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Konstantinos Zacharos [a], Dimitris Koliopoulos [a], Maria Dokimaki [a] & Helen Kassoumi [a]
[a] University of Patras, Greece

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Views of prospective early childhood education teachers, towards mathematics and its instruction

Konstantinos Zacharos*, Dimitris Koliopoulos, Maria Dokimaki and Helen Kassoumi
University of Patras, Greece

The questions this paper attempts to answer are related to the attitudes of student teachers of the Department of Early Childhood Education at the University of Patras (Greece) towards mathematics, as well as their views on the instruction of mathematics in Early Childhood Education. The research sample included 52 students in the fourth semester of studies, who were invited to answer a questionnaire with respect to mathematics and its instruction. The findings reveal the negative attitude our research subjects adopt towards mathematics. Their epistemological views on mathematics and its instruction do not constitute a single and solid conceptual system. These findings underline the need to improve the mathematical education offered to student teachers of Early Childhood Education.

Les questions posées par la présente recherche concernent les attitudes envers les mathématiques ainsi que les conceptions sur l'enseignement de mathématiques des étudiants—futurs enseignants du Département de l'Education Pré-scolaire de l'université de Patras. Cinquante-deux étudiants de la quatrième année de leurs études ont participé à cette recherche en remplissant un questionnaire sur les mathématiques et leur enseignement. L'analyse des réponses a montré que les étudiants ont des attitudes négatives envers les mathématiques et que leurs conceptions épistémologiques sur les mathématiques et leur enseignement ne constituent pas un cadre conceptuel unitaire et cohérent. Ces constatations soulignent la nécessite de reformulation du contenu de l'éducation mathématique adressé aux étudiants—futurs enseignants à l'école maternelle.

La pesquisa actual está intentando responder a cuestiones relacionadas con las actitudes de los estudiantes—futuros institutores—de la Facultad de Pedagogía Preescolar de la Universidad de Patras (Grecia), en relación a la matemática y con sus puntos de vista en relación a la enseñanza de los conceptos matemáticos en la Educación Preescolar. La muestra representativa de la investigación se compone de 52 estudiantes del cuarto semestre de la carrera a quienes se solicitó responder a un cuestionario relacionado con la matemática y su didáctica. El escrutinio del cuestionario indica que los sujetos de la muestra mantienen una actitud negativa ante la matemática y su didáctica. Además, sus convicciones y conjeturas de ellos no componen un sistema de comprensión unificado y conciso acerca de la matemática y su didáctica. Dicho

*Corresponding author: Department of Early Childhood Education, University of Patras, Rion (Patras), 26500, Greece. Email: zacharos@upatras.gr

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escrutinio subraya que hace falta mejorar la educación de la matemática que se presta en nuestra Facultad de Pedagogía.

Die vorliegende Studie untersucht die Einstellung von Studenten—zukünftigen Lehrern—des Fachs Pädagogik am Institut für Frühe Kindheit, Universität Patras, Griechenland, gegenüber der Mathematik. Insbesondere befasst sie sich mit deren Wahrnehmung der Vermittlung von mathematischen Begriffen im Kindergarten. Im Rahmen der Studie wurden 52 Studenten des vierten Semesters aufgefordert, einen Fragebogen zur Mathematikausbildung auszufüllen. Aus den Ergebnissen resultiert eine negative Haltung der Befragten gegenüber der Mathematik und deren Unterricht. Des weiteren bilden ihre Wahrnehmungsweise der Mathematik und des Mathematikunterrichts kein einheitliches und konsistentes konzeptuelles System. Diese Ergebnisse heben die Notwendigkeit einer Verbesserung der angebotenen Mathematikausbildung in unserem Fachbereich Pädagogik hervor.

Introduction

In the field of mathematical education research points out that the beliefs and attitudes of teachers—either pre-service or in-service—play an important role in the development of teaching practices and, as a result, affect the interests and attitudes of students accordingly (Thompson, 1984; Pajares, 1992; Ernest, 1996; Phillippou & Christou, 1998; Szydlik *et al.*, 2003).

