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Problem Solving and Emotional Education in Initial Primary Teacher Education

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Our work is based on two premises. The first is that affective factors (beliefs, attitudes, and emotions) influence teaching and learning mathematics, and problem solving in particular. The second is that initial teacher education is an important element in the process of improving overall educational practice. On this basis, our research group has been working on evaluating the influence of affect in mathematics problem solving for prospective teachers, and on designing and implementing a program of metacognitive intervention that integrates cognitive and affective factors. The present communication describes our research in this line.
Keywords: Affective Domain, Initial Teacher Education, Primary, Problem Solving

INTRODUCTION

Assessment reports (OECD, 2003; OCDE, 2005; MEC, 2007) have shown how poor performance is in mathematics, but also how important mathematics problem solving (MPS) can be to overcome this situation. In this regard, Castro (2008) and Santos (2008) remind us that attempts to teach pupils general strategies for problem solving (PS) have been unsuccessful.

Since the 1980s, PS has come to be regarded as the backbone of mathematics content, since it involves skills of analysis, comprehension, reasoning, and application. But at the same time it is regarded as content specific, being a basic skill for pupils to acquire: "Problem solving has maintained and even increased its presence and importance in curricular proposals, both nationally and internationally" (Castro, 2008, 119). Nonetheless, there is a marked lack of attention in textbooks to heuristic strategies for PS (Schoenfeld, 2007; Pino & Blanco, 2008).

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The various curricula established for mathematics education describe 'basic skills' associated with PS which need to be developed in the classroom. These basic skills form part of earlier proposals of models of PS (Schoenfeld, 1985; Bransford & Stein, 1987; Mason, Burton & Stacey, 1988; Puig, 1996). In particular, the curricula call for the development and evaluation of aspects related to:

The problem itself – the comprehension and analysis of its statement, the design and implementation of strategies for its solution, habits of verification, and consistency within the relevant context.

Communication of the process and results, including the ability to transmit in sufficiently precise oral and written language, the ideas and processes that were developed so that they can be understood by the pupil's peers.

The affective domain and emotional education, by valuing such personal attitudes as perseverance in the search for solutions, confidence in one's ability to arrive at the solution, and a positive attitude in comparing solutions with peers.

These recommendations recognize the importance of the pupils' individual and collaborative work in constructing their own learning about MPS. This takes on especial relevance when one recalls that pupils consider MPS to be a mechanical and rote activity, so that they have few resources to represent and analyze problems, and do not think of looking for different

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State of the literature

- Despite the importance of mathematics to solve problems of everyday life, various studies reflect a high rate of failures in the area mathematics, which is worrying for parents, teachers and researchers.
- Numerous investigations indicate that students solve mathematical problems through mechanical and memorísticos procedures, and lack of resources and heuristics in the MPS.
- Also, current literature noted that students present negative attitudes, emotions and beliefs towards mathematics, influencing the lack of confidence and self-efficacy to the MPS, which leads to suffering from anxiety even before the task. All this influences performance.

Contribution of this paper to the literature

- This study goes one step further, showing an intervention program that integrates the emotional control with a MPS model so that pre-service teachers learn to solve mathematical problems and to become aware of their emotions, self-regulating their learning process.
- It demonstrates how, an intervention in this regard, manages to reduce anxiety and negative affectives factors in MPS.
- This study highlights the importance of including the emotional literacy among the factors to develop in the pre-service teacher training.

strategies or methods to solve a problem, nor even make use of the suggestions they are given to help them in the task (Garofalo, 1989; Córcoles and Valls, 2006; Gil, Blanco & Guerrero, 2006b; Báez, 2007; Harskamp & Suhre, 2007; Santos, 2008).

Problem solving and the affective domain

Charles and Lester (1982) and McLeod (1992) highlighted the influence of the affective domain in PS. They showed that the cognitive processes involved in PS are susceptible to three aspects of affection: emotions, beliefs, and attitudes (McLeod, 1992). Báez (2007), in a synthesis of the findings of various research (Schoenfeld, 1992; Mtetwa & Garofalo, 1989; Stodolsky, Salk & Glaessner, 1991), gives an extended list of pupil's beliefs about MPS, including:

- ✓ *Mathematics problems have only one correct answer.*
- ✓ *There is only one right way to solve any mathematics problem.*
- ✓ *Mathematics is a solitary activity which pupils usually do not understand – they just memorize it and apply it mechanically.*
- ✓ *Somebody who understands mathematics very well is able to solve a problem in five minutes or less.*
- ✓ *The mathematics learnt in school has little application to the real world.*

When pupils are solving problems, they often experience feelings and emotions which cause tension in their search for a plan to find a solution. This may result in interest or, on the contrary, in a blockage due to the weight of negative emotions triggering anxiety and or abandonment.

Indeed, some of the emotional states experienced by pupils during the PS process are regarded as undesirable (Thompson & Thompson, 1989). Pupils make negative comments in relation to mathematics prior to problem solving, and this is interpreted as a sign of distress and of their negative attitude towards mathematics (Marshall, 1989). For Richardson and Woolfolk (1980), a pupil's anxiety in the context of mathematics consists of feelings of tension, helplessness, and mental disorganization when faced with solving mathematical tasks.

