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Personal Teaching Efficacy in Teaching Statistics: A Case Study

Over the past few years, statistics has gradually been established as an essential strand of the K-12 mathematics curriculum. In order to be treated as one of the five major units of mathematics teaching, teachers need to hold rich knowledge and accurate self-efficacy beliefs in order to implement effective instruction. The present case study investigated the personal teaching efficacy of two pre-service teachers within the area of statistics. Semi-structured interviews were conducted in order to investigate personal teaching efficacy beliefs of two pre-service teachers. The analysis revealed that despite their lack of teaching experience and pre-service training in teaching statistics, both teachers overestimated their competence to teach several statistical concepts and expressed low interest in professional development in this field. The results lead to suggestions for practical implications on the pre-service teacher's training in the teaching of statistics and further research implications.

Introduction

Statistical concepts have been included in the mathematics curriculum – at least as not basic topics– since the first half of the 20th century (Jacobbe, 2007). However, for the last 20 years statistics has been emerging as a separate, major strand of study all over the world (Garfield & Ben-Zvi, 2008; Mills, 2007; NCTM, 2000) and Cyprus is no exception. In particular, the mathematics curriculum in Cyprus is divided into five strands: numbers, measurement, geometry, algebra, statistics-probabilities (National Curriculum, 2010). As well as that, the primary school textbooks place strong emphasis on statistics, as they include various tasks on statistical concepts and make connections with concepts from other strands (Meletiou-Mavrotheris, Paparistodemou, & Stylianou, 2009).

What scholars commonly call "statistics education reform movement" (Tishkovskaya & Lancaster, 2012) is stimulated by a variety of factors, some of which are: the importance of statistics for promoting critical reasoning and its vital role in real life and in various career fields (Gal, 2002). A dominant factor for the success of every curriculum reform is the teacher (Shaughnessy, 1992). Therefore, the shift of statistics to a focus area of mathematics curriculum is necessary but not sufficient for the improvement of statistics education. There are at least two more obstacles in statistics education, which pertain to teachers' statistics knowledge and their beliefs in the field.

Focusing on the first parameter, teachers' knowledge contributes to teaching quality and student achievement (Hill, Rowan, & Ball, 2005). Statistical knowledge for teaching differs from mathematics knowledge for teaching, due to the more subjective and uncertain nature of statistics compared with mathematics (Burgess, 2006; Gal & Garfield, 1997). However, teachers possess low-level knowledge for teaching statistics (Chick & Pierce, 2008; Godino, Batanero, Roa, & Wilhelmi, 2008) and encounter crucial difficulties in understanding core

statistical concepts, because of their superficial statistical education (Shaughnessy, 2007). For instance, when asked to interpret graphs, teachers do not consider the distribution as a whole, paying attention only to particular aspects, such as the average or an outlier (Espinel, Bruno, & Plasencia, 2008). Also, their knowledge of measures of central tendency is mainly procedural, without being able to comprehend what these measures represent within a specific context (Groth & Bergner, 2006; Jacobbe, 2012).

As concerns the second key variable, it was found that teachers' beliefs about mathematics and mathematics teaching drive their instructional practices (Pajares, 1992; Richardson, 1996; Wilkins, 2008; Wilson & Cooney, 2002). A type of beliefs acknowledged to be of great importance is teachers' self-efficacy (Pajares, 1992). Teachers' efficacy is linked to teachers' professional behavior (Charalambous, Philippou, & Kyriakides, 2008), teachers' effectiveness and students' achievement (Cakiroglu, 2008; Huinker & Madison, 1997; Wilson & Cooney, 2002).