The above conception is a reliable guideline for planning courses for student teachers in the Department of Early Childhood Education at the University of Patras (Greece). The planning of such courses may lead to better educational results taking into account the beliefs and attitudes of students towards mathematics and its instruction, and carefully adjusting the content and the modes of instruction.

Theoretical remarks

Attitudes and beliefs

Attitudes and beliefs are usually treated as aspects of a mental construction to which an ontological dimension is attributed (Ruffell *et al.*, 1998). Attitudes are considered as a multidimensional mental construction containing cognitive, affective and conative elements relating to each other. Cognitive elements comprise expressions of beliefs about an attitude object, affective elements consist of feelings towards an attitude object, while conative elements relate to expressions of behavioural intention (Ajzen, 1988). Beliefs, on the other hand, are defined as an amalgamated mixture of subjective knowledge and feelings about a certain object or person. (Philippou & Christou, 1998, p. 190). They comprise single beliefs, i.e. personal constructions of a partial nature, not necessarily related to one's general convictions, as well as grouped belief systems that are described as organized constructions (Thompson, 1992). Every organized construction may operate in an 'isolated' state, leading to a single person holding contradictory beliefs. Beliefs do not require social acceptance and do not result as the direct reflection of external influences. They are

individual constructions distinct from knowledge, which in turn does seek validation. In an attempt to schematically distinguish the term 'attitude' from the term 'belief', one may say that beliefs are considered as part of the cognitive component of attitudes (Ruffell *et al.*, 1998).

Attitudes, beliefs and educational practices

A person's attitude towards mathematics is often described as positive or negative. Teachers' attitudes and beliefs towards mathematics and its instruction are often reflected in their educational practices and thus affect their students' attitudes, interest and success in mathematics.

Despite the fact that the teaching of mathematical concepts forms a major part of the current Curriculum of Early Childhood Education, there are valid indications as to the fact that teachers undermine the instruction of such concepts, usually due to their own negative attitude towards mathematics (Peterson *et al.*, 1989; Thompson, 1992; Phillippou & Christou, 1998). Research has shown that the opinion teachers have of their self-effectiveness is a key factor in triggering the pursuit of a job or the confrontation of a challenge, such as the instruction of mathematics (Phillippou & Christou, 1998).

Teachers' beliefs towards the nature and instruction of mathematics

There is an association between the beliefs of teachers towards the nature of mathematical knowledge and their views on modes of instruction (Thompson, 1984). There are numerous views on the philosophy of mathematics and on the production, spreading, duration and universality of its application. According to Ernest (1991, 1996) and Threlfall (1996), views on mathematical knowledge can be classified into two categories. The first category, described as *absolutist* (Ernest, 1991, 1996; Threlfall, 1996), considers mathematics as a compilation of objective and absolute knowledge that is not subject to historical or social influences (Ernest, 1991, 1996; Threlfall, 1996). The view supporting the universality and objectivity of mathematics with respect to teaching practices promotes behaviorist approaches and is identified with the predominant pattern of school mathematics and its modes of instruction. The second category is based on the views of modern historiography as regards mathematical knowledge. In this case, advances in both science and the management of scientific knowledge are placed within a social and historical framework. This view includes as a potentiality the perpetual *disproof* of theorems and fundamental principles of mathematics. The philosophical '*fallibilist*' view (Ernest, 1991, 1996; Threlfall, 1996) as regards the instruction of mathematics will be achieved through instructive models that stress the social aspect of learning. The above philosophical notions are closely connected to pedagogical views and the modes of educational practice implemented in the classroom (Ernest, 1991, 1996; Threlfall, 1996, Lazim *et al.*, 2004).

According to Ernest (1991, 1996) there is a close reciprocity between the absolutist views on mathematics and the negative attitudes towards it. In addition,

there can be perceived an interrelation between the fallibilist views of the mathematical knowledge and the humanitarian image of mathematics promoted through contemporary educational tendencies that are encountered in mathematical instruction. In the second case, mathematics is presented as a creative activity, accessible to all, thus resulting to a modification of negative attitudes and beliefs regarding mathematics and its teaching.

