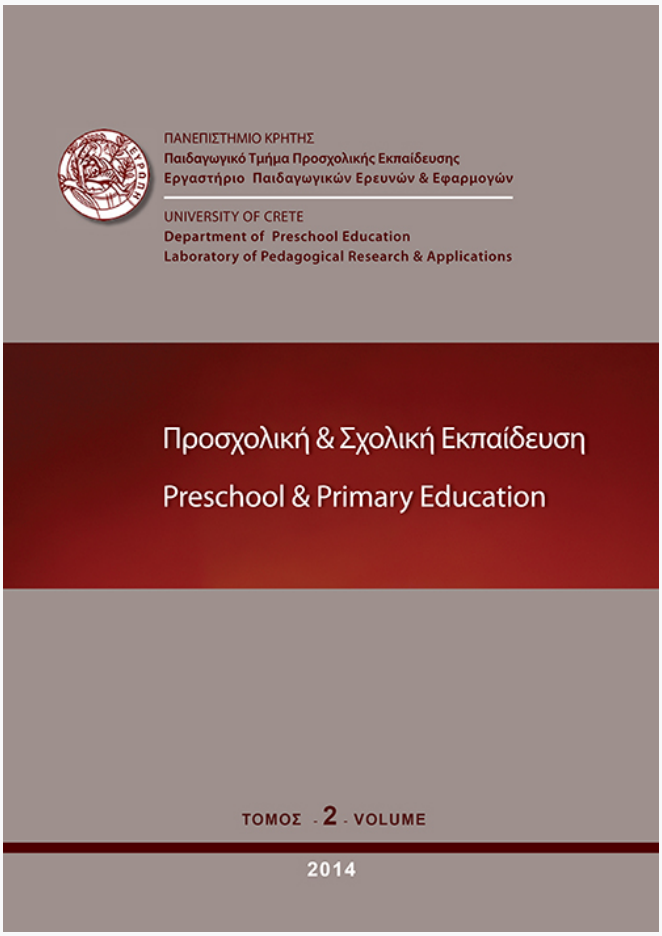
Preschool and Primary Education

Τόμ. 2 (2014)



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doi: 10.12681/ppej.85

Βιβλιογραφική αναφορά:

Xenofontos, C. (2014). The cultural dimensions of prospective mathematics teachers' beliefs: Insights from Cyprus and England. *Preschool and Primary Education*, *2*, 3–16. https://doi.org/10.12681/ppej.85

Preschool & Primary Education
2014, Volume 2, Issue 1, pp. 3-16
ISSN: 2241-7206

doi: dx.doi.org/10.12681/ppej.85

The cultural dimensions of prospective mathematics teachers' beliefs: Insights from Cyprus and England

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Summary. Based on the idea that mathematics education is, in general, culturally located, this paper discusses the cultural dimensions of prospective elementary teachers' beliefs in Cyprus and England, and how these relate to the general educational culture of the two countries. Two volunteer groups (twelve students from each country) from a notable university in each country accepted an open invitation for participation and were qualitatively interviewed. This paper discusses two common sub-themes that emerged under the general theme, Explicit Pedagogic Practice, and takes into close consideration students' beliefs about the use of teaching resources and group work. The findings suggest that the beliefs held by each cohort are framed by the cultural-educational rhetoric of its respective country. In the conclusion of the paper, some implications about teacher education are discussed.

Keywords: *Culture, mathematics, prospective teachers' beliefs, teacher education*