Thus far, a vast number of studies have been devoted to shed light on teachers' efficacy generally in mathematics (Bates, Latham, & Kim, 2011; Brown, 2012; Cakiroglu, 2008; Charalambous et al., 2008; Newton, Leonard, Evans, & Eastburn, 2012; Swars, Smith, Smith, & Hart, 2009). However, limited research exists on teachers' efficacy specifically in the domain of statistics (Harrell-Williams, Sorto, Pierce, Lesser, & Murphy, 2013; Estrada, Batanero, & Lancaster, 2011). Those studies have focused mainly on in-service teachers' efficacy and have yielded contradictory findings. What is notable is that no relevant study has been carried out in the context of Cyprus, despite the emphasis teachers are required to pay on statistics. At the same time, only few studies have explored the way in which teacher education experiences offer opportunities for teachers to learn the necessary mathematical knowledge for teaching (Steele, Hillen, & Smith, 2013). Since the field is still in its infancy, it seems to be fruitful for research. We believe that a better understanding of teachers' beliefs can foster the implementation of curriculum innovative practices (Song & Looi, 2012).

Literature Review

The Construct of Teacher Efficacy

The concept of teacher efficacy is grounded in Bandura's (1997) social cognitive theory. Self-efficacy is defined as one's belief in one's abilities to organize and accomplish tasks, so as to meet specific goals (Bandura, 1997). Teacher's sense of efficacy can be conceptualized as a teacher's belief in his/her own abilities to organize instruction and promote learning (Hoy & Woolfolk, 1993; Huinker & Madison, 1997; Tschannen-Moran & Hoy, 2001). It has been characterized as subject-matter specific (Tschannen-Moran et al., 1998). For example, a teacher may feel much more comfortable to teach Geometry than Algebra.

Teacher efficacy consists of two components: general teaching efficacy and personal teaching efficacy. The first term refers to teachers' belief about the learning outcomes they can give rise to (Huinker& Madison, 1997; Tschannen-Moran & Hoy, 2001; Tschannen-Moran et al., 1998). General teaching efficacy actually

constitutes the belief that "students are teachable" (Ross, Cousins, &Gadalla, 1996). This judgment goes beyond the individual capability of the teacher, taking into account the impact of external factors on learning, such as students' socioeconomic status (Tschannen-Moran & Hoy, 2001).

On the other hand, the second aspect is more specific. It reflects the extent to which a teacher believes that he can teach, regardless of any external influences (Tschannen-Moran et al., 1998). Personal teaching efficacy has three dimensions: efficacy for instructional strategies, student engagement and classroom management (Tschannen-Moran & Hoy, 2001). This study focuses on personal teaching efficacy and particularly on efficacy for instructional strategies.

The Importance of Personal Teaching Efficacy

In general, an extensive body of research has suggested the predictive power of self-efficacy beliefs for one's actual behavior (Bandura, 1997; Pajares, 1996; Pajares & Schunk, 2005; Schunk & Miller, 2002; Zimmerman, 2000). In fact, self-efficacy intervenes between knowledge and action (Huinker& Madison, 1997). Given that, personal teaching efficacy of a teacher is extremely influential to the process of teaching and students' learning outcomes (Pajares, 1992).

First of all, personal teaching efficacy is closely related to the instruction time teachers dedicate to each concept (Bandura, 1993; Wenta, 2000 cited in Harrell-Williams et al., 2013) and to the energy they invest in overcoming the obstacles they face (Tschannen-Moran & Hoy, 2001; Zimmerman, 1995). It has strong impact on the learning goals they set for their students (Bandura, 1997; Tschannen-Moran & Hoy, 2001). Teachers with high self-efficacy beliefs tend to use student-centered teaching approaches (Cakiroglu, 2008) and effective strategies for classroom management (Brown, 2012).

Furthermore, prior literature highlights the link between teachers' sense of efficacy and their disposition towards professional development. Even so, researchers have not yet reached consensus on this issue. On the one hand, some researchers argued that teachers with strong efficacy to teach specific concepts are more willing to become familiar with and use contemporary teaching approaches, aiming at maximizing learning gains (Ashton & Webb, 1986 cited in Huinker & Madison, 1997; Pajares, 1996). On the other hand, Richardson and Placier (2001) claimed that teachers should be aware of their weaknesses before they expend time and effort on strengthening them. From this viewpoint, teachers with low opinion of their abilities to teach a certain topic are more likely to be interested in attending training sessions.

