five schools mentioned, characteristics of each are shown in Table 2.

**Table 2**  
**Characteristics of the Schools Studied**

School	Approach
N° 1	Freinet
N°2	Montessori
N°3	Private Traditional
N°4	Public Traditional (South)
N°5	Public Traditional (North)

### Variables

Variables to be studied were defined as follows:

Independent variable = pedagogical approach: Traditional, Montessori and Freinet.

Dependent variable = Problem Solving

### Instruments

We used two instruments developed by Esquivias (1997), referred to as "Problem Solving Instruments, 3rd and 6th grades". Prior to their definitive use, two pilot studies were carried out and the corresponding modifications and adjustments were made. As for the instrument's reliability, a Cronbach alpha statistical test was performed, allowing us to determine internal consistency of the items. In this test an Alpha reliability coefficient of

.6831 was obtained, and a standardized Alpha of .6905, indicating a statistically significant consistency of the items that make up the instrument. The instruments consist of five sheets containing 15 multiple choice items each, with two different formats corresponding to the degree of difficulty at each educational level, 3rd and 6th grades. As examples, we present one item from each type of test.

**Example Item No. 14 from the 3rd Grade Test**

14. - Imagine that you are standing at the base of a staircase with 10 steps. You are asked to go up 4 steps, then go down 1, then go up 4. Which step did you end up on?  
 ( )

A) Step number 7  
 B) Step number 10  
 C) Step number 8  
 D) Step number 5  
 E) Step number 6

**Example Item No. 14 from the 6th Grade Test**

14. – Indicate which group indicates the right values for each of the letters in the following operation:  
 ( )

operation                      TERE                      where: T = 3  
     TOÑO  
     LULU

A)    T=3, L=6, Ñ=8, R=4, E=7, U=5, O=2  
 B)    T=3, O=0, E=1, U=1, Ñ=5, L=4, R=6  
 C)    T=3, R=4, L=8, Ñ=2, O=1, U=5, E=7  
 D)    T=3, U=8, O=1, Ñ=2, E=7, L=6, R=4  
 E)    T=3, Ñ=5, E=7, O=1, R=6, L=0, U=8

*Design*

The design is of a non-experimental type, since it is carried out without deliberately manipulating the variables: observing an existing, descriptive cross-sectional or transversal situation, and because measurement is taken on a single occasion, thus obtaining the incidence of values manifest by the variable under study (Hernández et al, 1991). Additionally it is supported with a mixed design type 6 X 1 (Cook and Campbell, 1979), for the purpose of observing the relationship which exists between research variables, and therefore the effects on the dependent variable *PS*.

## *Procedure*

### Stages:

- 1) This research was performed with the participation of students from the three pedagogical approaches mentioned, and from five schools who took part in the research.
- 2) When instruments were applied, the teacher was asked to remain in the classroom, without participating or communicating with the students, so that the group would not be altered and would feel more confident in the teacher's presence.
- 3) In each case the same person applied the instruments. Application was performed once per group, within an interval of three weeks from the first school until the last one.
- 4) Two different instruments were applied according to academic level, 3rd and 6th grades at each school.
- 5) Each of the 259 instruments applied was scored objectively.
- 6) Instruments were ordered in groups by schools, grade level, and scores obtained.
- 7) Data codification was performed.
- 8) Gross averages were calculated. A decreasing order was established according to scores obtained.
- 9) A final score for the *PS* instrument was obtained by multiplying each of the gross averages by  $\frac{2}{3}$  (.66666), in order to adjust the number 15 (maximum possible number of correct answers) to a scale from 1 to 10.
- 10) Comparisons of averages correspond to the total sum of scores from both 3rd- and 6th-grade groups by school, by approach, obtaining a final score.
- 11) The corresponding statistical analysis was carried out, including a descriptive type statistical analysis, with frequencies, averages and standard deviation.
- 12) A comparative-type statistical analysis was also carried out, including: analysis of variance and correlation between variables, as well as their respective histograms.
- 13) The Cronbach Alpha statistical test was performed in order to determine the internal consistency of the instrument items.
- 14) Statistical data analysis was performed using SPSS (Statistical Package for the Social Sciences), versions 7.0, 8.01 and 10.
- 15) Results were obtained, and discussion and conclusions were drawn from them.

