Preschool educators' self-efficacy beliefs about teaching probabilistic concepts and their change in the course of participating an inquiry-based training program

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ABSTRACT
Which are the self-efficacy beliefs that teachers hold when they are asked to teach concepts on probabilities in preschool education? Is it possible to improve negative self-efficacy beliefs through a training program? Thirty-two preschool educators participated in our study and attended a mathematical training program on probabilities, which were lately introduced in the revised preschool curriculum. The structure of the training program centered on the "inquiry-based" pedagogical approach. The results showed that the mathematical inquiry-based training program could improve participants' initial negative self-efficacy beliefs on teaching probabilities in preschool students and consequently may have positive effects on their educational abilities.

KEYWORDS
Mathematical training, probabilities, perceived self-efficacy beliefs, preschool teachers, inquiry-based approach

RÉSUMÉ
Quelles sont les croyances d'auto-efficacité que les enseignants ont lorsqu'ils sont invités à enseigner des concepts sur les probabilités aux élèves du préscolaire ? Est-il possible d'améliorer les croyances d'auto-efficacité négatives en utilisant un programme éducatif ? Trente-deux éducateurs préscolaires ont participé à notre recherche et ont suivi un programme éducatif sur les concepts mathématiques des probabilités, qui a été récemment introduit dans le programme préscolaire. La structure du programme éducatif on était conçue en fonction de l'approche pédagogique fondé sur l'investigation. Les résultats ont montré que le programme éducatif pouvait améliorer les premières croyances négatives d'auto-efficacité des participants sur l'enseignement des probabilités chez les élèves du préscolaire et, par conséquent, avoir des effets positifs sur leurs capacités éducatives.

MOTS-CLÉS
Éducatif mathématique, probabilités, croyances d'auto-efficacité, enseignants préscolaires, approche pédagogique fondé sur l'investigation

INTRODUCTION

Previous research on science learning and on cognitive psychology has shown that understanding scientific information in physical sciences and mathematics is not a direct and easy process. Contrary, it is a gradual process, during which a lot of changes --ontological and representational-- need to be made that do not happen over a night (Vosniadou & Skopeliti, 2014). This is the case not only for school students but for adults as well. Studies with elementary school students (i.e., Ni & Zhou, 2005) with college students (i.e., Trumper, 2000) and with elementary school teachers (i.e., Atwood & Atwood, 1996) have shown that they have considerable difficulties understanding scientific information in physics and mathematics.

These difficulties influence negatively teachers, when they have to instruct scientific information and explain them to students, while at the same time they fell that their knowledge in the field is insufficient. In such cases, what seems to be necessary is teachers' participation in well-designed training programs that will give them the appropriate background knowledge, and at the same time will improve their self-confidence in instruction and consequently will shape their teaching practices. The purpose of the present study was to evaluate a training program that presents on preschool teachers a scientific mathematical concept, and investigate its influence on their perceived self-efficacy beliefs in teaching the specific mathematical concepts.

The present study

In the recently reviewed curriculum in Greece it is stated that in the domain of mathematics in preschool education[1] the instruction of probabilities should be included. According to recent research findings young students have the ability to understand the basic concepts on probabilities, as long as they are presented in the appropriate educational context that makes them easily understood and interesting for the students (Antonopoulos & Zacharos 2013; Batanero, Burrill, & Readin, 2011; Batanero & Diaz, 2012). However, the effective instruction of a new topic requires the teachers to be "up to date"; i.e., have the appropriate background knowledge, which may help them correspond to the demands that may appear after any change in the educational system. One way to do that is through the lifelong learning and training.

There's been a lot of research on the lifelong learning on mathematical training (i.e., Jameson & Fusco, 2014). Each time there is a change in the curriculum regarding the mathematics education, teachers should receive the necessary mathematical training that will help them include effectively in their instruction new mathematical concepts (e.g. Batanero et al., 2011; Estrada, Batanero, & Lancaster, 2011). During mathematical training, the teachers are called to be familiar with different mathematical topics, which will help them to correspond properly to their professional educational needs –i.e., content knowledge; general pedagogical knowledge; curriculum knowledge; learners' knowledge and their characteristics; and knowledge of education contexts, purposes, and values.

In addition to these topics, there is a continuously increasing interest specifically on probabilities which focuses on different aspects like: educational practices in teaching probabilities and the most appropriate educational practices (Antonopoulos & Zacharos, 2013; Batanero et al., 2005; Jones, Uribe-Flores, & Wilkins, 2011), necessary knowledge base (Stohl, 2005), perception of randomness, educators' and future educators' attitudes and beliefs

[1] In Greece preschool education involves two years of schooling (K1, the children of an average age of 4.5 years old, and K2, the children of an average age 5.3 years old). In most preschool classes, K1 and K2 children are grouped together in one class.