Factors Affecting Teachers' Efficacy

According to Bandura's theory (1995, 1997), mastery experiences have the most significant impact on teachers' sense of efficacy. This assertion has been empirically tested and corroborated by several studies (Swars, 2005; Tschannen-Moran et al., 1998). Successful teaching experiences in a domain offer teachers substantial evidence that they can facilitate learning (Bandura, 1995).

Moreover, experiences gained through observation of others who are similar to them have the potential to alter teachers' efficacy, as well. Such experiences are labeled vicarious experiences. In addition, self-efficacy beliefs can be either raised or undermined by social persuasion. If a teacher is encouraged verbally that he can reach his/her teaching goals, then he/she will be convinced that he/she can provide powerful learning experiences for his/her students (Bandura, 1995, 1997).

Relying on Bandura's theory, teachers' personal efficacy tends to be enhanced during pre-service preparation and as teachers become more experienced in their career (Hoy &Woolfolk, 1993). It is important to underline that teachers' sense of efficacy appears to be fairly stable once a teacher enters the profession (Kieftenbeld, Natesan& Eddy, 2011).

Beyond the sources of information proposed by Bandura, other critical points that influence teachers' sense of efficacy are their content and pedagogical content knowledge (Huinker& Madison, 1997; Steele et al., 2013), and beliefs concerning the subject area (Cakiroglu, 2000 cited in Harrell, Pierce, Sorto, Murphy, Lesser, & Enders, 2009). During instruction, teachers are expected to make teaching decisions within a context, drawing upon their knowledge and their beliefs (Llinares, 2000).

Personal Teaching Efficacy Beliefs Regarding Statistics

Although statistics has received increased attention by curriculum developers and mathematics educators, research works on teachers' efficacy beliefs in this domain are limited. On the one hand, Gal (1992) (as cited in Mills, 2007) claims that many teachers do not feel secure enough to teach the strand of statistics, attributing such a belief to their insufficient pre-service training (Begg& Edwards, 1999; Harrell et al., 2009; Shaughnessy, 1992). As a result, they are consciously reluctant to teach such concepts. Recent quantitative studies pursued in Australia (Callingham, Watson, Collis, & Moritz, 1995; Watson, 2001) and USA (Mills, 2007) have examined in-service teachers and provided empirical evidence that reinforces the above perspective. The aforementioned studies indicated that the teachers explicitly expressed a need for further training in teaching statistics.

In contrast, the qualitative studies undertaken in New Zealand by Begg and Edwards (1999) and Edwards (1996) have found diametrically opposed results. To be more specific, the former study focused on both in-service and pre-service teachers and the latter on merely in-service teachers. It was concluded that the teachers did not have accurate sense of efficacy for teaching statistical concepts. Although their pedagogical content knowledge in statistics was critically weak, they had reported rather high confidence to teach, without considering their deficient statistical education as an obstacle for their instruction (Begg& Edwards, 1999; Edwards, 1996).

Apart from the above findings, literature has documented differences in personal teaching efficacy about certain statistical concepts, especially in the case of in-service teachers. Generally, comparing primary and secondary teachers, Watson (2001) has shown that the latter had significantly higher confidence to teach concepts such as

median, graphical representations and mean.

More specifically, the in-service teachers express moderate confidence to teach the concept of mean (Callingham et al., 1995), whereas both in-service and pre-service teachers have rather low teaching efficacy towards concepts newly introduced in the mathematics curriculum, e.g. stem and leaf diagram (Begg & Edwards, 1999; Edwards, 1996). At the same time, in-service as well as pre-service teachers state clearly that they are competent enough to teach frequency graphs, like pictographs and bar graphs (Begg & Edwards, 1999; Callingham et al., 1995; Edwards, 1996; Watson, 2001).

Purpose and Research Questions

Learning to teach is considered to be a complex, active and constructive process (Sanchez & Llinares, 2003), so we have to explore further what teachers bring to the teacher education program and what teaching efficacy beliefs are constructed during the program. The current study aims to investigate personal teaching efficacy beliefs of two Cypriot pre-service teachers in respect to statistics. The lack of research in this domain highlights the necessity of concentrating on case studies, which will enable us to illustrate teachers' knowledge about statistics and their respective teaching efficacy, as the starting point before investigating the effectiveness of innovative processes.