Introduction

The view that mathematics education is culturally situated is a well-established one (Bishop, 1988; Gerdes, 2010; Leung, 2002). Its cultural location is framed by various factors, such as the historical background of a nation state, political events, specific cultural norms, language, as well as the general structure of education, its aims and aspirations (Wong, Taha, & Veloo, 2001). From the perspective of pre-service teacher education, recent large-scale attempts have focused on how various countries prepare their teachers to teach mathematics in primary and secondary schools. Such examples include the IEA's *Teacher Education and Development Study in Mathematics* (TEDS-M), with more than fifteen countries participating (Ingvarson, Schwille, Tatto, Rowley, Peck, & Senk, 2013) and the *International Comparative Study in Mathematics Teacher Training* (Burghes, 2011), an initiative involving ten participating countries, funded by the UK-based Centre for Innovation in Mathematics Teaching, at Plymouth University. In spite of their insightful role in enabling planning and decision-making, large-scale comparative studies of this kind, lack detail and do not account for those cultural issues that have been implicated in educational attainment (Andrews, 2007). These issues are more likely to be addressed by small-scale comparative studies employing qualitative methodologies (Atweh & Clarkson, 2001; Fairbrother, 2007). Drawing data from a small-scale qualitative project, which investigates prospective teachers' beliefs about mathematical problem solving in Cyprus and England, this paper presents and discusses certain beliefs participants have on explicit pedagogic practice, and how these are

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e-publisher: *National Documentation Centre, National Hellenic Research Foundation*
URL: http://childeducation-journal.org

related to the general educational culture of the respective countries. The aim of this paper is that its topic's discussion will contribute to the development of cultural awareness among teacher educators, which, in turn, would improve the quality of preparation of prospective teachers. This paper begins by examining the literature in relation to mathematics teachers' beliefs and their cultural dimensions, as well as observing the research on prospective mathematics teachers' beliefs and teacher education.

Mathematics teachers' beliefs, their importance and relation to culture

For more than three decades, mathematics teachers' beliefs have gained extensive research attention, as it is widely accepted that they have a significant impact on what gets taught, how it gets taught, and what gets learnt in classrooms (Chapman, 2003; Ernest, 1989; Middleton, 1999; Thompson, 1984). However, this field of research has been characterised as messy (Pajares, 1992), not least because it includes many interrelated terms, such as attitudes, values, dispositions, conceptions and so on (Mason, 2004), which are often used interchangeably by authors (Törner, 2002). While I do not intend to *clarify this mess* in this paper, for the purposes of communication I follow Aguirre and Spear (1999), who construe teachers' beliefs as conceptions, personal ideologies, world views and values that shape practice and orient knowledge. However, the relation between beliefs and instructional practices is complex and beyond simple cause-and-effect (Anderson, White, & Sullivan, 2005). Indeed, a number of case studies have highlighted substantial disparities between espoused and enacted beliefs (Beswick, 2005; Raymond, 1997; Thompson, 1984), while others indicate that both beliefs and actions depend on the changing nature of the classroom context (Schoenfeld, 2000; Skott, 2001).

Culture and its relation to mathematics teachers' beliefs is central to this paper. How culture is designated is a complex process, loaded with different meanings. In my work, I follow Hofstede's (1983, p. 76) definition, according to which, culture is viewed as "part of our conditioning that we share with other members of our nation, region, or group, but not with members of other nations, regions, or groups". Culture, as a shared meaning system, can be formed at various levels, such as, cultural representation at an individual level, groups, organizations, nations, and the global culture (Erez & Gati, 2004). Many comparative studies in mathematics education have concluded that in-service teachers' beliefs (Andrews & Hatch, 2000; Correa, Perry, Sims, Miller, & Fang, 2008) and instructional practices (Andrews, 2007; Givvin, Hiebert, Jacobs, Hollingsworth, & Gallimore, 2005; Leung, 1995), are more closely aligned within individual countries rather than across them. Simply put, it is, for instance, more likely that a teacher in France will hold similar beliefs about mathematics and how to teach it, and to behave in similar ways to other French colleagues in classrooms, than to a mathematics teacher in another country. Examples of studies intended to investigate the cultural dimensions of mathematics teaching include the two TIMSS video studies (e.g., Hiebert & Stigler, 2000), Ma's work (1999) on Chinese and US elementary mathematics teachers, their training, subject matter and pedagogical knowledge, and instructional practices; and, from an exclusively European perspective, Andrews' (2007, 2009) analyses of mathematics teaching in five countries: Flemish Belgium, England, Finland, Hungary, and Spain. Distinct national patterns of behavior in typical mathematics classrooms of a country have been described, for example, as the *characteristic pedagogical flow* (Schmidt et al., 1996) or the *cultural script* (Stigler & Hiebert, 1999). More recently, in an attempt to explain how culture informs teachers' beliefs and practices, Andrews (2011) has proposed teachers' work within three curricula: intended curriculum (the systemic curricular model within which they operate); idealized curriculum (a unique set of articulable personal goals); and, received curriculum (cultural norms that influence instruction, where articulation is restrained).