(Aydoqdu & Peker, 2016; Estrada et al., 2011; Williams & Nisbet, 2014), and finally the cultural, social and political factors that affect the instruction of probabilities (Greer & Mukhopadhyay, 2005).

Finally, according to recent theoretical approaches developed in the field of life-long training, emphasis is given not only on the cognitive outcomes from adult education but also on the emotional advantages that enhance learning in adults (Karalis, 2010; Schuetze, 2005). Nowadays, the readiness for lifelong learning, cultivation, and training is one of the major concerns of the individuals. The term lifelong learning is widely used to declare a continuum of all learning and educational activities of every kind, content or grade that takes place within formal, non-formal or informal contexts (Karalis, 2009, p. 70). It is supported that adults' participation in well-designed training programs may give them the appropriate background knowledge, which will improve their self-confidence in instruction and consequently may shape their teaching practices.

The purpose of the present study was to evaluate a training program that presents on preschool teachers the scientific mathematical concept of probabilities. More specifically, our purpose was to investigate the effect of this training program on preschool teachers' perceived self-efficacy beliefs in teaching the concepts of probabilities in preschool students.

Educators' teaching self-efficacy beliefs

Self-efficacy is characterized as the perception that someone has of his own personal abilities to correspond in a given situation (Bandura 1986; Flores, 2015). According to Flores (2015), who was based on Bandura's theoretical framework, "Human social function and performance are products of a dynamic interplay between personal, behavioral, and environmental influences" (p. 3). In certain cases the perceived self-efficacy beliefs may work as predictors of someone's efforts, since they can influence their behavior (Pajares, 1996) and their performance expectations (Bandura, 1997). Thus, it is supported that self-efficacy may mediate their career adaptability and predict their career optimism (McLennan, McIlveen, & Perera, 2017).

Previous studies have shown that teachers' self-efficacy beliefs influence significantly their behavior inside the classroom, their readiness to receive new ideas, and their views towards the teaching practices and the students' performance (Chester & Beaudin, 1996). This finding applies particularly in the case of teaching mathematics compared to literacy or science (Gerde et al., 2017). More specifically in the case of teaching mathematics, psychological parameters, like teachers' attitudes towards mathematics, or their self-efficacy beliefs, are strongly related with teaching mathematics (Aydoqdu & Peker, 2016; Crootenboer & Hemmings, 2007; Gerde, et al., 2017; Jameson & Fusco, 2014; Lee, 2005; Pajares & Kranzler, 1995; Philippou & Christou, 1998; Stipek et al., 2001). It appears that teachers with high self-efficacy beliefs are more likely to use sophisticated teaching techniques and practices and are more willing to experiment with innovative educational approaches in order to meet students' needs, compared to teachers with low self-efficacy beliefs who use mostly low-risk educational practices or sometimes even avoid to teach specific subject matter (see Chichekian & Shore, 2016 for a review).

This idea is further supported by the finding that preschool teachers' self-efficacy differs across different kinds of domains such as science, literacy and mathematics, with the self-efficacy of teachers being the lowest for mathematics, which affect their teaching (Gerde et al., 2017). Finally, the idea is strengthen when the students that will receive the instruction of mathematics are young. In such a case the teachers get even more anxious and experience negative emotions in the thought of teaching mathematics in young preschool students (Copley, 2004; Unglaub, 1997).

At this point, it has to be mentioned that the teachers' attitudes towards a specific course as well as their self-efficacy teaching beliefs are well-established and resistant to change (Stipek et al., 2001; Watson, Caney, & Kelly, 2004). There is a good chance of changing these negative attitudes and beliefs, if the educators participate actively in well-organized training programs (Philippou & Christou 1998).

This is the case also for the thematic of probabilities. Educators' participation in training programs on probabilities may change their attitudes towards the specific course. Most of the previous research has focused on the influence that a mathematical training program may have on the self-efficacy beliefs of elementary and high school educators (Stipek et al., 2001; Williams & Nisbet, 2014). In our research the participants are preschool educators, who have to deal with a new challenge; teach mathematical probabilistic concepts on preschool students.

Teaching the concepts on probabilities in preschool education

When the curricula are changed and new topics are included in the instruction of mathematics, like the topic of probabilities in preschool mathematics, the educators should have additional training, since they have received different university education on mathematics, and most of them are not instructed in the concepts on probabilities (Batanero & Diaz, 2012). Thus, the educators have to teach students to be able to characterize events and situations as 'certain', 'possible', or 'impossible'. They have to understand if some events are certain or impossible, or if they are possible but not certain. Students have to understand that some events are more likely to happen than others. Preschool students must be familiar with experiments of 'sample space', and they should be able to determine if a random experiment is "fair" or "unfair" and "correct" the conditions of this experiment so that it will be "fair".

