THE HISTORY OF MATHEMATICS DURING AN INQUIRY-BASED TEACHING APPROACH

Areti Panaoura
Frederick University, Department of Primary Education
pre.pm@frederick.ac.cy

ABSTRACT

The use of the history of Mathematics in teaching has long been considered as a useful tool in order to enable students to construct conceptually the mathematical concepts. At the same time the inquiry-based teaching approach is proposed to be used in order to improve students’ learning by using their natural tendency to curiosity. The use of the history of mathematical concepts during an inquiry-based teaching approach is expected to multiply the positive effects on students’ learning. The present study examines in-service teachers’ beliefs and knowledge about the use of the history of mathematics in the framework of the inquiry-based teaching approach at the educational system of Cyprus, and the difficulties teachers face in adopting and implementing this specific innovation in primary education. At the first phase of the study a questionnaire was used in order to investigate teachers’ knowledge and beliefs about the use of the history of mathematics in education and mainly in relation to the inquiry-based teaching approach. At the second phase of the study two case studies were examined, where teachers introduced a mathematical concept by using the history of mathematics in order to identify the practices they used and the difficulties they faced. The results indicated that the teachers’ knowledge about the use of the history and mainly the experimental nature of mathematics is significantly related with their positive beliefs about the inquiry-based teaching approach. Teachers’ worries were mainly concentrated on their difficulties to manage the time and the content of the subject and to face efficiently and flexibly their students’ mistakes and difficulties.

Keywords: history of mathematics, inquiry-based activities, teachers’ knowledge, beliefs and practices

1. INTRODUCTION

The idea of using the history of mathematics in education is not new (Goktepe & Ozdemir 2013). Over the past three decades researchers from various countries have discussed the possibility of introducing new concepts within relevant historical context (Yee & Chapman 2010), at different educational levels. Some researches describe the affective impact from using the history of mathematics in education (e.g. Furinghetti 2007, Marshall 2000) and others discuss the necessity to include the history of mathematics in pre-service teachers’ university programs (e.g. Fleener et al. 2002) in order to train teachers to use it with their students. There are several reasons to incorporate the use of the history of mathematics in education, and the major one is the impact of such a practice on the development of the mathematical disposition of students.
(Clark 2006). Using authentic problems from the history of mathematics provides material for students to actively engage in classroom discourse (Gulikers & Blom 2001), and to realize the role of the construction of the science of mathematics.

At the same time inquiry-based learning is not a recent movement in mathematics education, and it has been recommended as an appropriate basis for student learning in mathematics for the last decades. Numerous studies and reports of committees continue to call for inquiry-based teaching and learning approaches in mathematics (e.g. Marshall & Horton 2011) in order to encourage students to think critically and creatively. Teachers need to know how to approach their teaching in a way that is reflective, responsive and flexible (Marin 2014).

Having in mind that the use of the history and the inquiry-based teaching approach are among the major objectives in mathematics education, we have decided to examine the use of the history of mathematics in a framework of the inquiry-based teaching approach at the early stages of primary education and mainly to investigate teachers’ difficulties in applying in their instruction the proposed innovation. Burton (2003) defines history of mathematics as a vast area of study which includes investigating sources of discoveries in mathematics, highlighting that it includes investigations of the achievements of significant mathematicians and their ideas. At the Curriculum of Mathematics which was constructed in 2011 for primary education in Cyprus the use of history of mathematics is suggested and the usual use of inquiry-based teaching approach is proposed as the main teaching approach. The two central concepts for the inquiry-based teaching approach are the use of investigations and explorations.

Radford, Furingetti and Katz (2007) acknowledge that questions related to the pedagogical role of the history of mathematics remain open to investigation. Teachers have various beliefs such as about themselves as teachers, the nature of the discipline of mathematics, the factors that affect the learning and the teaching of mathematics. The present study concentrates on teachers’ knowledge about teaching mathematics by using the inquiry-based teaching model in the framework of the history of mathematics and mainly their respective practices in authentic teaching situations. We concentrate our attention on the experimental epistemological dimension of mathematics (Ernest 1991) which is directly related with the inquiry-based teaching and learning approach. It is important to examine how teachers use their knowledge and their beliefs in order to design instructional activities fostering mathematical inquiry by using the history of mathematics. The specific research questions were:

1. How are teachers’ knowledge and beliefs about using the history of mathematics related with their knowledge and beliefs about the use of inquiry-based teaching approach?
2. What are the teachers’ practices on using the history of mathematics during an inquiry-based teaching approach?
2. THEORETICAL FRAMEWORK