Prospective mathematics teachers' beliefs

As research indicates, prospective teachers enter their teacher education programs with well-developed views on teaching and learning, on the one hand, but are resistant to change, on the other. These views are fundamentally influenced by former schooling experiences (Ambrose, 2004; Cooney, Shealy, & Arvold, 1998; Kagan, 1992) and, like all learners, prospective teachers can learn by drawing upon their own beliefs and previous experiences to understand new ideas, but their beliefs and knowledge may not be adaptable enough to allow for new views on learning and teaching (Anderson & Bird, 1995). In general, prospective teachers' beliefs tend to remain established through teacher education programs. Employing their earlier beliefs, prospective teachers may construe, and even challenge their teacher education coursework in ways different to how their instructors intended. Furthermore, while school placements, part of the preparatory programs, offer students the opportunity to apply theoretical ideas and reflect on their own teaching experiences in order to modify their beliefs, they are not always successful (Bauml, 2009; Ng, Nicholas, & Williams, 2010). Mentors and practical classroom conditions may have a negative impact on the beliefs of student teachers, who might then acquire different notions about teaching and learning, contradicting those taught during coursework (Toll, Nierstheimer, Lenski, & Kolloff, 2004). As a result, many teacher educators, when dealing with students who return from their placements, "wish to 'wash them clean' from the ideas they have learned" (Toll et al., 2004, p. 164). As the literature suggests, pre-university schooling experiences and school placements appear to have a significant impact on prospective teachers' beliefs, sometimes more so than the taught part of teacher preparation programs.

Perhaps disregarded by research so far is the fact that student teachers' prior experiences are culturally situated, and those who had taught them before university, and were their mentors during their undergraduate school placement, are thought to behave (not always consciously) in culturally 'monitored' manners (e.g. Andrews, 2007, 2011; Schmidt et al., 1996; Stigler & Hiebert 1999). Furthermore, it is worth taking into consideration that teacher preparation programs have their own organizational culture (in terms of modules, content, philosophy, instructors' values, and so on), which, in turn, is nested within a particular national culture (see Erez & Gati, 2004). Regardless of the differences between two programs in the same country (e.g., File & Gullo, 2002, and their comparison of two courses at a Midwestern university in the USA), it could be argued that programs in the same country share the same national teacher-education culture, adapted to the needs of the society in which they operate. My previous work with prospective teachers concludes that their beliefs about definitions regarding didactical concepts (such as *problem* and *problem solving*), at both the entry (Xenofontos & Andrews, 2012) and the exit stage (Xenofontos & Andrews, 2013) of their undergraduate studies, vary significantly across nations, and are generally related to the cultural aspirations and educational policies of their countries. However, there is a gap~~,~~ in the whole gamut of teacher education research~~,~~ concerning studies on the cultural location of prospective teachers' beliefs. Therefore, in this spirit, this paper, as far as explicit pedagogic practice is concerned, examines the similarities and/or differences of prospective teachers in Cyprus and England.

Methodology

Participants and data collection

This paper is based on data from a small-scale comparative study of Cypriot and English prospective elementary teachers' beliefs about mathematics, in general, and problem

solving, in particular. Following an open invitation to the whole of their respective cohorts, a volunteer group of final-year undergraduate elementary teacher education students in Cyprus and England attended individual interviews shortly before the end of their respective courses at a notable teacher education department in each country. The semi-structured interviews were framed by Ernest's (1989) three dimensions of teacher beliefs: about the nature of mathematics, mathematics teaching, and mathematics learning. Two additional dimensions on self-efficacy (self-efficacy as both a solver and a future teacher) were included. Thus, irrespective of their country of origin, all students' interviews were framed by the same set of general questions. The interview protocol is presented in the Appendix at the end of the paper.