It must be noted, however, that teaching practices are not usually strict logical entailments of a specific philosophy towards mathematics. Social and political parameters of education and instruction also interfere, together with additional values and assumptions and 'it is theoretically possible to consistently associate a philosophy of mathematics with almost any educational practice or approach' (Ernest, 1996). Even though there is no logical necessity in correlating the teachers' educational behaviour to their epistemological and philosophical views, nevertheless, the fact that this correlation is often detected may be due to psychological mechanisms that tend to restore the maximum coherence and consistency possible within a person's system of ideas and beliefs (Ernest, 1991).

This research aims at tracing the beliefs and attitudes of students—and prospective teachers— of Early Childhood Education towards mathematics and its instruction, within the framework of a new introductory module concerning the instruction of mathematical concepts in Early Childhood Education. The main research areas we attempt to address are the following:

1. Student teachers of Early Childhood Education's attitudes and beliefs towards mathematics. In particular, their views on the relation of mathematics to social practices, as well as their philosophical views on the nature of the science of mathematics.
2. Their views on the practices that ought to be used for the instruction of mathematical concepts in Early Childhood Education.

Methodological approach

Method

The method used for collecting the empirical data is a survey (Cohen & Manion, 1994). This method enables us to collect data at one particular moment in time and describe the current circumstances. The tool used for collecting the research data was a questionnaire which was completed by the students. This questionnaire reflects the aims of our research and can be found in the appendix.

Research sample

The questionnaire was distributed to 52 students in the fourth semester (out of a total of eight semesters) at the Department of Early Childhood Education of the University of Patras (Greece). More specifically, the questionnaire was handed out and answered individually by all those attending class on the first day the module

'Instruction of Mathematical Concepts in Early Childhood Education' was taught. This is an introductory module and, furthermore, the students attending it have no previous experience on this subject.

Questionnaire structure

There are seven questions in the questionnaire (see Appendix). There are questions requiring 'scaled responses' (Cohen & Manion, 1994), open-ended questions and, finally, combinations of open-ended questions asking for 'structured' and 'unstructured' responses.

The questions have been divided into two clusters (see Figure 1). The first question examines whether the attitudes of the students in our sample towards mathematics had already been shaped by the time they reached senior high school ('Lykeion'). The second and third questions aim at detecting the students' philosophical opinions on mathematics. The questions in the second cluster attempt to find out the students' opinions on the instruction of mathematics. The fourth question, in particular, investigates whether the subjects of our sample consider the instruction of mathematical concepts in Early Childhood Education as useful, while the fifth question goes into the effects of the statement made in the previous one. Finally, the last two questions (sixth and seventh) look into our students' opinions regarding approaches to the instruction of mathematical concepts in Early Childhood Education and the extent to which they keep up with the general philosophical opinions on mathematics.

Findings and their evaluation

Based on the research findings we proceeded with their evaluation, taking into account both the aims of our research and our theoretical references.

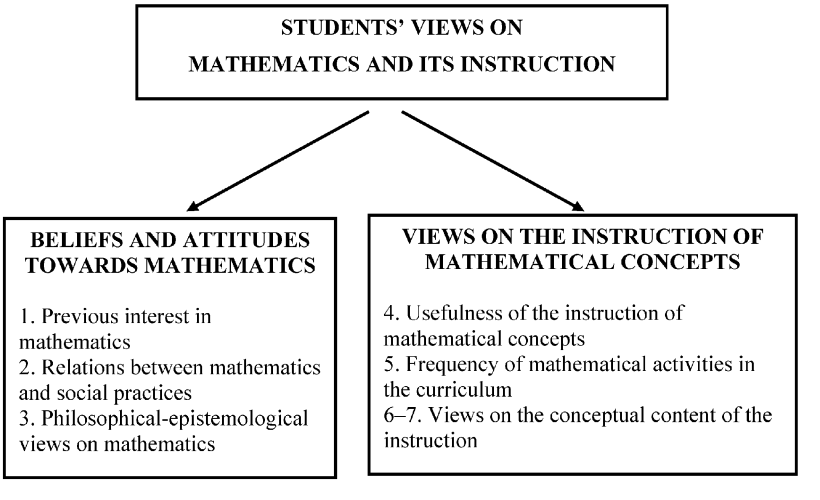

Figure 1. Structure of the questionnaire

Beliefs and attitudes towards mathematics

The details of the first question indicate that 75% of the subjects of our sample showed very little—if any—interest in mathematics while at senior high school ('Lykeion').