2.1 The history of Mathematics in mathematics education

Teachers have long been encouraged through curriculum and the scientific community in mathematics to incorporate aspects from the history of mathematics into their teaching (Lopez-Real 2004). Jankvist (2009) suggests the use of the history of mathematics by highlighting the increased motivation and the realization that mathematics is a human creation. Introducing the history of mathematics in school curricula enhances learners’ motivation, promotes favoured attitudes, and draws attention to possible obstacles faced in the generation and evolution of mathematical concepts. As a pedagogical tool it can serve as a guide to the difficulties students may encounter as they learn a particular mathematical topic (Haverhal & Rsocoe 2010). Schubring and colleagues (2000) also posit that programs based on the history of mathematics could increase self-confidence in working with mathematical tasks and develop learners’ ability to apply mathematical methods. A journey through the history of mathematics could also enable learners to construct mathematical meanings and support new conceptions about mathematics by changing learners’ existing beliefs and attitudes (Dubey & Singh 2013). In addition, the historical dimension encourages learners to think of mathematics as an evolving body of knowledge, rather than as a well-defined entity composed of irrefutable and eternal truths (Barbin, Bagni, Grugnetli, & Kronfellner 2000).

Jahnke (2000) suggested three general ideas which might be suited for describing the special effects of studying a source on the teaching of mathematics: (a) the notion of replacement according to which mathematics is seen as an intellectual activity rather than a set of techniques, (b) the notion of reorientation according to which history reminds us that the mathematical concepts were invented and (c) the notion of cultural understanding according to which integrating history of mathematics invites us to place the development of mathematics in the scientific and technological context of a particular time and in the history of ideas and societies and also to consider the history of teaching mathematics.

For many years, the rationale of employing the history of mathematics in teaching has explicitly or implicitly been hinged on the notion of “recapitulation”, according to which ontogenesis recapitulates phylogensis. Although this principle has been challenged on the grounds of different socio-cultural conditions, Sfard (1995) points to “inherent properties of knowledge” which result in similar phenomena that can “be traced throughout its historical development and its individual construction” (p. 15). These inherent properties or epistemological obstacles could provide the grounds for a meaningful negotiation of meaning using history as a means towards an epistemological laboratory (Radford 1997).

Studying the development of mathematical ideas also opens up the possibility of seeing mathematics as a socio-cultural creation and helps
“humanize” mathematics (Fauvel 1991). As Siu (1997) claims, using the history of mathematics in the classroom does not necessarily increase students’ cognitive performance, but “it can make learning mathematics a meaningful and lively experience, so that learning will come easier and will go deep” (p. 8). Such programs also have the potential to help students overcome mathematics anxiety or mathematics avoidance. In addition to that, historical and epistemological analysis of the content helps teachers understand why a certain concept is difficult for students to grasp. Such an understanding is important, because it can inform selection of tasks/problems to introduce a particular concept, the strategies teachers employ in helping students develop understanding of this concept, and the time they allot to working on this concept (Barbin et al. 2000). The mathematics teachers in the study by Lit and Wong (2001) were very supportive in theory for using history in their teaching. Siu (1998), in an invited talk given at the working conference of the 10th ICMI study on the role of history of mathematics in mathematics education, offered a list of thirteen reasons why a school teacher hesitates to make use of the history of mathematics in classroom teaching such as “I have no time for it in class”, “Students don’t like it”, “There is a lack of teacher training on it”, “Students do not have enough general knowledge on culture to appreciate it”, etc. The suggestions which are included in Curriculum or Reports of Committees do not necessarily mean that teachers are able to apply them in their teaching, either due to their lack of positive beliefs and self-efficacy beliefs or due to teaching difficulties and obstacles, which they are unable to overcome when they face them.

2.2 The inquiry-based teaching approach

Inquiry-based teaching and learning is based on the principles of social constructivism (Aulls & Shore 2008), according to which a learner assimilates a new situation and experience on previous experiences and depending on interindividual differences constructs the new knowledge. The scientific journal of ZDM in Mathematics Education has published a special issue in 2013 with nine papers focusing on inquiry-based mathematics education and their implementations, indicating that many questions remain unanswered. The challenge for educational systems is to enable its teachers to adopt the values of the inquiry-based pedagogy. Chin and Lin (2013) claim that there are obstacles and difficulties such as: (i) teachers did not experience inquiry-based learning in mathematics in their own school years, (ii) they do not have complete understanding of the inquiry-based teaching, (iii) there are practical constraints such as that the allocated teaching hours are not enough, (iv) the influence of teaching for success in tests.