Focusing on students at the exit point of their teacher education studies, offered an opportunity to examine the extent to which their beliefs had been informed not only by their experiences of mathematics as children, but as adults engaged in teacher education programs. Each group comprised twelve prospective teachers: the Cypriot group included eight females and four males, while the English included only females. The interviews, which lasted between thirty and forty minutes, took place at the participants' universities and were conducted in Greek and English, respectively, by the bilingual author. All interviews were audio-recorded and transcribed, and the names used in this paper are pseudonyms.

Data analysis

The data analysis took place in two stages. The first stage entailed a data-driven analysis (Kvale & Brinkmann, 2009) of the material from one country independent of the other. By employing the constant comparison process (Strauss & Corbin, 1998), themes were identified in the data of each country. The main purpose of this stage was to ensure that country-specific themes did not get lost. The second stage intended to determine whether country-specific themes from one data-set resonated with the other. In so doing, the extent to which themes from one data set could be used for analyzing the other was also examined. This process led to the identification of seven common themes, which were construed as culturally neutral, namely: (a) the nature of mathematical problems (b) the nature of mathematical problem solving (c) the self as a problem solver (d) affective issues of learning (e) cognitive issues of learning (f) explicit pedagogic practice; and (g) the self as a teacher of problem solving.

One of the general common themes concerned students' beliefs about *Explicit Pedagogic Practice*, that is, teachers' roles and instructional practices, teacher-pupils and pupils-pupils interactions during mathematical activities in classrooms, as well as the use of teaching resources. Under this theme, various sub-themes, or categories, as otherwise called (see Kvale & Brinkmann, 2009), emerged. This paper chooses to present two common sub-themes, concerning students' beliefs about *recourses for teaching ideas* and *group work*, not least because the two cohorts expressed very different beliefs about these issues. The actuality of such differences is in line with Grant's (2000) argument that things with the same name do not necessarily have the same function in every culture.

Recourses for teaching ideas

Both groups of students talked about the use of resources for inventing teaching ideas, tasks, and activities. However, their beliefs about the nature of these recourses varied significantly. The Cypriot students commented on the use of the National Textbooks as a main resource, while their English peers argued for the need of a variety of resources. The participants' beliefs are presented below, and discussed in further detail.

The Cypriot students: Use of National Textbooks as a main teaching resource

The practice of the mathematics National Textbooks was a theme that emerged from all twelve students' responses. Nevertheless, two poles of opinions appeared with regard to textbooks as a teaching resource. On the one hand, three students made no attempts to critique the content of the textbooks. In fact, they agreed that textbooks are provided so that teachers follow them. In one typical response, Alexandros declared, "*for teaching mathematics, teachers should use the national textbooks. They should follow the book, they should follow the order things have in the books*".

The other nine students also admitted how they had been working with the national textbooks during school experience. Contrary to their other classmates, they expressed dissatisfaction with the quality of the tasks included in the textbooks, as well as reservations regarding the tasks' appropriateness for every classroom and every child. As Nefeli stated, "*I can't say I was 100% satisfied with the problems in the textbooks. The books suggest some problems without taking the pupils' level of competence into account*". Christoforos agreed and shared his personal experience with a very competent pupil in his class. "*There was one pupil who was amazing. Mathematics was, for him, a piece of cake. So I had to find more difficult problems for him because those in the book were too easy*".

Despite their apparent dissatisfaction, all nine students had to follow the national textbooks because their mentors (the classroom teachers) asked them to. As Marianna argued, "*because I didn't have my own classroom, I had to do what the classroom teacher wanted me to do. He wanted me to follow the book, so I had to*". Despina was particularly critical of the fact that in-service teachers follow the national textbooks as their main, and most times, only, teaching resource:

> *You know, in Cyprus, most teachers follow the books as if they are the Holy Bible. They are so stressed about covering everything that is in the book. They care about the appearance of their lessons and not the quality. Because, you know, the school inspectors who are going to evaluate them will check the pupils' work in the textbooks.*

The English students: Teachers need to use a variety of resources

All twelve students argued that there was a vast variety of resources from which teachers could find mathematical problems and ideas for mathematical activities. With respect to her own teaching, Alice claimed she had been using "*lots of things, lots of books, lots of internet, erm resources, Primary National Strategy resources, and publications*". All her classmates expressed similar views, and shared their experiences from school placements.