Research in mathematics education (McLeod, 1994) indicates that while students have a positive outlook towards mathematics at the beginning of their school life, this often changes and becomes negative towards the end of high school. This fact is reflected in their choice of optional modules during their studies. It must be noted here that there are three study clusters to choose from during the last two years of senior high school: two of the clusters address students who wish to continue their studies in the fields of science and technology while the other addresses students whose interest lies in humanities. Each cluster's curriculum is structured accordingly: in the first two, mathematics and science are prevalent while in the humanities cluster the weight attributed to it is undermined. Our survey shows that the majority of students in our sample (73%) had opted for the humanities cluster while studying in high school.

The majority of students (46.2% of the sample) do not correlate mathematics with social practices (see second question) or have not formed an opinion on the existence of such correlations (17.3% of the sample).

If students replied to this question in the affirmative, they were asked to provide an example of the use of mathematics outside the established school framework. The students' answers varied: one group of students mentioned everyday financial transactions, such as the settling bills and managing personal finances in general. Others mentioned the use of mathematics when dealing with other everyday problems, such as the following case:

> If you cannot grasp mathematics, you cannot exist as a member of society. For example: The Pythagorean Theorem may be used in order to calculate the length of a side or the area of a piece of land(!)

Another group of students viewed mathematics as an essential tool used in order to gain access to other scientific fields. Finally, there were some students who mentioned the general role mathematics plays in the formulation of scientific thought, as happened in the case of the following student:

> Mathematics should be taught in all stages of education because it exercises the mind and helps form a rational way of thinking.

In the third question the majority of students answered that mathematics is a scientific field that comprises absolute truths, whose development is not connected to social processes (59.6% of the sample). This leads us to conclude that school projects an absolutist picture of mathematics.

In cases where students did not agree with either of the suggested opinions, the alternative opinions they proposed go beyond the suggested answer formulation, e.g.:

> Mathematics explains and correlates the concepts of before, now and after. It helps broaden the way one perceives things.

or constitute an amalgam of the first and second suggested answers, e.g.:

> Mathematics has universal value and its development is not related to social processes.

The findings derived from the questions above demonstrate that, on entering university, the student teachers of Early Childhood Education have already shaped their beliefs and attitudes towards mathematics. They are rather negative towards mathematics, while their philosophical and epistemological opinions approach absolutism, as described in our theoretical framework.

Views on the instruction of mathematical concepts in early childhood education

In the fourth question the students were asked not only to answer 'yes' or 'no' as to whether the instruction of mathematical concepts in Early Childhood Education is useful, but to justify their answers as well.

When students answered in the affirmative, the answers were classified as follows:

The first group (36% of the sample) comprises those answers which consider the instruction of mathematical concepts in Early Childhood Education as useful because:

> The basic mathematical concepts must be understood.

or, in other words:

> Children should begin to acquire mathematical knowledge starting from early childhood; basic notions first, more complicated ones later.

Another type of answer (25%) states that the instruction of mathematical concepts in Early Childhood Education is useful because:

> The instruction of mathematics in Early Childhood Education prepares children for the use of mathematics in Comprehensive Education.

Others (9.6%) mention that mathematics contributes to performing everyday transactions. The following answer is representative of this group:

> I consider it useful (i.e. the instruction of mathematics) because little children should learn about numbers starting from early childhood. They should start using mathematical operations, which will help them with their minor transactions.

Some students (5.8%) consider the instruction of mathematical concepts useful because this may help infants develop a positive attitude towards mathematics.