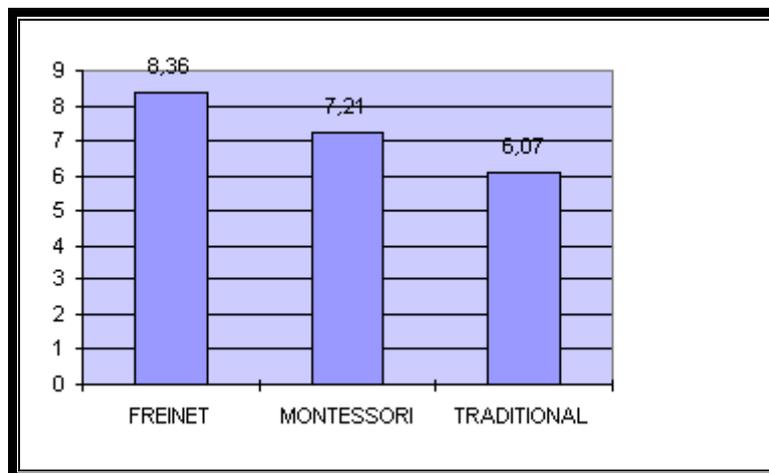
## Results

In Table 3 and in Chart 1, we can clearly observe how children from the Freinet school get the highest scores both in third and sixth grades, and that the lowest scores belong to the traditional public school.

**Table 3**  
**Summary of Statistical Analysis**

SCHOOL	GROUP	N° OF STUDENTS	AVERAGE	SD
Freinet	3rd	29	7.838	1.470
	6th	33	8.882	1.101
Montessori	3rd	18	5.772	2.134
	6th	17	8.659	.870
Private	3rd	20	5.930	1.664
Traditional	6th	31	7.335	1.289
	3rd	20	4.210	1.686
(North)	6th	21	6.729	1.301
Traditional (South)	3rd	41	5.788	1.901
	6th	29	6.455	1.697

**Chart 1**  
**Problem Solving. Both 3rd and 6th-year Groups by Approach**



The significant statistical differences among the groups, with a significance level of .05 or more, are shown in Table 4 , where (\*) represents significantly different pairs in terms of their results.

**Table 4**  
**Problem Solving Analysis of Variance**

SCHOOL	AVERAGE	5	4	3	2	1
Freinet	15.0581	*	*	*	*	*
Montessori	10.7804	*				
Priv. Traditional	10.7600	*				
Traditional public (North)	10.4683	*				
Traditional public (South)	8.0514					

Degrees of freedom expressed in total (between groups and within groups), Table 5, are 258. Results obtained in the Freinet school are different with a significance level of .05 or more with regard to all the other groups, both from the Montessori school as well as from the schools with a traditional approach.

**Table 5**  
**Data from the Analysis of Variance**

Source	Sum of DF	Mean Squares	F Squares	F Ratio Prob
Between Groups	4	1645.6052	411.4013	64.1718.0000
Within Groups	254	1628.3790	6.4109	
<b>Total</b>	<b>258</b>	<b>3273.9842</b>		

There are statistically significant differences between the pedagogical approaches with regard to problem solving in their formative educational process (Table 4 Analysis of variance of the *PS* variable).

The school with the highest scores on the *PS* reasoning instrument for both 3rd and 6th grade groups is the school conducted according to Freinet techniques, with an average of 8.36.

The school which appears next is Montessori, with an average of 7.21.

In third place with regard to scores obtained, the “private traditional” school has an average of 6.63.

There exist statistically significant differences when comparing the Freinet school with the others, and differences exist between the Montessori and Private Traditional schools, suggesting that more studies and serious future analyses be carried out between these approaches.

The traditional public schools (the two remaining, both North and South), are those showing lowest scores in reasoning, with averages of 5.47 and 6.12.