Nine participants talked about the use of printed teaching resources. For example, Nicole stated:

> *I've got two books, erm, Haylock is the author of them, both. There's one, like, mathematics in primary school. And one is more like a book for teachers. And it tells you a topic, like say calculation. And it explains to you as a teacher, and tells you how to do it. That's a really good book as well. It has a DVD!*

All students expressed disagreement with this over-dependency on textbooks and schemes of work because, as claimed, they constrained teachers. For Emma, these could just be used for ideas, but not as the main teaching resource. According to her, "*I might use them prior to doing my planning, to find ideas, use textbooks. But, uh, within school context, there's not so much use of textbooks*". In some of her placements, Alice had to use a particular scheme of work, something she found restrictive.

> *I've been on placements where I used their schemes of work, where it tells you what you're teaching and tells you what you're doing. But I find that quite rigid. It doesn't always suit your class. So on my latest placement, I didn't have any schemes, and I find it much, you know, it's a lot more work trying to come up with it all on your own, but it's better.*

Online resources appeared to be very popular among the English group. In fact, ten out of the twelve students talked about the use of internet for finding mathematical problems and ideas for activities. Joanne, in particular, admitted that the internet was her main resource of ideas. As she said,

> *I mostly use the internet (laughter). Mostly the internet. So many things have been published now that you can just go and find them. But usually when I find them, I adapt them to the children because I find activities that are stimulating for them, but they're either too easy or too hard. So I try to adjust it.*

Stefanie said that she had joined educational websites and associations.

> *There's actually a site I've signed up to this year; you pay like twelve pounds a year. I haven't used it before but the teacher in the previous school said, "sign up for twelve months", you know, it's worth doing. And I've joined the ATM[1]. You get things from that.*

Linking students' beliefs about resources to their respective educational culture

All Cypriot students talked about employing National Textbooks as a main resource for teachers to find mathematical problems and ideas for classroom activities. An over-reliance on the mandated textbooks, published by the Ministry of Education and Culture was reported by both TIMSS 2003 (Mullis, Martin, Gonzalez, & Chrostowski, 2004) and TIMSS 2007 (Mullis, Marin, & Foy, 2008), according to which 97% and 90% of the participating Cypriot pupils, respectively, were taught by teachers reporting textbook use. The majority of the participants, here, were critical about the quality of the textbooks, questioning their appropriateness for an average Cypriot pupil. However, as they argued, they had been using these textbooks during their school placements because their mentors asked them to.

Contrary to their Cypriot peers, *all* English students appeared to hold quite progressive beliefs about the teaching resources for problem-based activities. In particular, the whole group argued that teachers could use a variety of resources for finding ideas, such as, for example, a different textbook series, the National Strategy, the internet and educational websites, consulting other colleagues, and so on. Their ideas were very similar to those described by Miles and Darling-Hammond (1999) about the innovative teaching resources used in high-performing U.S. schools. The responses of the English volunteers could be described as expedient, given that in England there are no national textbooks (see Mullis et al., 2004; Mullis et al., 2008), and many English schools do not use any particular schemes of work. Therefore, many teachers are expected to prepare their own material for instruction. In Cyprus, however, the Ministry of Education and Culture provides the national textbooks, therefore, teachers are expected to follow the mandated textbook, closely. Textbooks can be helpful to teachers, if they are used as a source of information and ideas. However, as Freeman and Porter (1989) warn, mandated textbooks may dictate the content of mathematics instruction in elementary schools.

Students' beliefs about group work

Different beliefs were expressed by the two cohorts as far as group work and collaborative learning is concerned. In particular, the Cypriot students argued that grouping pupils entails many difficulties; in fact, some students favored individualized teaching. Their English peers, on the other hand, commented on the importance of group work in mathematics. Below, the two cohorts' beliefs are presented more elaborately.