The learner-focused perspectives of mathematics education require teachers to use pedagogical methods which actively engage students in developing conceptual understanding of mathematical concepts (Chapman 2011). According to Taylor and Bilbrey (2011) the research outlines two facets of
inquiry-based instruction which are open education and differentiation. The major characteristic of the open education is that instruction is driven by the desires of the students, while the differentiation approach allows students’ preferences to guide how particular content is encountered. Hakkarainen (2003) proposes an inquiry pedagogical approach called progressive inquiry for young learners in learning science, while Song and Looi (2011) explore the application of an adaptation of this approach to mathematics inquiry learning. The learner-focused perspectives of mathematics education requires teachers to use pedagogical methods which actively engage students in developing conceptual understanding of mathematical concepts (Chapman 2011). Teachers need to develop their ability to foster student decision-making by balancing support and independence in thinking and working (NCTM 2000). The teacher’s role has evolved from concept deliverer to concept facilitator.

Hegarty–Hazel (1986) categorized four levels of inquiry-based activities which ranged from specific guidance and close question to open exploration and open question. For example at the first level the teacher provides specific inquiry question, solving procedures and solution, while at the last level the teachers provide learning environment for students to generate inquiry question. Both teachers and students need slow and stable steps in order to be moved from the traditional algorithmic procedures to the challenge of the conceptual processes.

One of the main emphases of the new proposed teaching model of Mathematics in the centralized educational system of Cyprus which is presented at the New Curriculum (NCM 2011), is the use of exploration and investigation of mathematical ideas as two dimensions of the inquiry-based teaching and learning approach. Last year during the implementation of the new school mathematics curriculum, the new obligatory for use textbooks for grades 1, 2, 3 and 4 had already been introduced (ages 6-9 years old). The whole idea is to introduce a mathematical concept by using an inquiry-based activity through which the teacher generates curiosity and interest in the topic and he/she asks students to express their ideas and communicate by using the language of mathematics. The emphasis is on using authentic and open-ended problem solving activities without only one correct answer and each student is expected to respond in respect to his/her previous knowledge, experiences and unique way of thinking. Teachers are expected to support the students in working independently and creatively. In only few specific cases the activities which are included in the textbooks use the context of the history of mathematics.

3. METHODOLOGY

The present study was divided into two main phases. At the first phase the emphasis was on examining the teachers’ knowledge and beliefs about using the history of mathematics and mainly in cases of planning inquiry-based activities. To examine teachers’ knowledge and beliefs about the use of the
history of mathematics and the inquiry-based teaching approach, we constructed and used a questionnaire that consisted of two scales: one including 12 items that measured knowledge and beliefs about the use of the history of mathematics (e.g. Mathematics changes in order to fulfill the human or social needs) and another consisting of 12 items designed to capture knowledge and beliefs about the value and implementation of inquiry-based teaching (e.g the teachers’ guidance during inquiry-based teaching approach has to be limited). All items were measured on a 5-point Likert scale (1= strongly disagree and 5 = strongly agree).

The emphasis of the second phase was on examining the practices teachers use during the implementation of the inquiry-based activities by using the history of mathematics in authentic classroom situations. We wanted to make the link between what they say and what they actually do. Researchers can examine the teachers’ behavior well when following and observing them in an authentic context (Hwang, Zhuang & Huang 2013). By using the case study approach we emphasized detailed contextual analysis of teaching condition in real-life school situations. A teacher of the 2nd grade and a teacher of the 3rd grade were observed individually while they were introducing the place-value of two- and four-digit numbers by using the history of mathematics, and then a semi-structured individual interview was conducted with each one of them. The respective activities which were suggested to be used by the textbooks introduced the concepts by using an exploration and an investigation (the Greek version of the respective pages are presented in Figure 1 and 2). A protocol for the observation was constructed and used in order to concentrate the observer’s attention on: a) teachers’ guidelines at the introduction of the activity, b) teachers’ feedback on students’ difficulties and mistakes and c) the time which was allocated for the specific activities. The interview was concentrated on the practices they had used and the difficulties they had faced.

