



# Sources Instructional Effectiveness of Mathematics Teachers

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## Abstract

Tracing the didactic self-efficacy of mathematics teachers, the factors that affect it and the existing correlations between them are a key issue of the present work. The relationship between self-efficacy and teaching strategies, student involvement and class management was studied. The sources of didactic effectiveness were sought, which was according to the teachers themselves to shape their training needs. A quantitative survey of population characteristics has been carried out and the first conclusions are reflected in this paper. The sources of didactic effectiveness were carried out with the performance of the scale of Teachers' Efficacy Sources Inventory in a sample of  $N = 990$  teachers of mathematics, who work in public and private educational structures. In the present work, the aim of the work is mentioned in relation to the emergence of sources of didactic effectiveness that shapes the training needs of educational mathematics. The analysis of the initial data reveals that the personality traits of the teacher are a key source of effectiveness. Training programs show less correlation and this is an incentive for them to be shaped in order to enhance the effectiveness of teachers. It is very important that these views come from the practicing educational mathematicians themselves and should be studied in order to lead to a better organization and improvement of educational programs.

## Subject Areas

Education

## Keywords

Self-Efficacy, Mathematicians, Factor Analysis, Sources of Self-Efficacy

## 1. Introduction

Developments in society and in the field of education are rapid and multifac-

ceted. The teacher is always in the spotlight and is subject to constant scrutiny and challenge. At the same time, student learning is a complex phenomenon [1] [2] that interacts with the teacher, his quality of his teaching [3] [4], his emotional and physiological characteristics, his enthusiasm [5] and in general his self-perception [6].

The teacher is required to be excellently trained in his subject, to be under constant training and at the same time to have various skills, social and emotional [1]. High levels of self-efficacy lead to the use of innovative programs by teachers and the support of weak students [6].

The sources that seem to affect the self-efficacy of the individual were also sought. Personal experiences, social norms, social persuasion, emotional state of the individual [7] appear in the present work in the prism of the specialty of mathematics. Recent research data indicate that students' school failure is consistent with teacher inefficiency [8] [9] and high self-efficacy leads to high student performance [10] [11].

## 2. Theoretical Background

The self-efficacy of the teacher and especially of the mathematician is the object of study of the work. It is found in the scientific literature and in the term perceived self-efficacy (perceived self-efficacy) or as beliefs about self-efficacy (self-efficacy beliefs). It is considered as the perception that the individual has of his effectiveness and not necessarily his real image [6]. It does not refer to the objectivity of the individual's value, but to his personal beliefs about whether he has the required skills. Self-efficacy is defined as a set of perceptual crises that individuals have in their abilities to be able to plan and perform the actions they need to perform the specified types of actions [12].

Therefore, self-efficacy or the concept of self-efficacy is the subjective assessment, the personal beliefs of a person in terms of the skills he has to successfully perform the work he is engaged in. Self-sufficiency provides the tools to deal with specific situations, whether they are obstacles or opportunities in the execution of a project [12].

The self-efficacy beliefs that distinguish each individual are a process that changes, develops and modifies based on various sources of information, personal experiences and performance, learning provided by various social standards, social persuasion and physical and emotional status of each person.

Past performance achievements are a person's most basic and critical source of self-efficacy. Success in the outcome of specific actions leads to higher expectations of self-efficacy and increase the likelihood of adopting positive behavior despite any failures that coexist in the path of the individual [12] [13] [14].

The self-efficacy of the teacher is directly related to the student. It is related to the achievements of his students and to the teaching practices he applies [15]. It is also associated with excellent student management in unexpected situations [6]. When the teacher has high self-efficacy, students enjoy many benefits. The

more the teacher has acquired his/her self-efficacy, the more the students acquire their autonomy in terms of learning [16].

The low self-efficacy leads teachers to stagnation, abandoning their teaching methods and strategies taught in various trainings. They lead themselves to a voluntary resignation [6]. Teachers' emotions are also conveyed in the classroom as students' situations. The frustration and abandonment of the teachers lead to the abandonment of the effort on the part of the students as well. The encouragement and enthusiasm of the teacher, leads to greater behavioral and higher emotional participation of students.