The educational context of the teachers' mathematical training program

The teachers' mathematical training program was designed to help the participants understand in a deeper and more productive way the concepts of probabilities and it was based on the ground of the pedagogical approach mainly referred to as "inquiry-based" (Artigue, et al. 2012; Artigue & Blomhøj, 2013; Maaß & Artigue, 2013; Maaß & Doorman, 2013; National Research Council, 2000) or as "inquiry-oriented approach" (Stipek et al., 2001).

The great majority of preschool teachers consider learning of mathematics as a passive transfer of knowledge (Aydoqdu & Peker, 2016). In contrast to this idea, inquiry-based mathematics education supports the adoption of teaching practices that present the mathematics to trainers and trainees not as a ready-built structure to appropriate. Contrary, teachers and students are given the chance to learn and have the necessary experience on mathematics through experimentation.

There is a shift embedded in this approach; a shift from the traditional educational practices, where the educator relies mainly on a textbook-based teaching and where the student's purpose is to memorize rules that help them solve problems, to a more sophisticated, productive and constructive educational practice. However, this shift demands from the educators to have a higher level of self-confidence. This is the case because the educators are not restricted to use only the textbook, which actually guides their courses (Stipek et al., 2001). On the contrary they have the chance to use additional educational means than just the textbook.

The educational practices based on the inquiry-based approach include "various practices, such as: articulating or elaborating questions in order to make them accessible to mathematical work; modeling and mathematizing; exploring and experimenting; conjecturing; testing, explaining, reasoning, arguing and proving; defining and structuring; connecting, representing and communicating" (Artigue et al., 2012, p. 8). The supporters of the inquiry-

based teaching approach argue that the present approach is a "multifaceted activity" (Maaß & Artigue, 2013, p. 781), which improves mathematics' understanding and leads to a more productive use of the mathematical concepts, which is broadened outside the school and class context. In this educational context, participants pose questions, examine sources for information, develop the scientific discovery, become creative and autonomous, acknowledge mathematics as an experimental scientific field, and finally, face mathematics as a human social activity (Artigue et al. 2012; Maaß & Artigue, 2013; Stipek et al., 2001).

Research questions

The research questions of the present study were the following:

- Which were the initial self-efficacy teaching beliefs that the preschool educators had regarding the instruction of probabilities in preschool students?
- Did the training program on probabilities based on the inquiry-based pedagogical approach had a positive influence on the preschool teachers' self-efficacy teaching beliefs?

METHOD

Experimental Procedure

The training program lasted approximately four months and included 4 phases, which are presented in Table 1.

TABLE 1

The phases of the training program

Phase	Timeline	Description
1st Phase	December, 10th	• Preliminary questionnaire • Training seminar (2 hours): - Presentation of the basic concepts on probabilities - Discussion on designing the appropriate educational programs on the basic concepts on probabilities • Work within the groups (1 ½ hours) - Assignement in groups - Discussion on procedural issues - Construction of a preliminary plan on educational activities
2nd Phase	January, 14th	• Trainees worked into groups on the activities and the educational material that they could use in order to teach the basic concepts on probabilities
3rd Phase	February, 11th – March 18th	• Application of the educational activities on the basic concepts on probabilities
4th Phase	April, 20th	• Evaluation of the training program • Completion of questionnaire

1st Phase: All the participants replied anonymously in a questionnaire, which gave information on their educational and professional status (preliminary), and on their beliefs about their self-efficacy in teaching probabilities (pretest). Afterwards, all the participants attended a training seminar, which lasted 3 ½ hours; during the first 2 hours the participants attended a *training seminar on the concepts of probabilities*, while during the next 1 ½ they were *worked within the groups*).

Training seminar on the concepts of probabilities

The training seminar, which lasted the first 2 hours, included an elementary theoretical introduction on the probabilities. Emphasis was given on the definition of the concept of probability, of sample space, and of the probability of an event. Additionally, special attention was given on the instruction of making probability comparisons, and finally, on the distinction between theoretical and experimental probability. All the issues mentioned above were accompanied by corresponding examples.

The work within the groups

After the completion of the training seminar the participants chose by themselves the group that they would attend. One of the three groups had 10 members while the other two had 11 members each. Within the group, all the participants were asked to make some initial thoughts about the appropriate way to present students with the concepts of probabilities. Each participant stated her ideas and everyone kept detailed notes on the information that could be the appropriate initial material to work on. In each group there was a kind of "work-division" –some members of the group took the responsibility to write down all the useful suggestions that were proposed, while the others took the responsibility to communicate with the schools, where the teaching practices would take place, and to arrange the places, where the members of the group would meet and exchange information. Each group decided to meet in a school classroom during the afternoons, when no courses took place. Almost everyday the members of the group communicated via e-mail, in order to exchange information, until their next meeting took place.