There have been several recent works exploring this problem which have revealed how pupils' self-efficacy influences their performance (Báez, 2007; Harskamp & Suhre, 2007; Hoffman & Spatariu, 2008). Hernández, Palarea and Socas (2001) and Caballero (2008) note the lack of confidence of prospective primary teachers (PPTs) in solving mathematics problems, with most of them not considering themselves capable or skilled in this area, experiencing uncertainty, nervousness, and even despair, and ending in a block when faced with these tasks.

Intervention program for learning problem solving

In recent decades there has been a change of perspective in education, from behavioural and cognitive models to a more comprehensive and inclusive view of the general process of teaching and learning (T/L) (Sarabia, 2006). The aim is to address the pupils' cognitive and affective functioning within a particular social, cultural, and academic context, considering the internal processes of cognition, emotion, and affect as products of the pupils' interaction with their environment.

In this integrative model, knowledge is possible because of the meaning learners assign to it and the interpretation they make of content and context. Knowledge and learning are therefore the result of constructive mental activity through which the learners perceive, evaluate, and interpret the facts, reality, object, or situation they are confronted with. Learners are seen as key active agents in managing their own knowledge, generating new knowledge on the foundation of their own prior knowledge. There has thus been increasing

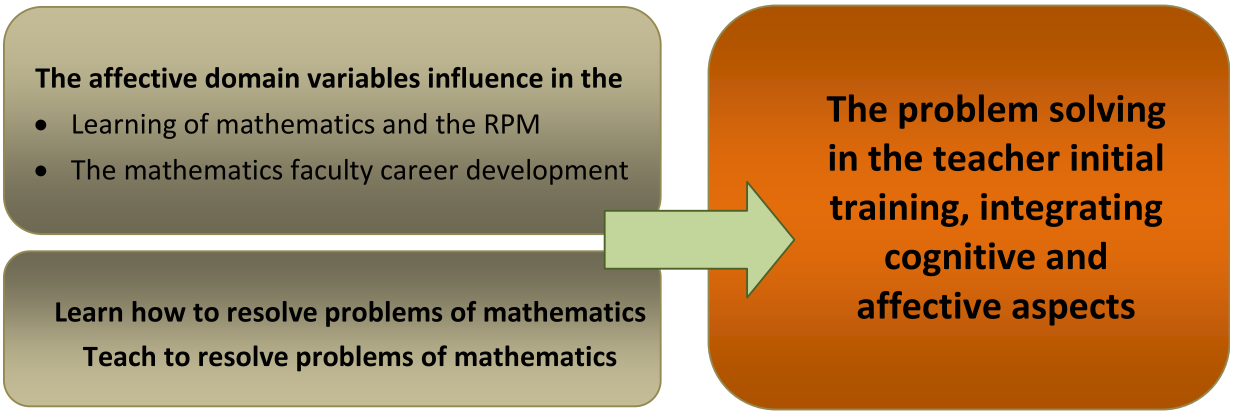

Figure 1. The Problem Solving in the initial training.

interest in learning strategies involving the deliberate use of the learner's pre-existing knowledge, which is important in educational practice.

The basis of learning is not the amount of content learnt, but the degree of autonomy and the level of meaningfulness with which pupils learn. This meaningfulness is related to personal, motivational, and emotional-affective variables, and to the interactive processes which take place in the act of learning.

Work on MPS learning in prospective teachers (Ponte, 1992; Puig, 1996; Blanco & Otano, 1999; Blanco, 2004; Chapman, 2000) has allowed one to better understand their knowledge, concepts, and beliefs. One of the most significant results concerns the blocking role of pre-existing concepts with respect to the new realities and to certain types of problem, thereby limiting the possibilities of action and comprehension (Ponte, 1992). In learning something, the learner makes use of previously acquired concepts, attitudes, ideas, and skills which underlie learning behaviour, and uses them to construct a learning strategy.

This has to include a process of action-reflection on the part of the learners in order for them to generate knowledge about the activities they are carrying out. In this process, learning involves an interaction between previous experience and the new knowledge and situations, and the result depends on the nature of this interaction. The key to understanding the process of construction of meaning in the classroom lies in establishing exchanges between teacher and pupils about the learning content. Such exchanges update and modify both their prior knowledge and their attitudes, expectations, and motivations about learning.

The evidence and arguments discussed above have highlighted the need to design and implement intervention programs on MPS which take into account this new integrative perspective on problem solving and emotional self-regulation (Guerrero et al., 2009). We consider it important to attempt a certain leap in quality, and offer specific actions and resources that can be implemented in initial teacher education as part of metacognitive programs that integrate cognitive and affective aspects (Amato, 2004; Zembylas, 2007; Furinghetti & Morselli, 2009).