### 3. Method

#### 3.1. Research Tools

The self-efficacy of educational mathematics is studied in relation to teaching strategies, student involvement and classroom management, through the performance of the Teaching Self-efficacy Scale TSES (Teachers' Sense of Efficacy Scale). The sources that affect the self-efficacy of mathematics teachers were also studied through the performance of the Scale of Teaching Self-efficacy Resources (Teacher Efficacy Sources Inventory). So here refer only sources of self-efficacy. Teachers were asked to grade on a scale Likert 5-point (1 no, 2 little, 3 moderate, 4 and 5 quite perfectly) the degree of influence on the effectiveness of the teaching that each of them attributed to each sentence [6]. On the scale there were 30 questions, which were studied, divided into subscales for better analysis of the results. Also, it is necessary to have a ratio of 5:1 [17] on the concentration of questionnaires. This condition is met in the present work.

#### 3.2. Participants and Sample

The research model of the review was used, collecting primary data from all over the country, through questionnaires. 990 questionnaires were collected, studied through a quantitative approach and their concentration enabled generalizations throughout the population [18] of educational mathematics. They are Mathematics educators in which 2.5% are private school educators and 97.5% are public school Secondary educators in Greece. 59% (586 participants) are men and 41% (404 participants) are women.

#### 3.3. Validity and Reliability of Teacher Efficacy Sources Inventory

Given the grouping of questions in sub-scales, they were analyzed for their internal relevance and reliability and the Cronbach's alpha index was calculated. Cronbach's alpha is considered reliable when the price range is greater than 0.70 [19]. In the present study the index of sources scale is 0.872, and the corresponding subscales of sources are between 0.744 and 0.893. Focusing on the scale of sources of teaching self-efficacy for mathematicians, questions were studied by dividing them into six categories which are distinguished in **Table 1**.

**Table 1.** Reliability statistics.

	Cronbach's Alpha	N of Items
<b>Teacher Efficacy Sources Inventore</b>	<b>0.872</b>	<b>30</b>
Personality Characteristics/Skills	0.828	10
Motivations	0.782	4
Social/Verbal Convince	0.744	6
Indirect Learning	0.781	4
Education	0.893	3
Physiological/Emotional Condition	0.872	3

### 3.4. Selected Results

First studied the demographic characteristics of the sample ( $n = 990$ ). According to EL.STAT (Hellenic Statistical Service) in 2015-2016 men were about 60% of mathematicians (7293 mathematicians with 4540 men). 44.83% of teachers have a master's degree. The same ratio of male and female mathematicians is presented in the work, giving it population characteristics. The same percentages presented at work. About 60% of the participants are men and 43% of the teachers have a master's degree. These elements increase the importance of research.

As to their age in 37.17% ( $n = 368$ ) is 51 to 60 years. The lesser percentage of all respondents are as under 30 ( $f = 4.14\%$ ,  $n = 41$ ). 78.38% ( $n = 776$ ) are permanent teachers. As regards training, the 77.58% ( $n = 768$ ) has been trained in the subject of their studies and only 0.91% ( $n = 9$ ) of teachers said they have not attended any training.

In **Table 2** are aggregated characteristics of the sample of mathematics education specialist.

Mathematical self-efficacy was also explored in terms of sources of self-efficacy, which will be specifically mentioned in the present study.

As shown in **Table 3**, major sources of efficiency are "love for students" ( $M = 4.53$ ,  $SD = 0.723$ ) and "direct communication with students" ( $M = 4.51$ ,  $SD = 0.650$ ). The following are also important sources: "the ability to control the classroom" ( $M = 4.47$ ,  $SD = 0.657$ ), "the desire to improve teaching" ( $M = 4.43$ ,  $SD = 0.706$ ), "Self-confidence" ( $M = 4.41$ ,  $SD = 0.624$ ). Also of great importance are their "ability to understand the needs of students" ( $M = 4.39$ ,  $SD = 0.675$ ), their "positive attitude and humor" ( $M = 4.33$ ,  $SD = 0.663$ ) and "the personal effort (study, concern for teaching issues)" ( $M = 4.32$ ,  $SD = 0.717$ ).

The "comparison of teaching with that of university professors" is chosen by teachers as sources of effectiveness with less involvement in increasing teachers' self-effectiveness ( $M = 2.54$ ,  $SD = 1.094$ ) and "the number of courses offered during training programs" ( $M = 2.98$ ,  $SD = 0.970$ ), related to personal experiences of the educators of teachers. This is followed by the "recovery of negative emotions during teaching" ( $M = 3.00$ ,  $SD = 1.116$ ) which belongs as a source of effectiveness in normal, emotional states.