Three members of the research team attended the meetings of the three groups as supervisors –each one of them in one of the three groups. The supervisor's role was discreet since s/he interfered only when clarification questions were posed or when the participants had doubts or wanted some sort of encouragement. Each group met at least once a week and the members of the group informed the others and the supervisor on their progress. It should be mentioned that all the supervisors were familiar with the practices of inquiry-based learning, since all of them had participated in a research program[2] that investigated the effects of inquiry-based educational programs in science and mathematics learning.

<u>*2nd Phase*</u>: Each group worked in three major topics on probabilities and had to make an instructional design on these topics, which would include specific instructional activities. According to the instructions given to the participants the activities should increase students' interest on the topic of probabilities, should correspond to the students' cognitive abilities and be of escalating difficulty, should not exceed in time the forty minutes, should give the chance to each student for practice individually, and finally should create a laboratory atmosphere, where the students would feel free to create hypotheses, test them, confirm them or re-phrase them. The participants were also asked to adjust this specific 'hypothetical learning trajectory' (Simon, 1995) in a one-week educational program.

Afterwards the members of each team met together or cooperated via e-mail on this repertoire of activities in order to design all the details. The next step was to create any additional educational material, when this was necessary. All this material, the printed instructions of the activities and the additional educational material, which was created by the teachers, was standardized and it was considered as the main material for each activity.

Finally, the three groups met together and presented their final work. All doubts and uncertainties were discussed, and the necessary changes were done, so that the proposed program of activities would be coherent and appropriate for implementation.

Furthermore, during the design of the instructional material additional emphasis was given on the inquiry-based learning approach. All the activities were designed in order to give

to the students the chance of experimentation with the instructional material, to work in small groups and co-operate, to make assumptions about possible results, to construct experiments of "chance", and to change the initial experimental conditions in experiments of "chance". Finally, the participants worked on a number of possible questions that they could pose to the students, in order to make sure that the students understood the goal of the activities and give completely justified responses.

3rd Phase: All the participants implemented all the activities in their school classrooms. During the implementation, they informed the research team about their progress of the training. The members of the research team selectively attended some of the classrooms where the training took place.

4th Phase: All the participants met to present and evaluate the outcomes of their teaching experience after they carried out the activities in their classrooms. This meeting lasted approximately three hours. During the meeting the participants made comments on how students corresponded to their educational program, if they were interested to participate in the activities, if they were willing for experimentation, and finally how they self-acted or how they interacted with their classmates and their educators. Additionally, they presented video excerpts from their educational practices, which received the other participants' comments.

In this final phase, the participants had to reply anonymously once again in the questionnaire (post-test). Additionally, they wrote individually and anonymously their evaluation of the training (final text).

Additional Material

For the purposes of our study we gave to the participants a questionnaire, which was used as pretest (before the training program) and posttest (after the training program). Additionally, all the participants wrote texts referring to their expectations from the educational training program (preliminary text) and texts referring to their evaluations of the educational training program (final text).

Questionnaire

According to Bandura (1986), the self-efficacy is estimated based on the calculation of self-perception or effectiveness in specific tasks before the implementation of those specific tasks. The subjects are asked to describe the most appropriate way to deal with these tasks and to predict the possibility of success in them (Bandura, 1986).

TABLE 2

Questionnaire used for the study

Preliminary Questionnaire
i. How many years have you worked as a service teacher? 0-5 ☐ 6-10 ☐ 11-15 ☐ 15+ ☐
ii. Specify the level of your studies? Graduate studies ☐ Master Degree ☐ PhD ☐
iii. Do you have any knowledge on probabilities? Yes ☐ No ☐ If yes, how did you receive it? School studies ☐ University studies ☐ Other ☐
iv. Have you attended any training program on the topic of probabilities? Yes ☐ No ☐
Pretest – Posttest Questionnaire
1. Do you believe that you are sufficiently prepared to teach the basic concepts of probabilities on preschool students? Yes ☐ No ☐
2. How do you feel as an educator asked to organize lectures and activities on the field of probabilities?

……

3. The concept of "sample" is important when teaching the experiments of "chance". (a) Do you think you could design simple experiments of "chance" so that the students would be able to determine the "sample" in these experiments? Yes ☐ No ☐

   (b) If yes, could you give an example of "sample" in an experiment of chance? ……

4. The concepts of "fair" and "unfair" games of chance are also taught within the topic of probabilities.

   (a) Do you think you can help students distinguish between 'fair" and "unfair" games of chance? Yes ☐ No ☐

   (b) If yes, could you give an example of an unfair game of chance? ……

5. How would you describe the aims of the new curriculum regarding the topic of 'probabilities' and their practical implementation?