From the 1990s to the present, the scientific literature has seen a proliferation of studies and experiments on the implementation and effectiveness of programs of intervention on emotional skills, emotional education, and emotional intelligence (Ortega & Cubillo, 2000; Graczyk et al., 2000; Mason & Scrivani, 2004; Irarte, Alonso & Sobrino, 2006). However, these works have mainly focused on primary an secondary levels of education.

Accepting these ideas, our research group began work on a specific project to design, test, and evaluate an intervention program aimed at assisting PPTs to "learn to solve problems and manage emotions". In our proposal (Blanco, Guerrero, Caballero, Brígido & Mellado, 2010; Guerrero et al., 2009), we integrate learning about MPS with emotional education. This integration we view as a continuing and permanent educational process targeted at strengthening emotional development as an essential complement to cognitive development.

THE RESEARCH PLAN

We assume that PPTs have cognitive and affective difficulties in MPS. Consequently, our project stems from the need to provide them with professional tools (an integrated model) and personal skills (emotional, cognitive, social, and behavioural) that will enable them to function in a way that is resolute, comprehensive, and healthy.

General and specific objectives

In this research we conducted 15 sessions with PPTs with the following two **general objectives**:

✓ *To evaluate the cognitive and affective dimension in MPS in initial primary teacher education.*

- ✓ *To design, develop, and evaluate a psychopedagogical program of intervention in which cognitive aspects of PS and emotional education are integrated into a single model, with the aim of fostering the performance of PPTs in learning both to solve mathematics problems themselves and to manage a PS class.*

As **specific objectives**, we propose:

- ✓ *To identify, describe, and analyze the cognitive and affective dimensions that influence MPS in initial primary teacher education.*
- ✓ *To analyze the expectations of control (expectations of success, locus of control, helplessness, and self-efficacy) in the study's participants.*
- ✓ *To design, test, and evaluate intervention programs on mathematics problem solving and emotional control with prospective primary teachers in the Education Faculty and during their teaching practice in primary schools.*

Data acquisition and analysis

Methodological pluralism is often appropriate as long as it is subject to the conditions of the problem, the objective of the research, and the nature of the data. In our case, the nature of the research problem and the data to analyze required us to use a combination of quantitative and qualitative methods.

The study design was validated by using different information gathering instruments in order to relate, compare, and contrast different types of data with each other. *These instruments were:*

Questionnaires, both open and closed. Depending on their structure, the teacher questionnaires were analyzed qualitatively or quantitatively. Different existing questionnaires were adapted to collect various types of information.

These questionnaires included, among others:

Adaptation of the BEEGC-20 Questionnaire (Battery of Scales of Generalized Expectations of Control) of Palenzuela, Prieto, Barrios and Almeida (1997). The purpose was to determine the students' causal attributions in relation to MPS. Four types of expectations were measured: of success, of internal and external control, of helplessness, and of self-efficacy. Administered at the beginning of the sessions. In the adaptation made for PS, we used 20 items, scoring them from 1 ("you totally disagree with the statement in question") to 9 ("you totally agree"). The value of the reliability coefficient obtained for this questionnaire was $\alpha = 0.815$, so that its internal consistency can be said to be fairly good.

Adaptation of the STAI (state-trait anxiety inventory, self-assessment questionnaire) of Spielberger, Gorsuch, and Lushene (1988). Its purpose was to determine the level of anxiety that MPS provokes in the participants. Administered at three different times (2008-11-11, 2008-12-16, 2009-04-21) to measure transient states and the evolution of anxiety both during the course and at four months after its completion.

Adaptation to MPS of the questionnaires of Gil, Blanco & Guerrero (2006a, b), Sarabia (2006), Báez (2007), and Caballero (2008) on the affective domain and mathematics. The purpose was to assess the students' beliefs, attitudes, and emotions concerning mathematics and MPS. Administered at the beginning of the sessions.

The Moodle Virtual Platform allowed us to interact with the students and store information for later analysis. We were thus able to evaluate their participation, to check whether certain learning objectives had been attained, and to provide feedback between students and teacher, as well as the platform being a motivating element in itself (Rodríguez, 2005). This instrument was used as the support for the development of diaries and forums. How this platform was used in the research is described in Caballero, Blanco, Guerrero and Brígido (2009) and Caballero, Blanco, and Guerrero (2010).

We used "focus groups" (Watts and Ebbut, 1987; Lederman, 1990; Gil, 1992-93) at certain times for the evaluation of the pilot trial, and at different stages of the final program.

Materials produced by the students. During the sessions we collected various outputs of the students from specific tasks or from evaluation activities.

In the data analysis phase, we used the computer program SPSS 15.00 for the quantitative analyses, and followed the recommendations and suggestions set out in various works such as those of Miles and Huberman (1984), Goezt and Lecompte (1984), and Wittrock (1986) for the qualitative analyses.

During the 2007/08 academic year, we implemented a pilot program which served to evaluate the characteristics of the population with respect to the affective domain and mathematics T/L (Caballero 2008; Caballero, Guerrero & Blanco, 2008), and to adjust both the program itself (Blanco et al., 2010; Guerrero et al., 2009) and the data acquisition instruments and analytical procedures.