> Children should become acquainted with the basic mathematical concepts, as those are adapted to everyday life, from an early age. This way, mathematics will be easy for them and they will not be prejudiced against it because of its difficulty.

Moreover, another group of students (9.6%) claim that the instruction of mathematics will contribute to the development of logical-mathematical thought in children. Thus, the usefulness of its instruction is justified, as argued in the following answer:

> [Mathematical concepts should be taught] in order to 'sharpen' children's minds and help them begin to reason.

Finally, there is a group of students (13.5% of the sample) who do not justify their positive answers.

In the case of negative answers, the students do not usually consider the instruction of mathematical concepts in Early Childhood Education useful because '*they will learn these concepts when they are in higher grades*'.

However, the fifth question shows that even though the students explicitly state the need for organizing the mathematical education of infants, only few of them (11.5% of the sample) would include more than three mathematical activities in their weekly curriculum.

The sixth question deals with whether the comprehension of a mathematical concept can be performed through a progressive process or if this is an absolute, once-and-for-all task. The students' answers were classified into the following categories: the first category includes the students (40.4% of the sample) who adopt an absolutist view regarding the instruction of mathematics; they believe that mathematics should be taught effectively starting from the earliest stages of education because one either does or does not comprehend a mathematical concept, whose comprehension is an absolute process with no intermediate stages. The following answers are representative of this view:

> If something remains incomprehensible, we should not proceed to any following stage.

or:

> I believe that mathematics is like a chain. There should not be any gaps during the duration of its instruction. This means that the subject should be effectively taught starting from the earliest stages of education.

On the other hand, some students (40.4% of the sample) claim that there actually can be a gradual and evolutionary comprehension of mathematical concepts which, according to our theoretical framework, relates to the fallibitist opinion. The following answer is indicative of this category:

> There are intermediate stages which can be reached through systematic study and practice, on the way to fully understanding a concept in mathematics.

Finally, several students (19.2% of the sample) did not provide an answer.

As attention shifts from general opinions on instruction to the specific instructive practices (which is the case in the eighth question, regarding length measurement), the fallibilist view gains more ground. Thus, the majority of students (69.2% of the sample) consider both measurements successful, even though they were performed by use of an unconventional length unit or were mere approximations:

> Yes, the measurement may be considered successful as long as paperclips are used as a 'unit' for measuring the length of a rod.

On the other hand, negative replies (23.1%) are represented by such answers:

> No, (the measurement is not correct) I would rather they used the measuring tape.

or:

Table 1. Epistemological views—approaches towards the comprehension of mathematical concepts

		Approaches towards the comprehension of mathematical concepts		
		Static	Progressive	No answer
Epistemological views	First view	14	14	3
	Second view	6	6	5
	Other view	1	1	2

> Children should learn right from the start what the correct instruments are for measuring such things (as length).

Finally, some students (7.7%) did not provide an answer.

Certain discrepancies are noted when comparing the answers referring to epistemological opinions on mathematics (third question) and the answers referring to instructive practices (sixth and seventh question) (see Tables 1 and 2 respectively). No correlation is observed between students' epistemological views and their approaches towards the comprehension of mathematical concepts ($X^2=5.394$, df=4, a=0.249, see Table 1), nor between their epistemological opinions and their opinions on instruction ($X^2=10.166$, df=4, a=0.038, see Table 2). This leads us to conclude that the beliefs of our subjects are individually isolated in all the above cases and do not form part of a single, solid perceptive system. As mentioned in the theoretical framework, this inconsistency may be due to the fact that perceptions are not directly connected with options and attitudes regarding instruction through a cause and effect relation. Thus, while one might have expected to see beliefs about mathematical knowledge reflected in beliefs about preferred instructive practices, this does not seem to apply here.