The Cypriot students: Difficulties of group work in mathematical activities

The theme described here emerged from students' responses with regard to classroom organization and management in mathematical activities. In particular, all twelve students argued that pupils' collaborative work in such activities was very difficult for a variety of reasons. Nevertheless, an interesting trichotomy of opinions appeared. Even though all students pointed out that group work was a complex idea that could not be easily applied, the students' responses could be clustered into three distinct opinion groups.

The responses of two students - Evgenia and Vasiliki - formulated the first cluster of opinions. According to them, pupils should work individually in mathematics activities because learning in such contexts happens from the individual. As Evgenia said,

> *the way I see it is that these kind of activities are not recommended for collaboration. Well, maybe it would be helpful for pupils to listen to their peers' opinions, but ok, no more than that (…) I believe that problem solving is a thinking process that takes place individually. One should work alone.*

Five students expressed their preferences for individual work. However, as they claimed, on many occasions their pupils were working in pairs, especially when the activity required peer interaction (i.e. dramatization of the problematic situation). These students explained how the main reason they had set this rule of "two-pupils-maximum" was because it was easier for them as teachers to control the classroom. As Despina said, "*groups of five are really messy. Pairs are good. Pupils talk anyway with those sitting next to them; you can't stop them. Therefore, I give them the opportunity to talk about something related to the lesson*". Christoforos agreed, as his response below shows.

> *Sometimes I had pupils working alone, sometimes in pairs. But definitely no more than two, because, for me, this is like playing around; I see no rationale in this. But yeah, sometimes I had them working in pairs, because for some problems it's better to work with a peer, like those with money. For example, one student would be the sales-person and the other would be the customer, asking for change and stuff like that. In these cases, having pupils working individually is not rational. (…) Usually, in these kinds of problems, if there were more than two pupils, the situation would be out of control. To be honest, I hadn't thought of grouping pupils for geometry problems. But if I have five of them working together on a geometry problem, I can't imagine where that would lead. This is the main difficulty with mathematics. If you have them working in groups, then only one will solve it. The rest will just play around.*

The responses of the remaining five students formulated the third cluster. These students expressed their preferences for collaborative learning and reported on how during school experience, their pupils had been working in groups of four or five. Nevertheless, all of them admitted how they had been lucky enough to be placed in classrooms in which group work was encouraged by the classroom teachers, namely, their mentors. Otherwise, they stated, it would be very difficult for them to initiate group work because Cypriot pupils, in general, are not cultivated enough for such pioneering ideas. According to

Alexandros, group work was beneficial to pupils. Teachers, he said, could give "*a problem to each group, and let its members work together, exchange ideas, find clues, and then explain to the rest of the class how they worked together as a group*". Sotiroula supported the idea of group work for a different reason. She admitted, "*it is very good for the teacher, so she doesn't have to prepare too much material. Many in-service teachers told me that*". Pavlos expressed a more general comment regarding the educational system in Cyprus. According to him, despite efforts across the nation to introduce group work in Cypriot classrooms, this has not yet been very successful because pupils were not "cultured" enough for that. His quote below summarizes the points of views of all five students regarding group work.

> *This idea of having pupils working in groups still needs a lot of work. Pupils are not used to working in groups. In the last few years, group work has been applied to Cypriot classrooms but it is very difficult and not particularly successful because too much noise is created. I think pupils find it to be a way to talk about things unrelated to the lesson. But the worst part is when good pupils solve the problem while the rest sit there doing nothing.*

The English students: The importance of group work

All twelve students supported the idea that pupils work together in mathematical activities, highlighting the value of collaboration and opinion sharing. Stacey responded characteristically by saying, "*it is important that they share ideas cause they might have different ways of solving [a problem] that someone else hasn't thought of. So I think group work is really important in problem solving*". In a similar vein, Alice commented on how "*through discussion, they might pick up on each other's ideas that would develop their own lines of thinking*". Interestingly, while there was a general consensus on the significance of group work, these students' responses formed two sub-categories, described below.

Seven of the students shared the belief that groups should be mixed ability so that lower ability pupils could benefit from higher ability peers. Gabrielle's quote summarises the opinions of her classmates.

