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The Affective Dimension Implied in Mathematical Problem Solving by Future Primary Education Teachers

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Abstract

Mathematical Problem Solving (MPS) is one of the fundamental competencies to be developed by pre-service primary education teachers. As such, some researchers have shown that the emotions perceived towards MPS can condition the methodologies used by graduates in primary teaching and, therefore, learning of their future students. Therefore, we must understand the affective dimension involved in MPS by preservice teachers. To this end, this work presents a descriptive quantitative analysis based on a validated questionnaire, which was administered in the third year of the Degree in Primary Education of a Spanish public university. The instrument consists of 21 items that must be assessed on a scale of 1 (strongly disagree) to 4 (strongly agree); these statements are encompassed in four domains: nature of mathematical problems, perceived self-efficacy in MPS, attitudes and emotional reactions towards MPS and evaluation of previous training received in the Degree in Primary Education. A statistical analysis was performed, combined with hypothesis testing, to know the influence of variables such as gender or previous background of the participants. Our results show positive attitudes towards MPS (e.g., perseverance or patience), ambivalent emotions (e.g., satisfaction and curiosity, but also fear and nervousness), medium self-efficacy and a mechanical and algorithmic vision of MPS. These results should support the proposals implemented around MPS in the initial training of teachers.

Keywords: Mathematical Problem Solving; Emotions; Attitudes; Preservice Teacher Training; Primary Education.

1. Introduction

Since the end of the last century, educational research has highlighted the influence of the affective domain (beliefs, attitudes, emotions, etc.) on the personal and social construction of knowledge [1]. In addition, it has shown that anticipated emotions (either stimulating or depressing) regarding learning activities and proposals can condition achievement [2]. Therefore, science and mathematics education should not ignore this two-way interaction between emotion and cognition [3].

Moreover, teaching methodologies act as variable mediators in the relationship between emotion and cognition. Among them, problem-based learning has demonstrated multiple educational benefits in promoting scientific and mathematical competencies, together with a better conceptual understanding [4,5]. However, transferring this methodology to classrooms can be challenging. In the particular case of pre-service Primary Education teachers, research on the subject has revealed fundamentally negative emotions of these individuals towards Mathematical Problem Solving (MPS) [6]. Among them, nervousness, anxiety or frustration predominate [7], which could inhibit them from applying this approach in the classroom.

Therefore, this work proposes an analysis of the affective domain of future Primary Education teachers towards MPS before starting a subject, "Mathematics and its Didactics III", which puts the focus on these issues. In this way, this study will serve as a starting point for the design and implementation of an effective training proposal around MPS in the Degree in Primary Education.

2. Method

The research follows a descriptive and inferential statistical approach.

2.1. Objectives

Three main objectives are set on the affective dimension of pre-service Primary Education teachers regarding MPS:

1. Characterize their epistemological and educational beliefs, attitudes, emotions, self-efficacy and satisfaction with the training previously received in the Degree.
2. Analyze differences, depending on gender, in perception about MPS.
3. Analyze differences, depending on previous training, in perception about MPS.

2.2. Sample

The sample consists of 62 participants with an average age of 23.1 who take the subject "Mathematics and its Didactics III", which is framed in the 3rd year of the Degree in Primary Education of a Spanish public university. There are 27 women (43.5%) and 35 men (56.5%); 40 (64.5%) have accessed the Degree directly from the Baccalaureate –post-compulsory secondary education– and 22 (35.5%) have done so through other paths, such as Vocational Education and Training. Among the first, 11 individuals completed a Baccalaureate on Science, while 29 opted for a non-scientific one (Humanities or Social Sciences).

2.3. Instrument

This study relies on a validated questionnaire [7] consisting of 21 items that must be assessed on a Likert scale from 1 (strongly disagree) to 4 (strongly agree). The statements fall into four dimensions with regard to MPS: epistemology (A), self-efficacy (B), attitudes and emotions (C), and evaluation of previous university training (D). These items can be found in Tables 1-2.

2.4. Data analysis

A descriptive statistical analysis through frequencies, means and standard deviations is carried out. In addition, Mann-Whitney's *U* non-parametric test for independent samples is used in order to answer objectives two and three. The null hypothesis (H0) is set as: “perception towards MPS is not conditioned by the gender / prior training variable”. A confidence interval of 95% ($p<.05$) is selected to rebut it.

Regarding the third objective, in this study we only compare the individuals who completed a Baccalaureate on Science (n=11) with those who did it about Humanities or Social Sciences (n=29).

3. Results

3.1. Objective 1

Tables 1 and 2 show the percentages of agreement (answers 3-4) and disagreement (1-2) with the questionnaire items, as well as the average values and standard deviations. The least dispersion corresponds to the perception of applicability of mathematical strategies (item 4), procedures that demand perseverance (items 19 and 20) and are favoured by group interaction (item 15). However, future Primary Education teachers conceive MPS as a mechanical and repetitive process (item 3), which leaves no room for luck (item 11).