When averaging the *PS* averages of the last three schools, we obtain a group score of 6.07 for the Traditional Approach, leaving this approach in third place with respect to the other two.

## **Discussion and Conclusions**

Given the characteristics and results of this research, seeking to partially describe, from a sample, the current situation of Primary Education in Mexico with regard to the "Problem Solving" variable in different pedagogical approaches, we conclude the following:

- The optimal pedagogical approach for the stimulation and practice of “complex thinking skills” (Problem Solving), was the Freinet approach, to a lesser extent the Montessori type school, and at a disadvantage were schools with Traditional pedagogy.
- It becomes indispensable to include content where *PS* is practiced, taught and developed as a fundamental aspect of Primary Education, while further educational research must be directed toward identifying what elements are essential for adequately generating "complex thinking skills" in the student.
- Complex thinking skills require, on one hand, adequate pedagogical treatment (method), encouragement (educational philosophy), in addition to a suitable and tolerant intervention (teaching mentality and attitude), in order that each individual's own expressions may appear without being ignored, repressed, or punished.
- According to results found in this study, primary school that follows traditional pedagogy teaches to a lesser extent how to solve problems in general (without considering specific mathematic ones). As was already indicated: “...problem-solving should constitute a necessary content item in the various areas of the mandatory curriculum” (Pozo et al,1994).
- Primary education urgently requires a suitable redefinition (curricular reconceptualization), that goes beyond the teacher-pupil interaction: it is an entire style of teaching and learning, within a context of stimulation and motivation, in addition to being a different way of being perceived and respected as an educator, and of seeing and respecting the pupil, thus encouraging all his or her capacities.

- We may infer from the results of this research that the Mexican National Education System presents limitations when it comes to both human and material resources, since motivation and responsibility on the part of teachers is an important point of analysis. Within the context of educational problems, Schmelkes (1994) concludes that teachers do not feel capacitated, or are rather uninformed about their role in society, while on the other hand resources available to them are also insufficient.
- Every society needs schools where students are taught to think and to create and not to repeat, or simply accept what is already established. Human beings are “thinkers”, why not bring that into our country's educational practice?
- A new teaching model is required which takes into account all human potentialities, but most importantly, that provides material and human resources necessary for optimally preparing, training and capacitating all those responsible for this educational process, so that changes are observed and lived out in practice, in the classrooms and not only "on paper". Then, as a result, we would indeed be allowing for the student's full self-expression, Article 3 (Constitución Política de los Estados Unidos Mexicanos [Political Constitution of Mexico], 2000).
- Among the main distinctive characteristics of the Freinet school methodology we find: the school daily, interschool correspondence, the book of life (printed in the classroom), the files, lectures (the child takes the floor), gardens, workshops (skill development), assemblies (critical positions), etc.
- Another important characteristic of the Freinet school is encouragement of cooperation in group work. Interaction in cooperative groups has already been addressed by several authors (Coll, 1997; Díaz Barriga and Hernández, 2001; Hernández, 1998), and has its foundation in theoretical postulates of Vygotsky's sociocultural paradigm.
- However, a limitation of this study is the absence of control over certain variables such as motivation, intelligence, personality, academic performance or teacher, which could explain differences observed in *PS* among the different pedagogical approaches.
- We note that very similar results were also obtained in a study of the "creativity" variable using the same population (Esquivias and Muria, 2001), and underscore that creativity is also a complex thinking skill.
- In closing, we consider it important to mention that the Freinet school shares many of the constructivist principles of Piaget's psychogenetic theory, as well as Ausubel's theory of significant learning. Coll (1988) indicates that one of these principles is the

self-structuring of knowledge, “that is, they see the student as the true agent and the one ultimately responsible for his or her own learning process, 'like the artisan of his own construction' ”.

- We consider that a deeper analysis of educational practice in the Freinet school might contribute greatly towards constructivist principles being reflected in concrete actions in the classroom, that they not be limited only to being nicely expressed in official curricular plans and programs in our country.

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