Some Results

In this section, we shall describe some of the research results regarding the study population and the MPS program, presenting them under the headings of the two general objectives defined above.

The study population

The analysis of the questionnaires on conceptions showed the PPTs to still express a very traditional conception of MPS. Thus, they formulate problems with a closed form of wording that explicitly or implicitly indicates the procedure to follow to get the solution. The basic referents are arithmetic operations and, to a lesser extent, the calculation of areas. It is interesting to note that the contexts they describe are those that have been traditional in mathematics problems in textbooks since the nineteenth century. Thus, in both years of the study we found references to problems of taps, of the number of heads and legs of farm animals, of trains and distances, and of the comparison of ages. And no representation at all of any specific situation corresponding to their immediate environment.

Table 1. Results for item 2 (capacity) of the BEEGC-20 adapted to Mathematics Problem Solving

N	M	SD	Minimum	Maximum
51	3,35	2,057	1	8

Table 2. Results for item 14 (security) of the BEEGC-20 adapted to Mathematics Problem Solving

N	M	SD	Minimum	Maximum
51	3,43	2,685	1	9

Table 3. Results for item 3 (perseverance) of the BEEGC-20 adapted to Mathematics Problem Solving

N	M	SD	Minimum	Maximum
51	1,80	1,400	1	7

Table 4. Results for item 9 (luck) of the BEEGC-20 adapted to Mathematics Problem Solving

N	M	SD	Minimum	Maximum
51	1,78	1,101	1	5

Table 5. Inferential analysis of the results of the Mathematics Problem Solving adaptation of BEEGC-20 by gender

Test for independent samples: *t*-test for equality of means assuming homoskedasticity							
	t	d.f.	Significance (two-tailed)	Difference of the means	Std. Err. of the difference	95% confidence interval of the difference	
						Upper	Lower
Contingency	1.581	48	0.120	3.696	2.338	-1.005	8.398
Helplessness	0.675	48	0.503	1.130	1.674	-2.235	4.495
Luck	-0.753	49	0.455	-1.548	2.054	-5.676	2.580
Self-efficacy	1.016	48	0.315	2.734	2.691	-2.677	8.146
Expectation of success	1.906	49	0.063	5.905	3.098	-0.321	12.130

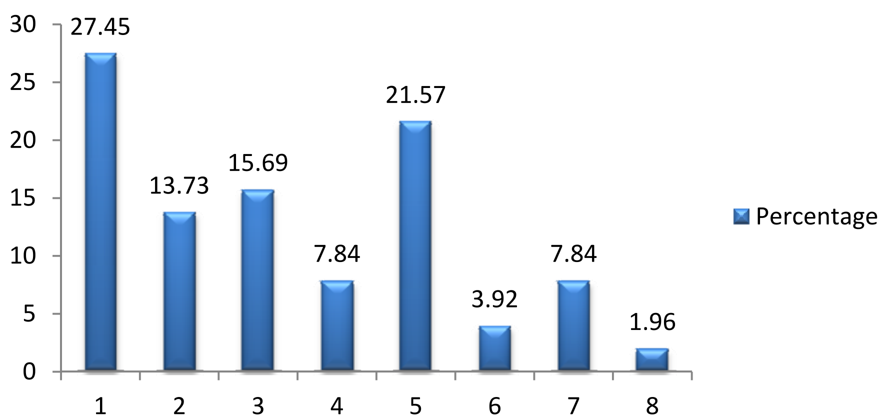

Figure 2. Results for item 2 (capacity) of the BEEGC-20 adapted to Mathematics Problem Solving

This situation led us to ask them whether they had considered the existence of other types of mathematics problem, and, if so, to set out two examples. The analysis of this question revealed their unawareness of other mathematics activities different from those they had proposed or from purely algorithmic exercises. Indeed, 14 of the 58 participants answered directly that no such alternatives exist. Of these, we would highlight two of their statements:

"I think not, because throughout my school life I've always done the same types of problems."

"The truth is that I have no idea. The mathematics problems that I know are those that everybody always does."

Of the PPTs who believe that there do exist alternatives, 20 again insisted on examples with similar situations but now related to other mathematics content such as equations, probability, or derivatives which had not specifically appeared previously. Another 11 indicated that there must be some but that they were unable to give examples: "*Clearly they must exist, but I am unable to find any examples*". Another 8 refer to logic or sudoku (number-square) problems, while 3 indicate that: "*After what we saw today they must exist, but right now I can't think of any*".

In the list of instruments used, we mentioned the adaptation to MPS of the questionnaire of Palenzuela, Prieto, Barros and Almeida (1997) on generalized expectations of control. We shall present some results of the descriptive study of certain items and of the comparisons by gender.

The great majority of PPTs doubt their ability as problem solvers *("2. Very seldom have I doubted my abilities when faced with solving a maths problem"; "10. I feel confident of my abilities to solve normal mathematics problems correctly"; "18. I see myself as having sufficient ability to tackle normal mathematics problems").* As is shown in Figure 2 and Table 1, only 13.72% indicate that they have confidence in their own capacities for tasks of this type (item 2), while 39.22% lack confidence in themselves as problem solvers (item 18).