Keeping in mind the fact that studies which apply self-report methods (King & Bruner, 2000) and measure sensitive constructs with high social influence (Tourangeau & Yan, 2007) face problems with social-desirability bias, we used the case study approach. As Rowley (2002, p. 16) notes, case studies "offer insights that might not be achieved with other approaches". This method provides detailed information about human beings and permits a more holistic understanding (Feagin, Orum, & Sjoberg, 1991).

In particular, the present study seeks answers to the following research questions:

1. What personal teaching efficacy beliefs the two prospective teachers hold in the area of statistics?

2. Are there any differences in their personal teaching efficacy regarding the following two sets of concepts: frequency graphs interpretation, i.e. bar graph, linear graph and pie chart, and measures of central tendency and dispersion, namely mode, mean and range?

Rationale of the Present Study

The significance of the paper is twofold. From a theoretical point of view, it contributes to the mathematics education research by addressing the observed research gap on pre-service teachers' efficacy to teach statistics in the educational context of Cyprus. From a practical viewpoint, the findings of the study are of interest to curriculum developers. Given the decisive role of teaching efficacy in teaching and learning, by gaining insight into statistics personal teaching efficacy of two pre-service teachers in Cyprus, the study will take a snapshot of teachers' level of preparation to respond to the demands that the revised curriculum has placed on them to teach statistics. Thus, the present work will help policymakers create those conditions that will ensure the successful implementation of this reform initiative.

Methodology

Sample and sampling method

The subjects of the case study were two generalist teachers, Maria and Andri (both names are pseudonyms), whichhave obtained a 4-year bachelor's degree in primary education from a Department of Education at Cyprus. They were selected through purposive sampling, based upon two criteria. Firstly, neither Maria nor Andri had teaching experience. They have not undertaken any teaching activity, except fora semester of fieldwork during their university studies. Secondly, they were both "local knowledge cases". Because of the familiarity between these teachers and the interviewer, there would be "ample opportunity for informed and in-depth analysis" (Thomas, 2011, p. 514) of pre-service teachers' personal teaching efficacy.

Data collection

The data were collected through individual semi-structured interviews. The interviews were conducted by the first author and lasted approximately 35 min each. There were video-recorded and then transcribed. The interview protocol we developed comprised two sections (see Appendix).

Section A focused on the educational background of the teachers. Participants were asked to provide details about the statistics-related courses they have taken during or after their undergraduate studies, and their fieldwork experiences, especially those that pertain to statistics content.

Section B intended to capture their personal teaching efficacy about statistics in general and towards specific concepts (frequency graphs interpretation and measures of central tendency and dispersion). Teachers were given a series of tasks (see Figure 1) extracted from the revised mathematics curriculum of Cyprus (National Curriculum, 2010). Based on these tasks, they were prompted to reflect on and evaluate their teaching competence, using a five-point scale (1=negative and 5=positive).

Data Analysis

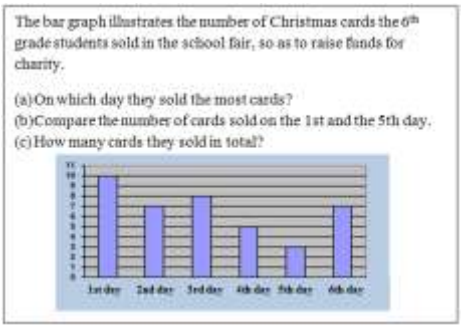
The data analysis was conducted in stages, by applying the principles of analytic induction (Jones, 2004; Pascale, 2011), and specifically the pattern matching technique (Yin, 2013). Firstly, we formulated a hypothesis for each research question, based on our literature review:

Hypothesis 1: Teachers' lack of teaching experience and statistics background leads to low-level personal teaching efficacy in statistics and diminishes their willingness to be further trained in the area.