Conclusions and discussion

The present study investigates the attitudes and beliefs of student teachers in the Department of Early Childhood towards mathematics and the instruction of mathematical concepts. We have based our work on theoretical and research approaches used in mathematics education in order to trace students' views (be they

Table 2. Epistemological views—procedure for measuring length

		Effectiveness of measurement		
		Yes	No	No answer
Philosophical views	First view	23	7	1
	Second view	12	2	3
	Other view	1	3	–

fully shaped or as yet dormant and incomplete) regarding the nature of mathematics as described by the absolutist and fallibilist points of view (Ernest, 1991, 1996; Threlfall, 1996). These philosophical and epistemological opinions are usually related to certain teaching practices. However, as has already been noted in the theoretical background, general philosophical-epistemological opinions are not connected with adopted teaching practices through a cause-and-effect relation.

The findings show that a great many of the subjects in our sample have a negative attitude towards mathematics. Some of the students who have had such negative outlooks towards mathematics since their school years will eventually turn out to be teachers and will then be faced with the task of having to teach a subject that does not please them. These people perceive mathematics as a kind of punishment and that is why they continue to teach it using the traditional methods. In turn, they unintentionally influence their students, some of whom will actually become teachers, into adopting negative attitudes themselves and thus the entire situation moves in a vicious circle (Philippou & Christou, 1998).

Tables 1 and 2 also demonstrate that the subjects' epistemological views are isolated from their approaches towards comprehending mathematical concepts; these two elements do not form part of a single, solid, coherent perceptive system regarding mathematics and its instruction. This fact has also been stressed in other surveys mentioned in the theoretical background (Ernest, 1996; Threlfall, 1996).

At this point we would like to point out some theoretical and methodological parameters that surfaced during our study and which could provide material for further processing. Firstly, the attempt to attribute an ontological dimension to attitudes and beliefs may prove satisfactory, given our need for an interpretative construction which will explain human behaviour based on a cause-and-effect scheme rather than the description of an existing entity. Nevertheless, even if we accept the existence of beliefs and attitudes, challenging people into admitting them can present problems. Indeed, on a methodological level, the process of investigating through the use of questionnaires could raise credibility issues. There is a chance the questions may 'lead' the subject into certain answers or behaviours which, although interpreted by the researcher as positive or negative attitudes towards mathematics, are actually misleading and cast restricting or defining predicates to human behaviour (Ruffell *et al.*, 1998). As a result, it seems necessary to enhance current research techniques by using more qualitative approaches (Cooney *et al.*, 1998; Vacc & Bright, 1998) and perhaps by penetrating deeper into certain fields of mathematics (Peterson *et al.*, 1989). This may render it possible to record the views of prospective teachers towards mathematics and its instruction in a more robust and reliable manner.

Reflections on the mathematical education of prospective Early Childhood Education teachers.

This study forms part of an effort to reform the mathematics education curriculum for students in our Department who will be prospective teachers in Early Childhood

Education. Our goal is to understand their views towards mathematics and its instruction so as to establish a framework for discussion through which the mathematics education modules can be focused on, reformed and subsequently improved.

Prospective teachers in Early Childhood Education are often intimidated by mathematics, and research has shown that they feel more confident teaching language modules (Copley, 2004). Teaching mathematical concepts is difficult for them, as they do not possess an intimate knowledge of mathematics. Early Childhood Education teachers are oblivious to essential mathematical procedures such as reasoning, problem solving, as well as the relation between mathematics and the ability of children to comprehend its concepts. Teaching strategies tend to focus on methods of calculation and presenting the procedures leading to the 'correct' answers, rather than develop the children's autonomy and encourage them to develop their own methods and reasoning. This is highlighted by some of the comments made by the students in our survey, such as this one, which refers to alternative ways for children to measure lengths:

> Children should learn right from the start what the correct instruments are for measuring.

Moreover, the teaching of mathematical concepts is not necessarily considered a prerequisite in the curriculum in Early Childhood Education, as is demonstrated by the following opinion expressed by a student of the survey:

> They will learn these concepts when they are in higher grades.

These findings highlight the need to fortify mathematical education in the curriculum of prospective teachers, since they will eventually be called upon to teach it in Early Childhood Education. In the following section, first we will elaborate on this notion and then we will describe the process used in the attempt to reform our Department's curriculum.