**Table 2.** Sample's characteristics.

CHARACTERISTICS	FREQUENCY	%	CHARACTERISTICS	FREQUENCY	%
<b>GENDER</b>			<b>EMPLOYMENT STATUS</b>		
Male	586	59.19	Permanent	776	78.38
Female	404	40.81	Supply	177	17.88
			Hourly	37	3.74
<b>AGE</b>			<b>YEARS OF SERVICE</b>		
under 30	41	4.14	0 - 5	109	11.01
31 - 40	133	13.43	6 - 10	111	11.21
41 - 50	313	31.62	11 - 15	268	27.07
51 - 60	368	37.17	16 - 20	179	18.08
over 60	135	13.64	over 20	323	32.63
<b>STUDIES</b>			<b>TRAINING</b>		
Basic degree	534	53.94	Field of Studies	768	77.58
Master's	426	43.03	Education Topics	555	56.06
Doctorate	29	2.93	Organization and Management	194	19.60
Other degrees	52	5.25	Other trainings	27	2.73
			No training	9	0.90
<b>EMPLOYMENT</b>					
Middle School	509	51.41			
High School	591	59.70			
Middle and High	135	13.64			
Other (Tuition, private sector)	25	2.53			

**Table 3.** Sources of teaching effectiveness.

PERSONALITY CHARACTERISTICS/SKILLS	M	SD
Your personal style and temperament	4.21	0.631
Confidence in yourself	4.41	0.624
Your positive attitude and humor	4.33	0.663
Originality and creativity in teaching	4.23	0.750
The talent for teaching	4.25	0.784
The ability to understand the needs of your students	4.39	0.675
The organization and schedule of teaching activities	3.98	0.807
Flexibility in teaching choices	4.15	0.763
Direct communication with students	4.51	0.650
The ability to control the classroom	4.469	0.657

**Continued**

<b>MOTIVATIONS</b>		
Personal interest/motivation	4.29	0.729
Personal effort (study, concern about teaching issues)	4.32	0.717
The desire to improve teaching	4.43	0.706
Love for students	4.53	0.723
<b>SOCIAL/VERBAL CONVINCENCE</b>		
The prospect of direct appointment to schools is of greater interest for professional development	3.05	1.236
The teaching experience in schools during teaching practice	3.66	1.011
Teaching experience in difficult classrooms or schools during teaching practice (minority, multicultural, special schools, etc.)	3.44	1.019
Successful teaching during teaching practice	3.64	0.932
Students' enthusiasm for the lesson during teaching	4.24	0.792
Positive feedback from colleagues who attend your teaching	3.63	0.956
<b>INDIRECT LEARNING</b>		
Compare your teaching with that of your colleagues	3.20	1.047
Comparison of your teaching with that of the teachers you have attended during teaching practice (micro-teaching, training, etc.)	3.31	.984
Compare your teaching with the teaching model you apply during teaching	3.34	.890
Compare your teaching with that of your university teachers	2.54	1.094
<b>EDUCATION</b>		
The type of courses offered during teacher training programs (compulsory or optional)	3.08	0.989
The number of courses offered during teacher training programs	2.98	0.970
The frequency of attending courses in teacher training programs	3.05	0.999
<b>PHYSIOLOGICAL/EMOTIONAL CONDITION</b>		
Feelings of stress or anxiety during your teaching	3.35	1.093
Feelings of tiredness after completing the course as a sign of incompetence or frustration	3.06	1.149
Retrieve negative emotions during your teaching	3.00	1.116

The proposal “the prospect of direct appointment in schools arouses greater interest in professional development” ( $M = 3.05$ ,  $SD = 0.999$ ) received a lower grade from the respondents and was followed by “feelings of fatigue after completing the course” ( $M = 3.06$ ,  $SD = 1.149$ ) and “the type of courses offered during training programs” ( $M = 3.08$ ,  $SD = 0.989$ ).