Item 14 (*"14. I rarely get thoughts of insecurity when I am solving normal maths problems"*) showed that the PPTs generally feel insecure when faced with mathematics problems. Thus, 70.58% state that they have feelings of

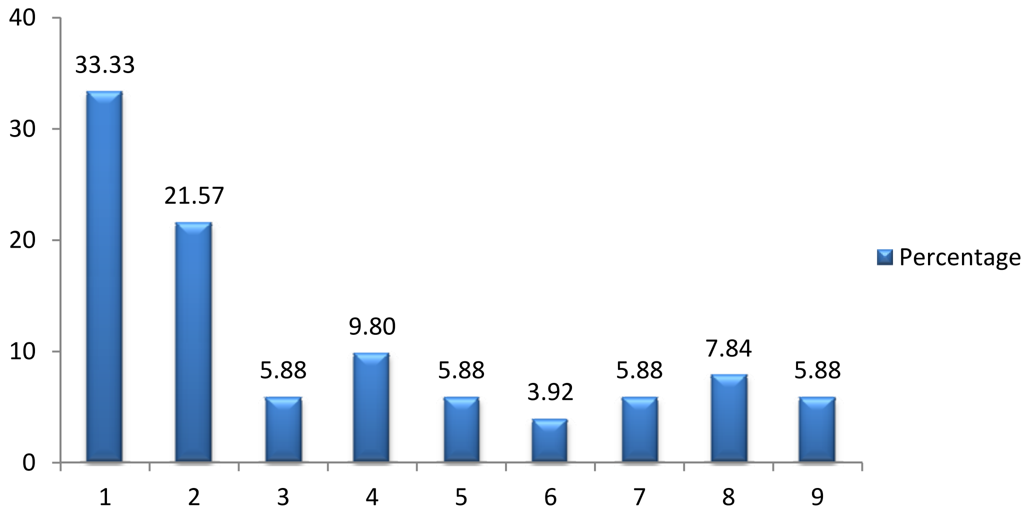

Figure 3. Results for item 14 (security) of the BEEGC-20 adapted to Mathematics Problem Solving

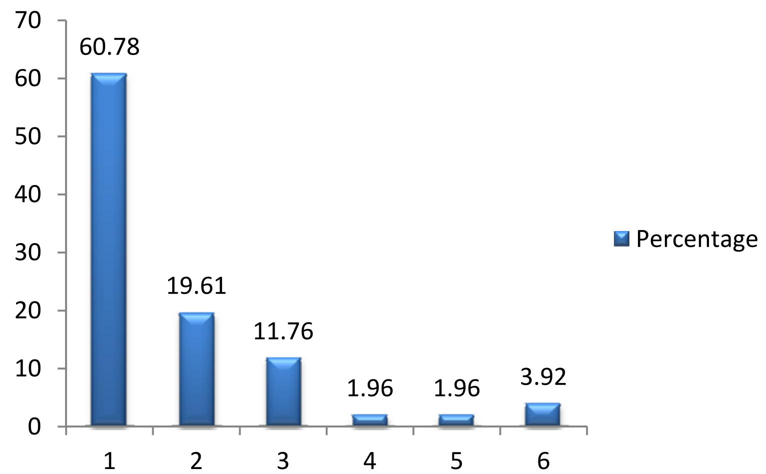

Figure 4. Results for item 3 (perseverance) of the BEEGC-20 adapted to Mathematics Problem Solving

insecurity when solving mathematics problems, as you can see in the Figure 3 and Table 2.

Considering the results for 'capacity' and 'security' together, one concludes that the PPTs have low self-efficacy expectations.

The PPTs consider to a greater or lesser extent that success or failure in MPS is a consequence of their actions (*"6. How I get on with solving mathematics problems will depend on how I act"; "11. In general, whether or not I solve a mathematics problem will depend on my actions"*). For both these items, slightly more than 50% are in agreement, and only a quarter disagree.

In contrast, the students do not consider that the result in PS derives from other sources such as luck (*"5. Mathematics problem solving has a lot to do with luck"; "9. Without a lot of luck, there's not much you can do in mathematics problem solving")* or the teachers (*"12. Let's not fool ourselves! Mathematics problem solving depends on which teacher you get"*). Similarly, they note the importance of perseverance (*"3. It is absolutely not worth making any great effort to solve a maths problem: they are difficult and not clearly posed"*) for finishing the task successfully (Figures 4 and 5 and their Tables 3 and 4, respectively).

These results show that the PPTs are characterized by having an internal locus of control, even though it is not very high, meaning that they consider the results they obtain will depend on their actions (perseverance, effort, dedication, ...).

One observes in Figure 6 that men have higher expectations of contingency, success, and self-efficacy. However, their expectation of helplessness is also slightly higher than that of women. There was no apparent significant difference between genders in their expectation or belief in luck.

To determine whether these differences between men and women were statistically significant, we performed the following analyses, all at a 95% confidence level, and therefore with a margin of error of 5%.