   Impossible to accomplish ☐ Difficult to accomplish ☐
   Possible to accomplish ☐ Easy to accomplish ☐

6. Do you think that the probabilistic concepts should be taught to preschool students?

   Yes ☐ No ☐

   If yes/If no, please define why. ……

7. Have you applied activities on probabilities on your preschool students? Yes ☐ No ☐

   If yes, please define their content. ……

   If no, please define why not. ……

8. Please, specify your agreement or disagreement with the following:

		Totally disagree	Disagree	Agree	Totally agree
a	I feel anxiety in the idea of teaching probabilistic concepts				
b	I fell confident in teaching probabilistic concepts				
c	I feel confident when I have to answer students' questions regarding probabilistic concepts				
d	I feel that I can adjust my teaching methods in order to reinforce their interest on probabilistic concepts				

9. How would you describe the specific training program after your participation in it?

(a) General opinion ……

(b) Positive remarks ……

(c) Negative remarks. ……

Since the purpose of our study was to investigate teachers' self-efficacy beliefs in teaching basic concepts of probabilities after their participation in a training program, we used a questionnaire that was given to the teachers to reply before (pretest) and after (posttest) the educational training program (see Table 2). The pretest included some preliminary questions, not found in the posttest, which gave us information about the educational and professional status of the participants (preliminary questionnaire).

The questions found in the pre-test and post-test questionnaire were based on the questionnaires designed and used for mathematics education research (TIMSS, 2007). We selected those questions that aimed to the purposes of our study.

The questions were divided in two groups (Table 3); the questions that referred explicitly to the perception of self-efficacy (q. 1, 2, 8a-8d) and the questions that referred implicitly to the perception of self-efficacy, either through the verification of the participants' knowledge on probabilities (q. 3 & 4), or through the examination of the participants' beliefs about the necessity of teaching probability concepts to preschool students (q. 5, 6, & 7).

The questionnaire included two types of questions: closed questions and open-ended questions. This gave us the chance to have qualitative data in our results and to record possible misinterpretations of the questions.

TABLE 3
The structure of the questionnaire

Explicit questions	**Implicit questions**	
Self-Efficacy Beliefs	Knowledge on the mathematical topic of probabilities	Beliefs on introducing the basic concepts on probabilities on the preschool curriculum
Questions 1, 2, 8a – 8d	Questions 3, 4	Questions 5, 6, 7

Texts on the training program
The participants of the study wrote texts describing their expectations from the training program (preliminary texts) and their experiences after the completion of the program (final texts). The content of each text was analyzed in order to collect qualitative data and useful information regarding the program, which is difficult to highlight from questionnaires.

Participants
Totally, 32 preschool teachers participated in our study. All participants were women, active teachers in middle-class schools in central regions of the country. According to q.1 of the preliminary questionnaire, 3 of the participants had 5 years of teaching experience, 10 of them had 6-10 years of teaching experience, 6 of them 11-15 years of teaching experience, and finally 13 of them had more than 15 years of teaching experience. Regarding their studies, 1 of the participants had a PhD, 7 of them had a master's degree, while 24 of them had completed their undergraduate studies on Educational Sciences. The great majority of the participants (19/32) claimed that they have received no instruction on the basic concepts of probabilities, while the remaining participants (13/32) stated that they have received the basic knowledge on probabilities during their undergraduate studies. Finally, there was no participant who attended a teachers' training program on probabilities in the past.

RESULTS

In order to analyze the data of the current study, we used non-parametric tests for the quantitative analyses (IBM SPSS Statistics 21). More specifically for the closed questions that could receive only two values (Yes=1–No=0) we used the McNemar test. For the closed questions that could receive more values from an ordinal scale we used the Wilcoxon test.

Additionally, the participants' responses in the open-ended questions were used for qualitative analyses, which would give us information on teachers' perceptions on self-efficacy. Finally, the participants' expectations about the training program as well as their evaluation of the program in the final stage of the experimental procedure gave us qualitative information about the training program overall.

Explicit questions. The educators' perceptions on self-efficacy
In Question 1 the great majority of the educators responded that they did not feel sufficiently prepared to teach probabilistic concepts on preschool students (31/32). All the negative responses changed to positive responses in the posttest, after the educators' participation in the training program. Participants' responses in the pretest and the posttest in q.1 were subjected in McNemar analyses test which showed statistically significant results for the time of the test ($x^2=27.03$; $p<.005$).

Question 2 was posed to the participants in order to see their attitude on teaching the probabilities concepts. A qualitative analyses of our data showed that the participants' responses could be grouped in the following categories: (1) 'sufficient', those educators who

felt that they could teach the concepts on probabilities sufficiently and (2) 'insufficient', those educators who used statements that revealed insecurity, anxiety, and/ or insufficiency in teaching the concepts on probabilities. The results showed that the great majority of participants (28/32) felt insufficient in teaching the concepts of probabilities in the pretest (e.g., "*I feel anxiety and puzzlement, since I do not have the necessary knowledge to organize activities on the topic*").