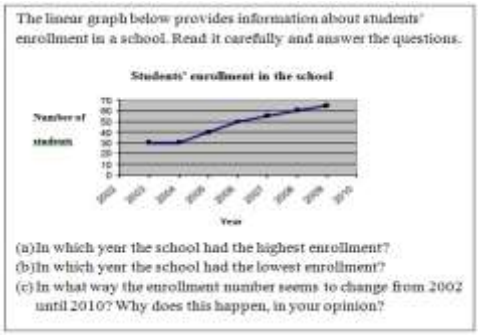
Hypothesis 2: Teachers feel more secure to teach the interpretation of frequency graphs than the measures of central tendency and dispersion.

Then, by reviewing the transcripts, we developed codes and the similar codes were grouped together to form categories. Each case was individually examined against each hypothesis, leading either to the validation or the revision of the hypothesis in such a way that it includes the case examined.

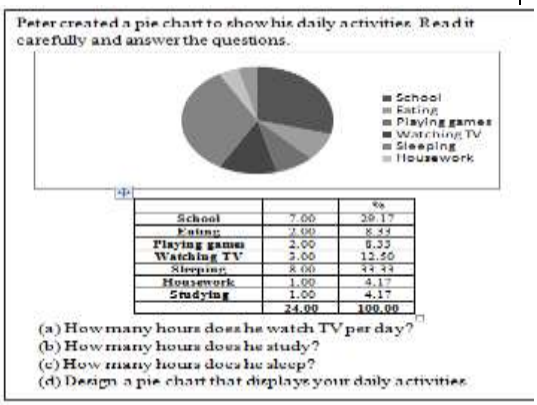
A. Bar graph interpretation task



B. Linear graph interpretation task



C. Frequency pie chart interpretation task



		%
School	7.00	29.17
Eating	2.00	8.33
Playing games	2.00	8.33
Watching TV	3.00	12.50
Sleeping	8.00	33.33
Housework	1.00	4.17
Studying	1.00	4.17
	24.00	100.00

D. Measures of central tendency and dispersion task

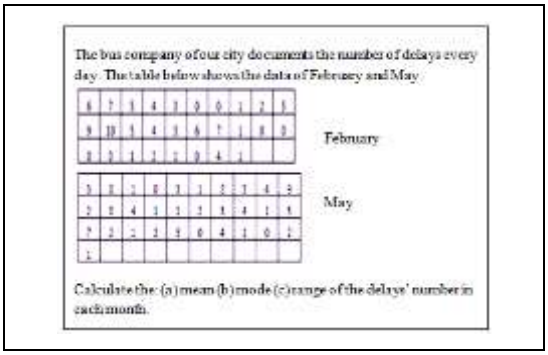


Figure 1: Statistical tasks extracted from the mathematics curriculum of Cyprus

Findings

The results of the study are presented in two sections, each of which is relevant to a research question.

Teachers' Personal Statistics Teaching Efficacy

Both participants had no teaching experience at all, not even during the period of fieldwork. While they attended the same mathematics and statistics related courses, they both had substandard education in statistics content and teaching. Their pre-service training in statistics was limited to an introductory-level course about the basic statistical concepts. This lecture-based course did not provide them opportunities to experience discovery-oriented statistics neither did it prepare them to teach statistics. Not even the obligatory course "Mathematics teaching" gave any emphasis to the teaching of statistical concepts. Besides that, both teachers possessed shallow curriculum knowledge in statistics. The following statements are illustrative: "Statistical concepts are taught in the upper grades of primary school, whereas the strands of Geometry, Measurement and Numbers are taught only in the lower grades", "Does the concept of percentage fall under

statistics?", "Does Cartesian product belong to the field of statistics?".

Notwithstanding their teaching inexperience and their poor statistical knowledge, the present study's cases do not confirm the pattern of the hypothesis that corresponds to the first research question. A pattern that arose from the interviews data was that both participants held high personal teaching efficacy beliefs in statistics. As shown in Table 1, both teachers placed themselves on 4 at a five-point scale. As well as that, Maria systematically used the phrase "I feel that I am capable of teaching statistics", and Andri noted, "These concepts are pretty simple, so I am competent to teach them". Importantly, Maria considered the external factors, and particularly the students, as the main reason for the problems she may encounter during the teaching process: "Students may not be able to explain to me their exact cognitive difficulties (in a statistical concept), but if they do so, then yes, I will be able to help them".