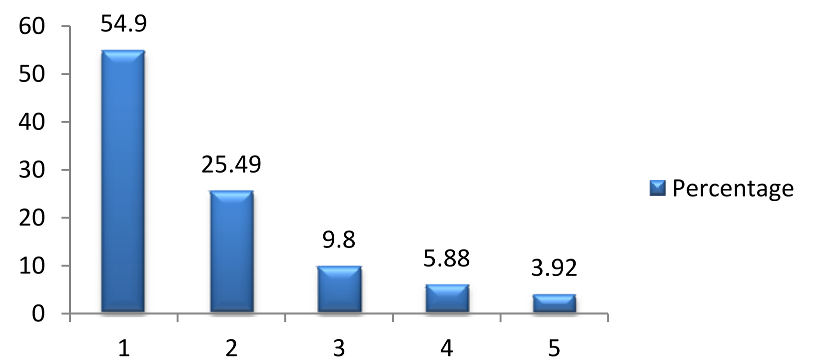

Figure 5. Results for item 9 (luck) of the BEEGC-20 adapted to Mathematics Problem Solving

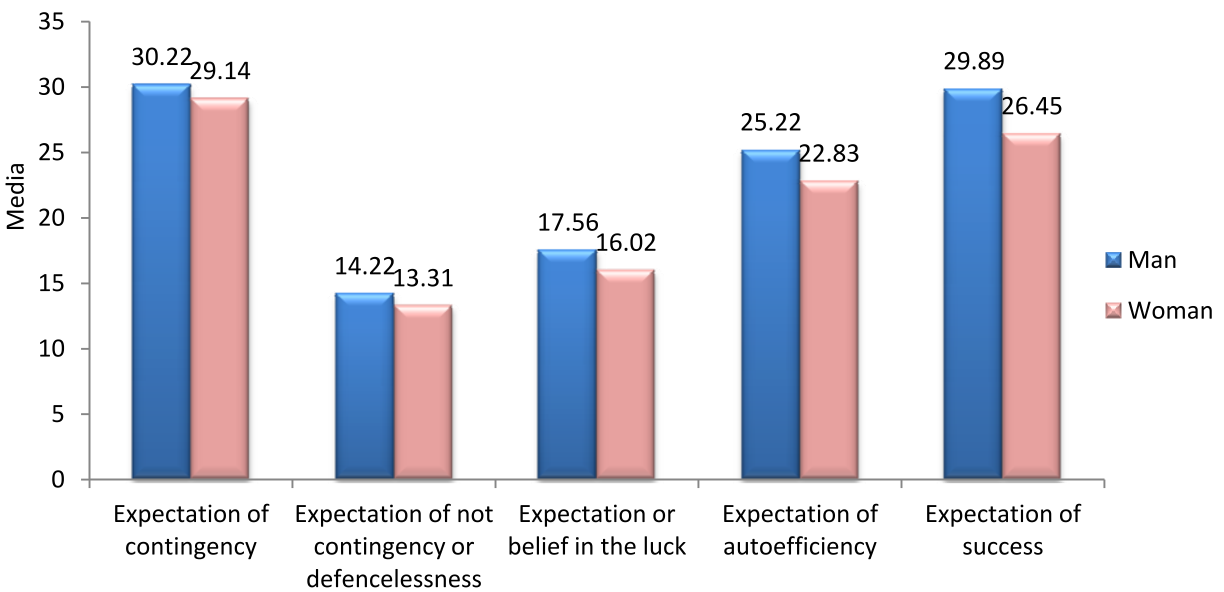

Figure 6. Results distinguished by gender for the BEEGC-20 adapted to Mathematics Problem Solving

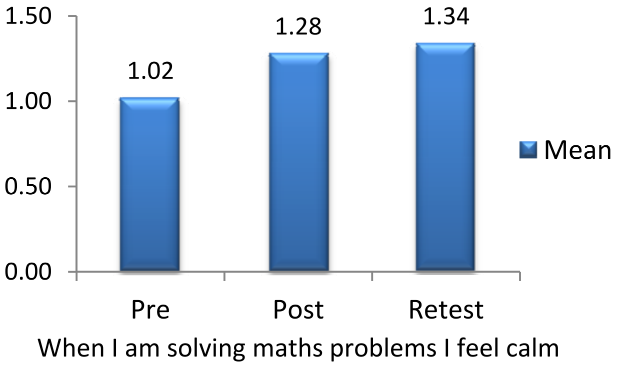

Figure 7. Results for item 1 (calm) of the STAI adapted to Mathematics Problem Solving

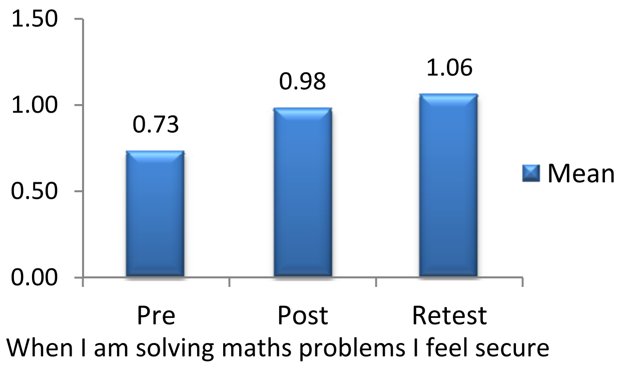

Figure 8. Results for item 2 (security) of the STAI adapted to Mathematics Problem Solving