A critical question in pedagogics is this: how does one go about improving the negative attitudes and beliefs towards mathematics and its instruction? Naturally, attitudes do not change easily and we should not anticipate any significant changes within the short period one spends studying at university (Smith, 1996). It has often been mentioned that pre-existing beliefs regarding teaching and learning tend to be persistent and resist change (Brown *et al.*, 1990; Pajares, 1992). Prospective teachers often leave university bearing the same attitudes and beliefs they had when they entered (Kagan, 1992). On the other hand, the process of university education has been known to contribute to the change in students' preconceived attitudes (Fernandes, 1995; Philippou & Christou, 1998). This happens because, while attending university, the students and prospective teachers are exposed to organized educational experiences under the guidance of teachers who are specialized in mathematics education.

This is why we ought to take into account the results of the current study in reforming the introductory modules in our curriculum towards the directions mentioned below: firstly we focus our attention on the creation of knowledge. We

attempt to highlight the epistemological opinions mentioned in the theoretical background and expect the prospective teachers participating in our educational courses to perceive the connection between the chosen educational activities and the philosophical and epistemological views towards mathematics and its education. Thus we intend to strengthen perceptions focusing on the social aspect of formulating scientific knowledge. This viewpoint tends to promote those psychological and educational theories which include teaching mathematical concepts in Early Childhood Education. It also promotes activities which will encourage students to question, doubt, reason and plan.

Another question that arises when planning the introductory courses in mathematics for prospective early childhood education teachers is this: what kinds of transformations is the knowledge acquired from research in the didactics of mathematics subjected to, when bound to constitute teaching material for early childhood education? In our opinion, this knowledge should—on the one hand—be based upon professional skills necessary for teaching mathematics at that specific level of education, while—on the other hand—be provided in such a way so as to reinforce the cultural elements of mathematical education. Reinforcing the cultural elements entails attempting to extract mathematical contexts from children's daily activities at the nursery school. It also entails placing mathematical activities within such a framework as would render them meaningful and, thus, interesting to children.

We focus our discussion on methods for planning introductory modules. Research has shown that getting the prospective teachers involved in situations where they can interact with their classmates and address mathematical activities with a variety of approaches, helps make them less hesitant and boosts their self confidence (Copley, 2004). This planned interaction between prospective teachers proves beneficial because collaborating and exchanging experiences helps reduce their stress regarding mathematics and its instruction (Copley, 2004). The prospective teachers discover that their fears and anxieties are not their own 'privilege' but are actually shared by many others as well.

Finally, prospective teachers have a lot to learn from the experience of teaching classes at an early childhood education level. They can benefit from their students and the ways in which they understand mathematics. They also come to realize that mathematics can be related to various fields of knowledge and everyday activities, which in turn can help modify their beliefs towards mathematics and, hence, their attitude towards it.

Notes on contributors

Konstantinos Zacharos is an Assistant Professor at the Department of Early Childhood Education, University of Patras (Greece).

Dimitris Koliopoulos is an Assistant Professor at the Department of Early Childhood Education, University of Patras (Greece).

Maria Dokimaki and Helen Kassoumi are post-graduate students at the Department of Early Childhood Education, University of Patras (Greece).

References

Ajzen, I. (1988) *Attitudes, personality and behavior* (Milton Keynes, Open University Press).

Brown, S., Cooney, T. & Jones, D. (1990) Mathematics teacher education, in: W. R. Houston, M. Haberman & J. Sikula (Eds) *Handbook of Research on Teacher Education*, 639–656, New York, Macmillan).

Cohen, L. & Manion, L. (1994) *Research methods in education* (Fourth Edition) (London and New York, Routledge).

Copley, J. V. (2004) The early childhood collaborative: a professional development model to communicate and implement, in: D. H. Clements & J. Sarama (Eds) *Engaging young children in mathematics, standards for early childhood mathematics education* (London, Lawrence Erlbaum Associates).

Ernest, P. (1991) *The philosophy of mathematics education* (London, Falmer Press).

Ernest, P. (1996) The nature of mathematics and teaching, *Philosophy of Mathematics Education*, 9 (Newsletter).