Another pattern that emerged from the data was the absence of interest in professional development in the field of statistics teaching. While they admitted the insufficiency of their statistics content and teaching knowledge, they did not perceive it as an obstacle for their instruction. For example, Maria commented, "I have not received adequate statistics education, but this is not a barrier to teach statistics in primary school". Consequently, even though they hastened to underline the value of professional development, they declared that gaining training in statistics is not one of their priorities. Moreover, when asked about their opinion on the focus of professional development programs in statistics, they laid greater stress on practical teaching ideas and activities, rather than on the expansion of their subject-matter and pedagogical content knowledge pertaining to this strand.

Table 1

Teachers' self-assigned grades for their personal teaching efficacy in the five strands of mathematics curriculum

	Andri (out of 5)	**Maria** (out of 5)
Statistics-Probabilities	4	4
Numbers	4.5	4
Measurement	4	4
Algebra	1.5	4
Geometry	3	4

The patterns observed in the two cases necessitate the modification of the initial hypothesis for the first research question. Based on the interviews' data, personal teaching efficacy is much more associated with their beliefs about the cognitive demand of the statistical concepts in primary school, than with their teaching experience and education. In detail, their high personal teaching efficacy is connected with their view that the primary school's statistical concepts are cognitively low-level, as suggested by the following excerpts:

> Maria: "I believe that primary school's statistical concepts are not so challenging … they are not too complicated to teach".
>
> Andri: "The most advanced content that students are taught in primary school includes the mean, mode etc… I think I

can teach concepts of such a level … They are relatively simple".

In relation to the above pattern, it is worth to mention the following point. At the beginning of the interview, Andri appeared to be plagued by self-doubts about her ability to teach statistics, assigning herself the grade of 2/5. However, her weak personal teaching efficacy was based on her uncertainty about what statistics is taught in primary school. In fact, she overestimated the difficulty level of the particular content: "The first things that come to my mind are the concept of probability and the content I was taught during my undergraduate studies, such as probability distribution, which was so difficult for me".

It is important to describe briefly a pattern that was detected in the interviews' data without being within the scope of the study. Both participants believed that they can learn to teach statistics in the future. For instance, Andri argued, "Even if I am not familiar with a concept (e.g. range), I can learn information about it and hence I will be able to teach it". Likewise, Maria noted, "In the case that I do not know the exact meaning of a concept, I can search for information and then I will explain it to my students". Such a perception can be characterized as a control belief (Op't Eynde, de Corte, Verschaffel, 2002). Since the exploration of this kind of beliefs is far beyond the purpose of this work, this issue calls for further research in the years to come.

Teachers' Personal Efficacy in Teaching Certain Statistical Concepts

As concerns the hypothesis of the second research question, the patterns we identified were different between the two cases. The case of Maria validates the hypothesis that teachers are more confident to teach frequency graphs interpretation than measures of central tendency and dispersion. In contrast, Andri's interview provides disconfirming evidence for the hypothesis, as the reverse pattern was observed.

To clarify, on the one hand Maria held very strong personal teaching efficacy for the interpretation of all the frequency graphs. Although she claimed that she had no mastery experiences in teaching the interpretation of bar graphs and pie charts, she evaluated herself with notably high grades (see Table 2). At the same time, for the interpretation of frequency linear graphs she gave herself full marks, attributing this grade to her fieldwork teaching experience in this concept. Nevertheless, as the interview progressed, it was found that these experiences did not relate to frequency linear graphs but to speed-time graphs.

With respect to the measures of central tendency and dispersion, Maria was self-evaluated highly. In particular, she graded her teaching competence about mode with 4/5, maintaining that, "This concept is unambiguous, so I can teach it effectively, without needing to use several examples". Regarding the concept of mean, she assigned herself the grade of 3.5/5, claiming that the mean calculation requires a much more complex procedure than the computation of the mode. Finally, she mentioned that there is no difficulty in teaching the concept of range, as "you simply have to explain them that they should subtract the smallest value from the largest … and that is all".