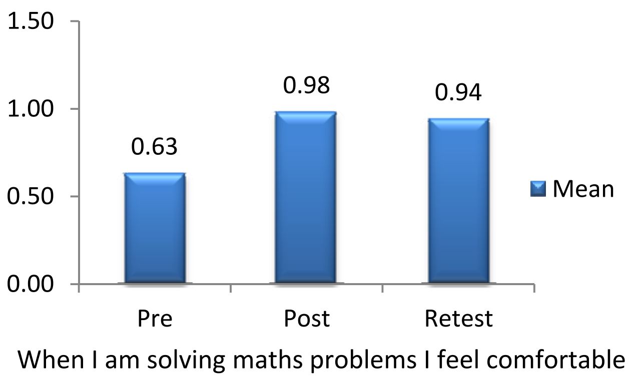

Figure 9. Results for item 10 (comfort) of the STAI adapted to Mathematics Problem Solving

First, we carried out the appropriate statistical tests to check for normality, randomness, and homoskedasticity, followed by the Kolmogorov-Smirnov, runs, and Levene tests for the group of men and the group of women using the different MPS-adapted BEEGC-20 scales. All the tests gave $p>0.05$, allowing us to proceed with a parametric Student's t-test for independent samples on each of the scales of the battery to determine whether there were significant differences in relation to gender. The results were the following (see Table 5):

The findings from the inferential analysis show that the apparently large differences between men and women in their expectation of success, contingency, and self-efficacy appreciated at the descriptive level were not significant ($p>0.05$) for any of the scales and subscales of the BEEGC-20 adapted to mathematics problem solving.

The Mathematics Problem Solving program

In the following, we shall consider the results of the self-assessment state/trait anxiety inventory (STAI) and the diaries and open forums on the Moodle platform.

There was confirmation of some of the previous results concerning the PPTs' lack of feelings of confidence and security when addressing MPS.

We shall present five graphs illustrating the comparison of items of the STAI items at the different stages (pre-test, post-test, and re-test).

Figures 7, 8, 9 and 10 show that there was a positive evolution in the period covered by the program. Although for items 10 and 12, as for some others, there was a slight regression in the re-test four months after completion of the program, the data still reflect an improvement over those obtained in the pre-test.

As shown in Figure 11, at the beginning of the emotional control and MPS intervention program, the mean indices for both men and women were above the inventory's reference level, with women presenting greater anxiety than men (34.52 vs 32.31, respectively).

At the end of the program (post-test), both showed a decrease in anxiety concerning MPS. However, while the mean index for the men was now below the reference level (17.56 vs 20.54), the value for the women was still above their reference level (28.95 vs 23.30).

Four months after completion of the intervention program (re-test), both men and women showed an increase in anxiety concerning MPS, although for the women this increase was very small. For both men and women, the mean was above the inventory's respective reference levels, with the women's mean index being 29.26 and the men's 25.22. The anxiety index was thus higher for the women than for the men at all three testing times.

Although these re-test means obtained four months after the completion of the intervention program were greater than those of the post-test, they were nevertheless lower than at the beginning of the program. I.e., there still existed a major advance in control of anxiety some months after the sessions had terminated. In particular, the mean index improved for the men from 32.31 initially to a final 25.22, and for the women from 34.52 to a final 29.26.

The forum that the participating PPTs used during their practice teaching provided us with important data on their reflections and concerns when faced with their first work in the primary classroom. We tried to get them to express their difficulties, questions, concerns, anecdotes, things they found interesting, etc., in relation to MPS.

Thus, many of their contributions concerned the stages in MPS followed in the program. We interpret these data as an attempt to present the activity of problem solving in a systematic and orderly manner. *"In the maths classes, I noticed that everything corresponds to a great order, all the pupils must follow certain steps when they are solving problems ... they [the classes] attach great importance to reading the problems carefully, and they even have to give similar examples applied to their [the pupils'] life"* (7 DP 1)[1]. Another student makes this same observation when she observes a similar situation in her class. *"At this point, I see it as very useful that the teacher should follow the steps"* (4 BG 1).

This valuation of the steps to follow also appears repeatedly in the diaries of the evaluation session (Session 13). Thus, they value these steps from a personal perspective (*"Going through the sequence of steps helps me to concentrate, and to analyze the problem and understand it better"* – 18 MV 2) and from a PPT perspective (*"We have looked at aspects that subsequently we will transmit to our future pupils and at methodology that we will use for this, such as the steps developed for problem solving and the methods of relaxation"* – 18 MV 3).

At the same time, they begin to evaluate some specific difficulties that arise from the pupils' performance in the class: *"I think the error appears in the comprehension of a written problem"* (9 BG 3), and *"They tackle problems as something mechanical"* (30 VG 2).