After the training program it was found that participants who gave in the pretest responses that revealed insecurity, anxiety, and/or insufficiency, in the posttest gave responses, which were categorized in the 'sufficient' category (e.g., "*I feel more confident than I used to feel before my participation on the training program. I have more ideas and a more clear view on how I could include this topic in the preschool education program"*). The non-parametric Wilcoxon test showed that this change in the participants' responses from pretest to posttest is statistically significant (*Z=-4.08; p<.001*).

The responses of the participants in Questions 8a, 8b, 8c and 8d before and after the training program are presented in Table 4. More specifically, in q8a 14 out of 32 participants stated that they feel anxious in the possibility to teach the concepts on probabilities. This number diminishes after the training program (7/32). Ten participants out of the 14, who expressed anxiety before the training program, changed their responses in the posttest. Thus, there were three participants who expressed no anxiety before the training program but felt anxiety after the training program. One possible explanation of this backwards tendency could be the lack of knowledge regarding the demands of teaching the specific topic, which could lead to an overestimate of their capacities. The Wilcoxon test did not show a very strong statistical change from pretest to posttest in q8a (*Z=-2.08; p<.05*).

In q8b in the pretest, 14 teachers claimed lack of self-confidence in teaching the concepts on probabilities. In the posttest 12 out of these 14 teachers changed positively their original claims. This difference between pretest and posttest in q8b is statistically significant (*Z=-3.11; p<.005*).

In q8c 15 educators stated that they feel insecure in the possibility to teach probabilities and receive questions from the students regarding the topic. Out of these educators only 2 in posttest continue to feel insecure. There was also one teacher who changed her original response in the opposite direction –she felt secure in the pretest but insecure in the posttest. The responses in pretest and posttest were subjected in a Wilcoxon test which showed statistically significant differences for testing time (*Z=-3.46; p<.005*).

Finally, in q8d 10 participants stated incapable to create activities in the field of probabilities, which would be attractive for the preschool students, while there was only one negative statement in the posttest. This change in teachers' responses in q8d is statistically significant (*Z=-2.39; p<.01*).

TABLE 4

Participants' responses in Questions 8a – 8d

	Totally Disagree		**Disagree**		**Agree**		**Totally Agree**	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Q.8a	6	12	12	13	13	7	1	-
Q.8b	2	-	12	4	15	18	3	10
Q.8c	1	-	14	3	13	21	2	8
Q.8d	-	-	8	1	19	15	3	5

Implicit questions. The educators' knowledge on probabilities

Questions 3 and 4 investigated the participants' knowledge on the topic of probabilities. In order to test the validity of their responses, we asked them to give examples that certify their knowledge on the concepts of probabilities. Only the educators, who could give valid examples in the second part of the questions, were considered to have the necessary knowledge on the topic, and the response "Yes" was considered as valid.

In q3 the majority of the educators (18/32) noted that they could not design activities in order to determine the sample of an experiment, which investigates the concept of 'chance'. The remaining 14 participants noted that they are capable of such a task and gave successful examples that revealed this capacity. After the completion of the training program all the participants felt capable and gave examples that certified this capacity. The difference between pretest and posttest in q3 is statistically significant ($x^2=31$; $p<.001$).

In Question 4 the great majority of our sample (23/32) stated that they do not feel secure to teach the concepts of 'fair' and 'unfair' in experiments of chance. It is important to mention that 9 of them, although in the first part of the question claimed that they feel capable to teach these concepts, in the second part of the question they appeared to be incapable, because they gave responses that did not add to their claim but added a more ethical view of these concepts (e.g., "*The games should always be fair"*). On the contrary there were only 9 participants who gave correct responses in the second part of the question.

The participants improved statistically their performance in this question after their participation in the training program ($x^2=32$; $p<.001$). Out of the 23 educators who were grouped in the category of the incapable to teach the 'fair' and 'unfair' concepts in the pretest, only 2 were placed in the same category in the posttest, while the remaining 21 participants moved to the 'capable' category giving correct responses in the second part of the question (e.g., "*A board game using a dice. The four sides of the dice are in favor of one player and only two in favor of the other player. The first player has a benefit"*). This finding is clearer in their responses in the second part of the question.

Implicit questions. Educators' beliefs on the idea of teaching the basic concepts of probabilities in the curriculum

In Question 5 out of the 24 participants who replied to the question (8 participants did not reply) 13 participants claimed that the aims are 'implementable' as opposed to 11 participants who described the aims of the curriculum on the topic of 'probabilities' as 'non-implementable'. After the completion of the training program all the participants described the aims of the curriculum as 'implementable'. This change from the pretest to the posttest was statistically significant ($Z=-2.71$; $p<.01$).