> *If they're in a small group, especially, I like to do mixed ability. Because then the higher ability can kind of pull up the lower and also, the lower have so many good ideas as well, that they sometimes don't get to express, whereas the higher ability would drag that out of them. I think if you have all the high ability together, they just try to shine over each other. Whereas if you put them with, like, some middle bits and lower bits, they get all the different kinds of ideas. And that helps them solve problems.*

Contrary, however, to the students above, their other five classmates explicitly favored ability grouping. For them, ability grouping was preferred mainly because it offered higher ability pupils the opportunity to move forward, while their lower ability peers could receive extra help by the teacher or the teaching assistant. Nicole, for example, talked about her experience from the days of her school placement. Her response was very similar to those of her colleagues.

> *When I was in Year 2, they were on, like, ability. The tables were ability. The highest group would work more independently, and the teacher would go and check over them. And then the children who needed additional support would have a TA[2] with them all the time. And then the teacher would flip between the more able and the children who were doing ok. And just like support them when they needed it but encourage them to work independently.*

All five students compared and contrasted the notions of mixed ability and ability grouping, and reached the conclusion summarized by Caroline's quote:

"It's nice having them in mixed groups but sometimes it ends up that the higher ability child would teach the lower ability child, but they don't learn. They just teach the lower ability how to do it, but we're not pushing them forward".

Linking students' beliefs about group work to their respective educational culture

Totally different beliefs were expressed by the two groups in regards to *group work* in mathematical activities. In particular, *all* Cypriot students argued that it is difficult for collaborative learning, while *all* English students favored pupil grouping and teamwork. Nevertheless, the opinions within each group varied. More specifically, the responses of the Cypriot group formed three explanations for the general claim above. A group of students stated that problem solving is an individualistic process that takes place within the mind of each solver, and that the outcomes of this process are indicators of each individual's knowledge and competence. Therefore, they argued, problems should be given to pupils individually so that teachers can become aware of what a pupil knows and offer help when needed. Such an opinion is merely focused on the individualistic cognitive elements of learning, along the lines of Radical Constructivism and its premises (e.g. von Glasersfeld, 2001). Very few Cypriot participants expressed positive beliefs about the practice of collaborative work. In effect, they explained how they couldn't employ this effort during their school experience because the school environment did not allow it. The pupils in their classrooms worked individually, and, in general, mentors endorsed individualistic learning. Indeed, quite often, the enthusiasm of newly qualified teachers is suppressed when they are placed in the context of school and classroom realities (Cooney, 1985). In addition, the school environment very often prevents the enactment of teachers' beliefs (Raymond, 1997). The Cypriot students here seem to have experienced such discouragement by their mentors during school placement, and may not have been 'washed clean' by their teacher educators (Toll et al., 2004) after their return from school placement.

The observed heterogeneity regarding any attempts of Cypriot participants to justify their views on why group work is not effective in Cypriot classrooms could, to some extent, be attributed to the fact that local mathematics education research has not explicitly examined issues of group work as far as teaching and learning are concerned. These issues have, however, sporadically appeared as collateral in the findings of colleagues, like Papanastasiou (2002) and Christou, Eliophotou-Menon, & Philippou (2004).

Contrary to their Cypriot peers, the English group praised the importance of group work, although, two clusters of opinions emerged. On the one hand, five students favored ability grouping, while, seven students expressed their preferences for mixed-ability grouping. Indeed, contradictory opinions about group composition also appear in the mathematics education literature. As Kulik (1993, p. 1) states, "for every research reviewer who has concluded that [ability] grouping is helpful, there is another who has concluded that it is *harmful*". Yet, their positive attitudes towards group work, collaborative learning, and social interactions in mathematical activities, regardless of the type of grouping, confirm the presence of a rather common rhetoric within the English educational system (Hallam & Ireson, 2007) that urges pupils to work collaboratively.