#### 4. Discussion

The personal beliefs that each person has about himself, act on his effectiveness. In the case of the teacher, it determines the intensity of his effort, his persistence

and the search for alternative approaches, to finally succeed to face any environmental requirements and reach the level of achievement [12]. The present study seems to agree with the research of Gould and Weiss [20] who argued that personal achievements enhance self-efficacy and personal failures reduce it. The personal experiences of individuals significantly affect the self-perception. Also agrees with the research of Mulholland and Wallace [21] who argued that the strong efficacy beliefs associated with the characteristics of teachers. This is a first element of reflection for trainings. The trainings carried out aim at the development of the teachers' skills, proposing the ways of approaching the student, originality in the teaching. But they must be more targeted to the needs of students and teachers.

The most important sources, expressed by teachers' choices, are "love for students" and "direct communication with students". This is in line with Poulou [22] work for primary school students, where they were also found to be the most important sources of effectiveness. They are also referred to as teachers' personal motivations that lead to personal positive experiences, a source of effectiveness according to Bandura. The "ability to control the classroom" and the "desire to improve teaching" that agrees with Milner & Hoy [23], who found that the teacher who studies, improves participation through the enthusiasm of his students.

From the sources of didactic effectiveness, the personal characteristics/skills and motivations of the teachers show a positive correlation, statistically significant ( $R_s = 0.508$ ,  $p < 0.05$ ). Thus providing incentives to teachers increases self-efficacy for themselves and their students.

The lowest source of effectiveness was indirect learning (Bandura), through the "comparison with the teaching of teachers in the university". The age of teachers and the Greek reality in relation to teacher appointments, justifies this choice. Anderson and Betz [24] have come to the same conclusion that the comparison of teaching plays an insignificant role. In the present work, training does not seem to be a significant source of effectiveness and this is in contrast to other research [7] [24] [25]. The negative choice in terms of training can be due to both the wording of the questions and the saturation from attending training programs. It is worth exploring. The negative choice in terms of training can be due to both the wording of the questions and the saturation from attending training programs. It is worth exploring.

The "recovery of feelings during teaching" and "feelings of fatigue after the completion of the course" which belongs to the category of normal emotional state according to Bandura, receives low marks in the choices of the respondents. This is in agreement with Bandura [7], Mulholland and Wallace [21] who argue that it is the least important source of effectiveness.

"The prospect of immediate appointment" also shows a low increase in the teacher's self-perception. In the present survey the most teachers, about 80% are permanent teachers and more than 78% have more than 11 years of service,

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perhaps interpreting this choice of teachers.

## 5. Conclusion

The concept of self-efficacy and the sources that support it are multifaceted and diverse concepts. In the present work, a first approach has been made regarding educational mathematicians and an incentive is given for further studies. Teachers should be motivated and appropriately designed educational programs to strengthen and empower the teacher. High teacher effectiveness leads to high rates of self-efficacy leading to non-teacher-centered methods and innovative programs that support weak students, successful teaching population management [6], greater student mobilization and more support to students' families [7]. According to Howard and Johnson [26], teachers' self-efficacy interacts with student involvement in the classroom. By strengthening the teacher, we support the education of the students.

## Research Limitations, Suggestions for Future Research

It is important to note that this study does not provide data in order to study the possible correlation of teaching self-efficacy to student performance. A multimethodological approach which would include videotaping or personal interviews, could yield a combination of more important results. The data collected refer to a population that is governed by common characteristics and for this, it is of particular interest.

Improvements could be made to the questionnaire and in particular to the training needs of mathematics teachers. It could be combined with qualitative research through interviews for a better and more complete study of data on the Greek reality. Quantitative research, however, cannot fully describe all those factors that affect the self-perception of a teacher and in this case a mathematician. Therefore, it would be interesting and a qualitative approach to this issue.

As the present investigation is a novelty for Greece, considered necessary research to spread throughout the population of teachers of mathematics. It is an interesting study that refers to senior mathematics students and to study those elements that increase their effectiveness. It could also be supplemented with other elements related to the material and its size, the curriculum, the new technologies, the types of training, which would give a more complete picture. Useful it might be a parallel study on the effectiveness of students and if it is consistent with the views of teachers.

All of this, however, would greatly increase the size of the questionnaire and leave it to other researches to focus only on sources of effectiveness. However, this work is a first search for the self-efficacy of mathematics, but also a trigger for further studies. The beginning was made ...

## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.



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