In Question 6 the majority of the educators who participated in the study (19/32) thought that the teaching of the concepts on probabilities on the preschool education was considered as a positive change in the curriculum even before their training. On the other hand 13 of the participants did not consider this change to be positive nor negative. Most of them seemed to be rather conservative, with prejudice (e.g.," *I do not know the topic. Thus, I cannot decide if it is possible to teach the concepts on probabilities in preschool children"*). Finally, the participants, who claimed that this change is positive, justified their decision based on the idea of preparing students for their upcoming educational needs (e.g., "*The concepts on probabilities are important for preschool children because they are exposed to them, before they enter elementary school"*) and on the idea of adding to the students' general mathematical culture (e.g., "*The domain of probabilities gives to the preschool students the chance to pose questions and experiment in order to reply to these questions"*).

After their training, the participants who were conservative with the teaching of probabilistic concepts in preschool children changed their responses and said that it is a

positive change in the curriculum. Additionally, they fully justified their responses (e.g., "*Yes, I believe that probabilistic concepts should be included in the preschool curriculum because they may help students develop their abilities on questioning and on argumentation"*; "*Probabilistic concepts are strongly related to everyday life and they are not very difficult for preschool students to understand them"*). The change from pretest to posttest in this question was statistically significant ($x^2=30$; $p<.001$).

In Question 7 the great majority of the participants (28/32) said that they have not designed any activity on the concepts of probabilities, despite the fact that they are already included in the new curriculum. This could be due to the fact that most of the participants were not trained in teaching the probabilistic concepts (e.g., "*Since I do not have the necessary knowledge on the probabilistic concepts, I cannot design any activities, which will help to teach them correctly to preschool students"*) or that some of the participants did not know the appropriate way to teach them (e.g., "*I do not know the most appropriate way to design and implement such activities"*).

In the posttest all the participants could design and implement activities regarding the concepts on probabilities. The differences between pretest and posttest was statistically significant ($x^2=26.03$; $p=.001$). As already mentioned, the members of the research team selectively attended classrooms to see how the participants applied the activities in their teaching program. This procedure showed that the participants could effectively run the activities that they have already designed and could create a pedagogical atmosphere following the principles of hypothesis testing and argumentation.

Educators' expectations from the training program

A close look to the participant responses to Question 9 revealed their initial expectations of the training program, which could be summarized to the following: the training could aid to their professional development (e.g., "*I expect to get trained on the field of probabilities, so that I will improve my work. It is really important for me to understand completely the concepts on probabilities in order to teach them correctly on the students"*), could add to the cooperation and the exchange of ideas and experiences with other educators (e.g., "*The training program will give me the chance to work more systematically on the topic of probabilities, but also to cooperate and exchange ideas with other educators, which I believe is a valuable process"*), and could improve their knowledge on the concepts on probabilities, their educational practices and also their beliefs on their self-efficacy (e.g., "*The training program will help me add to my knowledge on the topic of probabilities and be informed on the most appropriate educational practices"*).

Educators' evaluations of the training program

When the training program was completed, the participants had to evaluate it. Each one of them wrote a text where she expressed her opinion on the training. A close look to these texts revealed two major points regarding the training: (1) the program added to the participants' educational practices, (2) the students corresponded positively in the teaching of the probabilistic concepts.

Contribution of the training on the educational practices

The great majority of the educators explicitly stated that the training program helped them to improve their educational practices. They evaluated positively their cooperation with other colleagues in designing the appropriate activities. As a result, the training program was considered to be adequate for their needs. The fact that they had positive experiences after they taught the probabilistic concepts to preschool students, made them feel more confident in teaching this topic in the future (e.g., "*Our training on the topic of probabilities was adequate*

for our needs and the design of the program was fulfilling. I believe that my participation in the program is the beginning of a complete and appropriate teaching of the concepts on probabilities"; "[…] *The design of the training program, which was conducted from a small group of educators under the supervision of one coordinator, was complete and accurate.* […] *I will include the probabilities in the thematic that I teach"*).

Students' correspondence to the probabilistic concepts teaching

Another major point that was stated in the educators' texts was the positive correspondence that students showed in the instruction of the concepts on probabilities. This is obvious in the excerpts that follow; "*The implementation of the activities was satisfactory for the students and me. The students understood the concepts on probabilities easier than I thought they would. As a matter of fact, after a short period of time they transferred successfully the probabilistic concepts into a different educational context. I will definitely include the theme of probabilities into my educational program".*

DISCUSSION

The current research focuses on the preschool educators' training in the field of mathematics and more specifically on concepts of probabilities, which is a new topic included on the reviewed curriculum of preschool education, and its effect on their self-efficacy teaching beliefs.