When comparing her capability of teaching measures of central tendency and frequency graphs, Maria commented that

she is particularly more confident to teach the latter concepts, because she had more experiences during her secondary school education and deeper prior knowledge of them. Interestingly, she wondered, "How will teachers be able to teach a concept, if they do not even grasp it?". Therefore, the initial hypothesis is confirmed by the case of Maria.

On the other hand, Andri rated herself as feeling considerably confident when teaching the interpretation of all the three frequency graphs. To be more precise, on a scale from 1 to 5, she placed herself on 3.5 in terms of her ability to teach frequency bar graphs, even though she had no relevant mastery experience at all. It is remarkable that she appeared to be doubtful about the strand in which this concept pertains to. Similar personal teaching efficacy was expressed about the concept of pie chart. What was unlike was her confidence to teach the interpretation of frequency linear graph. Having some reservations about her ability to comprehend the linear graph, she evaluated her teaching competence with the grade of 3/5 and mentioned, "The bar graph is much more understandable with only a single glance".

With respect to the measures of central tendency and dispersion, namely mean, mode and range, Andri was convinced that she is incredibly competent to teach them. When asked to rate her teaching capability on a scale from one to five, she placed herself on 4.5 for all the three concepts. It is notable that Andri was not aware of the definition of range at the beginning of the interview and she requested for explanation. Then, she argued, "I can teach range effectively, regardless that I didn't know what it means until now. If I had been asked to teach it, I would have found out its meaning".

Table 2

Teachers' self-assigned grades for their personal teaching efficacy in statistics

	Maria (out of 5)	**Andri** (out of 5)
Bar graph	4.5	3.5
Linear graph	5	3
Pie chart	4.5	3.5
Mode	4	4.5
Mean	3.5	4.5
Range	4	4.5

Contrasting the measures of central tendency and dispersion and the interpretation of frequency graphs, Andri asserted that she felt immensely more secure to teach the former concepts. To exemplify this, she stated, "For these concepts, what is only needed is to explain to the students that they should always apply this model, this formula […]". For instance, concerning the concept of mean "there is a procedure, which you simply have to describe to them… add up the numbers and divide". On the contrary, she was noticeably more worried about the concept of frequency graphs, for the reason that "there is no recipe for this. It is more difficult for teachers to draw students' attention to it and help them interpret it correctly. Graph interpretation is quite different from performing a computational procedure".

Thus, the pattern that was evident in Andri's case did not confirm the initial hypothesis. While Andri held pretty high

personal teaching efficacy in the interpretation of frequency graphs, she had much stronger opinion of her ability to teach the measures of central tendency and dispersion, because she perceived these concepts as merely memorizing procedures.

Discussion

The goal of this study was to examine personal teaching efficacy of two pre-service teachers in the area of statistics. With respect to the first research question, in accord with the studies of Begg and Edwards (1999) and Edwards (1996), we found that the participants strongly believed in their abilities to teach statistics. Keeping in mind Bandura's (1995, 1997) claim that mastery experiences in an area are the most powerful sources of self-efficacy, the above result is completely unexpected, as the participants had no teaching experience. Additionally, the two pre-service teachers were unwilling to participate in professional development programs in statistics, due to their high personal teaching efficacy in the domain. This finding substantiates the argument that teachers can deal with a teaching deficiency, only if they have realized it (Richardson &Placier, 2001). Both teachers were more concerned about acquiring knowledge of innovative teaching methods rather than deepening their subject-matter and pedagogical content knowledge in statistics.

Based on the patterns of the cases examined, the hypothesis for the first research question needs to be reformulated in the following way. Teachers' beliefs about the complexity of the content taught in primary school heighten their personal teaching efficacy and reduce their interest in training. This conclusion reinforces the Cakiroglu's (2000) finding that teachers' efficacy in a domain is related to their beliefs about the content (Cakiroglu, 2000 in Harrell et al., 2009).

Concerning the second research question, the participants held high personal teaching efficacy for all the statistical concepts examined by the study. The above result provides support to studies which showed that pre-service teachers feel able enough to teach concepts such as pictographs and bar graphs (Edwards, 1996; Begg& Edwards, 1999; Callingham et al., 1995; Watson, 2001). At the same time, it is not absolutely consistent with the finding of Callingham and colleagues (1995) that in-service teachers have moderate sense of teaching efficacy about the concept of mean.