Concluding remarks and implications

Both groups of students can be seen as products of their respective teacher preparatory programs and their organizational culture, which in turn are nested within the national educational culture of each country (Erez & Gati, 2004). Also, the values ascribed to their teacher education programs are likely to have been influenced, perhaps not consciously, by their respective national mathematics education culture, or in Andrews'

(2011) terminology, the *received curriculum*. In other words, instead of aiming at a constructive change of prospective teachers' beliefs, these programs may, unconsciously, contribute to the preservation and reproduction of their existing beliefs, also held by older in-service teachers. From this point of view, the observation that many teacher education programs fail to change prospective teachers' beliefs (Ambrose, 2004; Anderson & Bird, 1995; Kagan, 1992) is not surprising. This failure could be attributed to a disregard of the cultural location of mathematics teachers' education by teacher educators, or even to a belief that mathematics (teacher) education is devoid of cultural matters.

Teacher education programs need, therefore, to acknowledge both their cultural dimensions (Gerdes, 1998) and that the beliefs prospective teachers carry as they enter their undergraduate studies are culturally influenced. Such an acknowledgment would constitute a first step in an attempt to "broaden the horizon of (future) mathematics teachers and increase their socio-cultural self-confidence and awareness" (Gerdes, 2010, p. 16). Instead of tearing down earlier beliefs of prospective teachers, teacher educators should consider alternative ways of thinking about, and addressing, beliefs (Ambrose, 2004). Programs should provide students with opportunities to explicitly address, question and explore their own beliefs at an early stage. In such circumstances, teacher educators could, for instance, make explicit how their educational system perceives "good" mathematical practice, by utilizing video-based lessons, an educational practice which helps prospective teachers become more reflective on their own teaching practices and those of others. Another suggestion of how teacher education can explicate its own cultural location and dimensions is by introducing an international-comparative element to existing mathematics education modules. Alternatively, new modules dealing entirely with mathematics education issues from a comparative perspective could be introduced. In either case, prospective teachers could learn about mathematics teaching practices applied by colleagues in other countries, and compare and contrast them with those applied in their nation's context. Of course, introducing prospective teachers to comparative mathematics education needs to be done with care. Assuming that things with the same name must have the same function in every culture is a common pitfall of comparative education (Grant, 2000). Nevertheless, learning from other national/cultural groups can indeed be informative, and may better facilitate a cultural awareness of our own beliefs and practices, which, at times, work at an unconscious level and, therefore, need to be challenged to reach the surface.

Endnotes

[1] Association of Teachers of Mathematics.

[2] Teaching Assistant.

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Appendix

The interview protocol

Belief dimension	**Problem-solving belief dimension**	**Examples of questions**
Nature of mathematics	Nature of mathematical problems and problem solving	1) What is a mathematical problem to you? 2) What characteristics should a good mathematical problem have? 3) Can you give me examples of mathematical problems from your personal experiences? 4) What does mathematical problem solving mean to you? Can you define it?
Mathematics teaching in general	Teaching in problem-based activities	1) What should teachers be doing during problem-based activities? 2) In what ways, and for what purposes, can problem-based activities be used in mathematics lessons? Are there different ways? 3) How can teachers organise a classroom for problem-based activities? Should they ask the pupils to work individually, in pairs or groups? Why?
Mathematics learning in general	Learning in problem-based activities	1) What are the benefits of interacting with mathematical problems? 2) What should someone do in order to improve her/his problem solving skills? 3) What difficulties can problem-based activities create for students as learners of mathematics?
Self-efficacy about mathematics	Self-efficacy in solving mathematical problems	1) How would you describe yourself as a problem solver? Why? 2) How do you feel when you face a mathematical problem? 3) What do you do when you face difficulties solving a problem? How do you overcome these difficulties?
Self-efficacy about mathematics teaching	Self-efficacy in using problem-based activities in future teaching	1) How do you feel about the idea of using problem solving activities in your teaching? 2) Suppose you were teaching a class of pupils. Would you describe a mathematical problem-based activity on a topic of your choice? What would you, the teacher, be doing? What would pupils be doing? 3) Suppose some children face difficulties during the problem solving activity. What would you do in order to help them?

Received: 19.12.2013, Revised: 28.1.2014, Approved: 31.1.2014