On the other hand, the greatest dispersion occurs in questions related to self-efficacy (e.g., item 8) and those related to emotions such as calm (item 9) or frustration (item 17).

Table 1. Statistical results regarding dimensions A and B about Mathematical Problem Solving (MPS)

A. Beliefs about the nature of mathematical problems and their teaching	**Ag %**	**Di %**	**Mean**	**SD**
1. Almost all math problems can be solved in a few minutes if you know the formula, rule or procedure that the teacher has explained or that appears in the textbook.	74.2	25.8	2.87	0.61
2. When solving a math problem, the final result is more important than the procedure previously followed.	17.7	82.3	1.95	0.77
3. Knowing how to solve the problems posed by the teacher in class, it is easy to solve others of the same type where some changes have been applied regarding data.	93.5	6.5	3.32	0.59

A. Beliefs about the nature of mathematical problems and their teaching	**Ag %**	**Di %**	**Mean**	**SD**
4. The skills or strategies used in math classes regarding problem-solving have nothing to do with those used to solve problems in everyday life.	14.5	85.5	2.03	0.57
5. I try different ways and methods to solve a problem.	82.3	17.7	2.98	0.63
B. Beliefs about oneself as a solver of math problems				
6. When more study time is spent on maths, better results are obtained in problem solving.	85.5	14.5	3.24	0.69
7. When I solve a problem I usually doubt whether the result is correct.	79.0	21.0	3.00	0.74
8. I have confidence in myself when I face math problems.	48.4	51.6	2.34	0.80
9. I am calmed and relaxed when I solve math problems.	48.4	51.6	2.39	0.75
10. When I work hard to solve problems I usually find the right result.	77.4	22.6	2.92	0.60
11. Luck influences successful resolution of math problems.	8.1	91.9	1.85	0.53

Table 2. Statistical results regarding dimensions C and D about Mathematical Problem Solving (MPS)

C. Attitudes and emotional reactions towards mathematical problem solving	**Ag %**	**Di %**	**Mean**	**SD**
12. When I face a difficult problem, I usually give up easily.	38.7	61.3	2.26	0.72
13. When I face a problem I experience a lot of curiosity about knowing the solution.	72.6	27.4	2.85	0.71
14. I feel anguish and afraid when the teacher asks me "by surprise" to solve a problem.	66.1	33.9	2.69	0.64
15. When I solve problems in a group I have more confidence in myself.	88.7	11.3	3.13	0.58
16. When I get stuck or blocked in solving a problem, I start to feel insecure, desperate, nervous...	80.6	19.4	3.08	0.68
17. If I can't find a solution to a problem, I feel like I've failed and wasted my time.	56.5	43.5	2.63	0.70
18. It gives me great satisfaction to successfully solve a mathematical problem.	98.4	1.6	3.55	0.53
19. When my attempts to solve a problem fail, I try again.	85.5	14.5	3.05	0.58
20. Solving a problem requires effort, perseverance, and patience.	100.0	0.0	3.37	0.48
D. Evaluation of previous training received in the Degree in Primary Education regarding mathematical problem solving	**Ag %**	**Say %**	**Mean**	**Sd**
21. In the Degree in Primary Education, I have discovered other ways to address math problems.	56.5	43.5	2.53	0.67

3.2. Objective 2

The gender-disaggregated analysis reveals significant differences in four of the statements. Men feel more confidence (item 8, U = 308.5, p<.05) and less fear (item 14, U = 321.5, p<.05) towards MPS. In turn, women value to a greater extent perseverance (item 20, U = 349.0, p<.05) and study time (item 6, U = 342.0, p<.05) than their male peers.

3.2. Objective 3

The application of the Mann-Whitney test does not reveal significant differences depending on the previous training of the participants, a fact that may be affected by the size of the subsamples (n=11 for the Baccalaureate on Science and n=29 for the Baccalaureate on Humanities or Social Sciences).

Nevertheless, in those questions regarding emotions (items 8, 9, 16 and 17), future teachers with a scientific background refer to positive emotions towards MPS more frequently.

4. Conclusions

The analysis carried out has allowed us to obtain a good characterization of the perceptions of pre-service Primary Education teachers about MPS. As such, they show and support an algorithmic and repetitive vision of it (although different strategies may have room), a medium-low self-efficacy (which can improve with time and effort), ambivalent emotions towards these activities (e.g., satisfaction and curiosity, but also fear, nervousness or frustration) and mixed opinions about the training previously received in the Degree. In the case of attitudes (importance of perseverance and study time), these are more positive in women, while men feel more confident and less afraid of MPS.

These results should support the proposals implemented around MPS in the initial training of teachers, seeking to promote a more dynamic and flexible view of mathematical problems, together with the feeling of positive emotions and attitudes towards its learning.

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