Also, they try to put into practice some of the heuristics that have been suggested to them. They value these positively as a method with which to overcome their difficulties: *"When pupils ask me about a problem that they don't understand, I try to get them to read the problem carefully and, as they do so, to specify all the data that they are given with drawings or by noting them down ..."* (10 GO 1). But there also appear important aspects about how to work on the statement of the problem, and how to look out for key words that may help the pupils 'guess' which operation will solve the problem. *"They found it hard to identify words in the text as indications of which operation they should use, but finally they managed to understand what the problem was telling them, hence the importance of reading for comprehension"* (13, FS, 2).

The PPTs appreciated the emotional control strategies as positive, and tried to use them. *"Ah! Also when they are nervous and restless, and no one would be able to stand them, I usually set them breathing exercises, and they are delighted"* (6 ML 2). This reflection is important because it may indicate a shift in this PPT's teaching behaviour with respect to the control of her group of pupils.

Aspects of emotional education were also among the most valued in the diaries of the evaluation session.

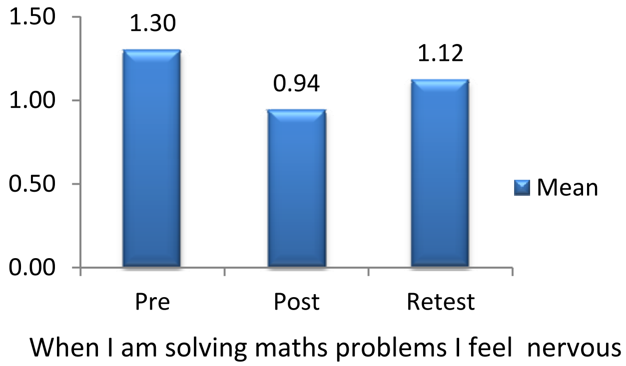

Figure 10. Results for item 12 (nervousness) of the STAI adapted to Mathematics Problem Solving

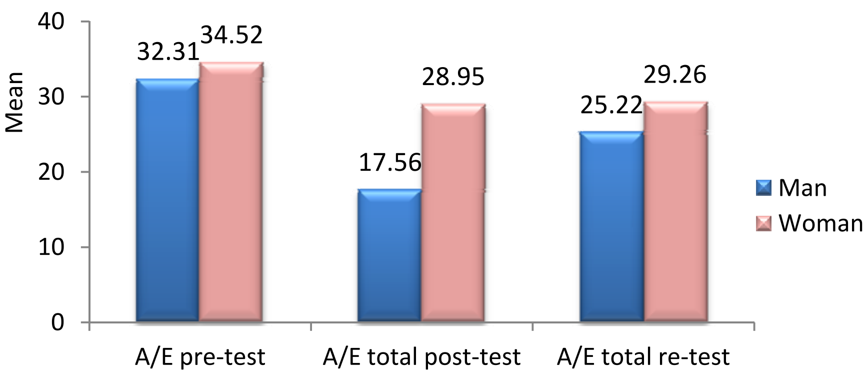

Figure 11. Results distinguished by gender for the STAI adapted to Mathematics Problem Solving

The contributions highlighted the need for more time to be able to really learn to solve problems. Thus: *"The program has changed our attitude towards MPS, since the content we need to solve these problems we have acquired throughout our lives, and it is impossible to change it in just 13 sessions"* (10 FS 1). However, this same student noted that: *"I think it has been very useful in my case, it helped me to be more orderly in presenting problems"* (10 FS 2).

Another point that seems important to note is how they integrate the cognitive and affective aspects of PS, thinking of their future performance as teachers. *"[I have] to say that this program is also useful in giving classes for us to take into account not only the pupils' skills, but also their attitudes and emotions which I know from experience have a strong influence both positively and negatively"* (7 DP 4).

CONCLUSIONS

The results confirm that affective factors have a major influence on PPTs in their mathematics teaching and learning and PS. This influence was clearly noticeable in their learning of both how to solve problems and how to manage a primary education class of mathematics problems.

Similarly, it was found that the intervention program led to the PPTs becoming aware of the importance of emotions in the teaching and learning process, and of the need to integrate them, together with the MPS model, into the dynamics of the classroom. In addition, it reduced their anxiety and other negative affective factors in MPS. This is not only helpful for them in problem solving itself, but for their management of a mathematics class, since the teacher's own emotional factors strongly influence the pupils and their performance. Similarly, following the program, one observed motivation towards methodological change, away from traditional approaches and towards pupil-centred learning.

Therefore, the evaluation of the intervention program indicates the desirability of incorporating aspects of affect, cognition, and emotional control into the processes of initial teacher education.

In addition, for future works, studying pre-service teachers´ mathematics teaching anxiety would be interesting, as it has analyzed by Peker (2009) with pre-service elementary teachers in Turkey.

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Footnotes

[1]The code is: A first number indicating the order of intervention in the forum; the initials of the two family names; the number of its unit of analysis.

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