Fernandes, D. (1995) Analyzing four pre-service teachers' knowledge and through their biographical histories, *Proceedings of the Nineteenth International Conference for the Psychology of Mathematics Education* Vol. II, 162–169 (Universidade Federal de Pernambuco, Recife, Brazil).

Kagan, D. M. (1992) Implications of research on teacher belief, *Educational Psychologist*, 27(1), 65–90.

Lazim, M., Osman, M. A. & Salihin, W. W. (2004) The statistical evidence in describing the students' beliefs about mathematics, *International Journal for Mathematics Teaching and Learning*. Available online at: www.ex.ac.uk/cimt/ijmtl/ijmenu.htm.

McLeod, D. B. (1994) Research on affect and mathematics learning in the JRME: 1970 to the present, *Journal for Research in Mathematics Education*, 25(6), 637–647.

Pajares, M. F. (1992) Teachers' beliefs and educational research: cleaning up a messy construct, *Review of Educational Research*, 62(3), 307–332.

Philippou, G. & Christou, C. (1998) The effects of a preparatory mathematics programme in changing prospective teachers' attitudes towards mathematics, *Educational Studies in Mathematics*, 35, 189–206.

Peterson, P. L., Fennema, E., Carpenter, T. P. & Loef, M. (1989) Teachers' pedagogical content beliefs in mathematics, *Cognition and Instruction*, 6(1), 1–40.

Ruffell, M., Mason, J. & Allen, B. (1998) Studying attitude to mathematics, *Educational Studies in Mathematics*, 35, 1–18.

Smith, J. P. (1996) Efficacy and teaching mathematics by telling: a challenge for reform, *Journal for Research in Mathematics Education*, 27(4), 387–402.

Szydlik, J. E., Szydlik, S. D. & Benson, S. R. (2003) Exploring changes in pre-service elementary teachers' mathematical beliefs, *Journal of Mathematics Teacher Education*, 6, 253–279.

Thompson, A. G. (1984) The relationship between teachers' conceptions of mathematics and mathematics teaching to instructional practice, *Educational Studies in Mathematics*, 15, 105–127.

Thompson, A. G. (1992) Teachers' beliefs and conceptions: a synthesis of the research, in: A. D. Grouws (Ed.) *Handbook of research on mathematics teaching and learning* (New York, Macmillan).

Threlfall, J. (1996) Absolutism or not absolutism—what difference does it make?, *Philosophy of Mathematics Education*, 9 (Newsletter).

Vacc, N. N. & Bright, G. W. (1998) Elementary pre-service teacher's changing beliefs and instructional use of children's mathematical thinking, *Journal for Research in Mathematics Education*, 29(3), 89–110.

Appendix

QUESTIONNAIRE

Your view on mathematics

1. Throughout your studies in senior high school ('Lykeion'), did you consider mathematics as being:

very interesting ☐ mildly interesting ☐

of little interest ☐ of no interest ☐

2. During your school years, did you form the view that mathematics is related to certain practices of social life?

Yes ☐ No ☐ I did not form any view ☐

3. If so, please provide an example:
4. Which of the following views on mathematics do you think is more correct? If you do not agree with either of them, please provide your own view.

(a) Mathematics is a human activity resulting from social practices. Mathematical knowledge is always ready to open to revisions as to the proofs of its theorems and fundamental concepts. ☐

(b) Mathematical truths are permanent and their development is not related to social processes. ☐

Your views on the instruction of mathematical concepts in early childhood education

5. Do you consider it useful to teach mathematical concepts in Early Childhood Education?

Yes ☐ No ☐

Why?

6. How often would you include mathematical activities in the weekly timetable of your own Nursery School? ☐
7. *Mathematics should be taught effectively starting from the earliest stages of education. One either does or does not comprehend a mathematical concept; its comprehension is an absolute process with no intermediate stages*. Please comment.
8. When introducing the concept of length in early Childhood Education, the length of a paperclip is used as the unit for measuring the length of a rod. Could answers such as *it is about five paperclips long* or *the length is five and a bit* be considered as correct measurements?