Regarding our first theoretical questions, the results showed that the great majority of the participants in the pretest replied that they did not feel prepared to teach probabilities in preschool students before the training (q. 1), they expressed feelings of insecurity and insufficiency (q. 2 & q. 8c), of anxiety (q. 8a), of lack of confidence (q. 8b) and they claimed that they could not organize activities on probabilities, which would be interesting enough for the students (q. 8d).

In the first set of implicit questions before the training program, about half of the participants stated that they have complete ignorance of the concepts of probabilities that should be taught in preschool classrooms (q. 3). Additionally, the great majority of the participants did not show complete understanding of the concepts of "fair" and "unfair" (q. 3).

In the second set of implicit questions, which investigated the degree of acceptance of teaching probabilistic concepts in preschool students, it was found that the great majority of the participants could not describe the aims of the new curriculum regarding the topic of 'probabilities' and their practical implementation (q. 5), about half of the participants thought that the teaching of the concepts on probabilities on preschool education is a positive change in the curriculum (q. 6) while their justifications are mostly based on the contribution of a more general mathematical training, and finally there was no participant that claimed that she managed to accomplish an activity based on probabilities (q. 7).

Regarding our second theoretical question, it was found that after the participation on the training program based on the inquiry-based approach the participants improved their self-efficacy teaching beliefs regarding the instruction of probabilities in preschool students. It appears that the training program had a positive influence not only on the preschool teachers' knowledge but also on their self-efficacy beliefs to teach probabilistic concepts.

More specifically, the participants' responses in the explicit questions showed that they felt more prepared, more secure and more confident to teach probabilities in preschool students (q. 1, 2, 8a-8d) after the training. In the first set of implicit questions the participants had a more complete understanding of the probabilistic concepts after their participation in the training program, which is also accompanied by an accurate justification. Finally, after

the completion of the training program the participants could reply more specifically in the second set of implicit questions regarding the necessity of teaching probabilistic concepts to preschool students (q. 6 & 7). For example, all the participants after the training believe that the inclusion of the probabilistic concepts in the preschool curriculum is a positive change and most of them based this claim on the importance of the course and on the idea of improving students' general mathematical culture.

The above mentioned findings seem to be consistent with previous findings, where it was investigated how training programs may contribute to the change of the educators' initial self-efficacy beliefs in teaching mathematics generally (Philippou & Christou 1998; Unglaub, 1997), or more specifically in teaching concepts on probabilities (Stipek, et al., 2001; Williams & Nisbet 2014).

CONCLUSIONS

Researchers often try to explain human behavior following the schema cause-and-effect. In situations like this an ontological perspective is attributed to emotional parameters. However, trying to challenge people to reveal their emotions seems to be a really difficult but also substantial question in educational research (McDonald, 2013; Ruffell et al., 1998; Zacharos et al., 2007); most importantly when emotional parameters are investigated amongst educators.

The current research is based in the use of a qualitative research method and some interesting information was gathered. For example, it was found that the scientific awareness improves the teachers' educational confidence and can positively change their self-efficacy teaching beliefs (see also Lee, 2005). This finding adds to the idea of introducing new mathematical concepts in the curricula.

Additionally, the educational context, where learning takes place, like the inquiry-based approach, also plays a crucial role and has to be taken into consideration. As shown in the current research, useful ways to reduce the educators' hesitation and improve their confidence are the interaction with other educators, the reinforcement of their autonomy, or the participation in designing activities on mathematics (Copley, 2004; Maaß, & Doorman, 2013).

However, the shift from a traditional to an inquiry-based approach is not easy. Usually educational programs, which were designed on the basis of the inquiry-based approach, did not have the expected effects, because the educators that were trained used their prior beliefs to explain the pedagogical principles of the programs. As a result, they applied traditional characteristics to the program (Stipek, et al., 2001). In addition, there are many contextual issues that may influence the educational systems in different countries. These issues socially and historically evolved, resist in changes, especially in school subject areas like science and mathematics. Furthermore, in some cases we "would see a system of professional development that is often ad hoc and, in some nations, almost non-existent after a period of ITE (Initial Teacher Education)" (Wake & Burkhardt, 2013, p. 859).

In concluding, despite the fact that there are strong indications that the appropriate training programs may improve the educators' feelings on their educational abilities, still there is a lot that has to be done in the context of the inquiry-based teaching. The educators have to adopt new roles and practices and get convinced that, if they accept new educational perspectives, they may have improved professional expectations (Artigue et al., 2012). On the other hand, if we expect teachers' professional sophisticated programs to be effective, then they should be intensive, including phases of analysis, implementation, and feedback and they should pursue long-term educational results. This procedure, which looks like as a spiral

model, could contribute gradually in developing teachers' practices (Maaß & Doorman, 2013).

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