Hence, it is important to revise the hypothesis for the second research question so as to include the instances of the study, as follows: In some cases, pre-service teachers have higher personal teaching efficacy about frequency graphs interpretation in comparison to measures of central tendency, especially when they had richer experiences in the former concepts during school years. However, if they see the teaching of measures of central tendency from a procedural perspective, they are more likely to have stronger opinion of their particular teaching capability. It is imperative that teacher education programs critically revise their practices, so as to prepare teachers who have accurate awareness of their competence to teach statistics. This will be a pivotal step towards the improvement of teaching quality and learning outcomes (Huinker& Madison, 1997; Pajares, 1992).

The above challenge could be overcome by following these two suggestions, in a balanced way. First, teachers' preparation programs need to enrich teachers' subject-matter and pedagogical content knowledge in the field (Horton, 1997 in Jacobbe, 2007), by providing them more valuable learning experiences about statistics content and teaching. Given the acknowledged differences between mathematics and statistics (Burgess, 2006; Gal & Garfield, 1997), particular emphasis should be placed on the specific aspects of knowledge needed for teaching statistics. Simultaneously, it is necessary to reinforce personal teaching efficacy of prospective teachers. Through the lens of Bandura's theory (1995, 1997), these programs should offer opportunities for more mastery and vicarious teaching experiences in statistics during their fieldwork, accompanied by positive feedback and support.

Limitations and Future Research

In retrospect, this research study has specific limitations. The most noteworthy limitation of the study resides on its case study approach, which restricts the generalizability of the findings. Another limitation is that we did not ascertain the reliability of the coding process, for practical reasons. As well as that, we do acknowledge that the social desirability response bias may have influenced the alignment between their real teaching efficacy beliefs and their expressed ones. Also, this study has exclusively investigated pre-service teachers' efficacy, without measuring their actual knowledge and/or ability to teach statistics. The aforementioned limitations indicate directions for further research. A topic that seems to reveal productive paths for research is the development of personal teaching efficacy in the domain of statistics, during teachers' career. A question that future research should address is: What is the degree of consistency between their teaching competence and teaching efficacy beliefs in statistics?

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Appendix

Interview protocol

Section A: Pre-service Teachers' Background

1. How many years of teaching experience do you have?
2. How many and which mathematics-related courses did you take during your undergraduate studies?
3. How many and which statistics-related courses did you attend during your undergraduate studies?
4. Did you attend any course in mathematics or statistics teaching?
5. Did you take part in any professional development courses in mathematics or statistics?
6. Did you have the opportunity to teach statistical concepts during fieldwork? Could you talk to me about these experiences? To what extent your instruction was effective?

Section B: Personal Teaching Efficacy in Statistics

Dispositions Toward Professional Development

7. What is your opinion about the preparation you had during your teacher education program in terms of statistics teaching? Was it adequate or not?
8. What grade level do you teach mathematics?
9. Suppose that you can participate in a teacher training course in mathematics. Which of the five strands of the curriculum will you choose and why?

Personal Teaching Efficacy Generally in Statistics

10. Do you feel equally capable of teaching all the mathematics strands of the curriculum?

11. How would you rate your teaching ability in every strand, using a five-point scale (1= No level of competence, 5= High level of competence)? Could you explain why you assigned each grade to yourself?
12. What statistical concepts do you believe are taught at the primary school level?
13. How well can you teach statistical concepts in primary school? Can you engage even the most low-achieving students in learning? Why do you think so?
14. Do you have any concerns about your competence in teaching statistics?
15. How confident are you that you can respond to your students' questions in statistics?
16. If students struggle to understand a statistical concept (e.g. mean), how easily can you explain or give examples of it to them?

Personal Teaching Efficacy Beliefs about Specific Statistical Concepts

17. Are there any statistical concepts that you find more difficult to teach?
18. How well can you teach the following concepts with the tasks shown in Figure 1? Using a five-point scale, indicate your level of teaching competence for each concept and explain.

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