The sample: Participants who completed the questionnaire at the first phase of the study were 162 teachers, who were teaching mathematics at the first, second, third and fourth grade last year. The new curriculum methods with the new obligatory for use textbooks which include inquiry-based activities at a framework of the history of mathematics have already been introduced only at those four primary school grades. 115 of the participants of the sample were females and 47 were males. 45 participants were teaching at the first grade, 43 at the second grade, 40 at the third grade and 34 at the fourth grade. All the participants were asked to complete the questionnaire voluntarily and anonymously. The teachers who took part in the second phase of the study were randomly chosen and both agreed to be observed during their teaching and take part in the individual interview.

Statistical analyses: In order to confirm the structure of the questionnaire and mainly in order to examine the interrelations between the four main factors of the study, a Confirmatory Factor Analysis (CFA) was conducted using Bentler’s (1995) Structural Equation Modelling (EQS) programmes. The
The tenability of a model can be determined by using the following measures of goodness of fit: $x^2/df < 1.95$, CFI (Confirmatory Fit Index) > 0.9 and RMSEA (Root Mean Square Error of Approximation) < 0.06. Cronbach’s alpha for the questionnaire was 0.87.

**Figure 1 and Figure 2: The exploration and investigation activities which were used**

2nd grade, unit 5
An exploration where an ancient Egyptian wrote the numbers of animals and students have to guess which numbers could be possible.

3rd grade, unit 7
An investigation where an archeologist found the presented numbers on stones which belong to ancient Crete. Students have to choose the right number which is presented in each stone.
4. RESULTS

4.1 Teachers’ knowledge and beliefs

Firstly the interest concentrated on the interrelations between the first-order factors as indicators of the impact of the cognitive and affective factors concerning the use of the history of mathematics and the use of the inquiry-based teaching approach. The initial model tested in this study hypothesized a first-order model with four main interrelated factors: (i) the inservice teachers’ knowledge about the history of mathematics, (ii) their beliefs about the use of the history of mathematics in teaching, (iii) their knowledge about the use of the inquiry-based approach and (iv) their beliefs about the inquiry-based approach and its implementation. The a priori model hypothesized that the variables of all the measurements would be explained by a specific number of factors and that each item-statement would have a non-zero leading on the factor that it was supposed to measure. Additionally the model (following the LM Test) was tested under the constraint that the error variances of some pair of scores associated with the same factor would have to be equal. As Kieftenbeld, Natesan and Eddy (2011) suggest few error variances need to be correlated when there is a local dependence between items. Local dependence occurs when participants’ responses to a particular item depended someway on their responses to other similar items.

Figure 3 presents the results of the elaborated model that fits the data reasonably well ($\chi^2$/df = 1.86, CFI = 0.932, RMSEA = 0.031). The first-order model that is considered appropriate for interpreting teachers’ beliefs and knowledge about the inquiry-based teaching approach which includes the use of the history of mathematics involves 4 first-order factors, as was proposed. The first factor consisted of 7 items concerning teachers’ knowledge about the history of mathematics. The loadings of all the items were >0.5 and all the regressions were statistically significant. The second first-order factor consisted of 6 items concerning teachers’ beliefs about using the history of mathematics in the teaching of mathematics at primary education. The third-order factor consisted of 5 items concerning teachers’ knowledge about the use of inquiry-based approach in the teaching of mathematics and the fourth-order factor consisted of 6 items concerning teachers’ beliefs about using inquiry-based activities in their teaching. By using the specific analysis we aimed to explore the way these four dimensions of the model were interrelated. The existence or the non-existence of statistically significant interrelations is interesting.
As it was expected the relation between teachers’ knowledge about the history of mathematics and their beliefs about using it as part of the teaching process was statistically significant and extremely high (0.813), indicating that teachers who understand mathematics as a dynamic science which has evolved throughout the centuries in order to facilitate the development of the science and the social needs, they are at the same time teachers with positive beliefs about using the history of mathematics in teaching. At the same time teachers who know the advantages and limitations of using the inquiry-based teaching and learning approach, have positive beliefs about using the specific method in order to encourage their students to investigate and explore a mathematical concept (0.753).

Statistically significant was the relationship between teachers’ knowledge about the use of the history of mathematics and their beliefs about using the inquiry-based approach (0.692). It seems that teachers who believe that mathematics has been created, constructed and enriched by humans during the development of the specific science, want to give their students the opportunity to work creatively and critically in order to explore or investigate a mathematical concept. Teachers who have positive beliefs about using the inquiry-based approach in their teaching have at the same time positive beliefs about the use of the history of mathematics (0.718).

The non-existence of a statistically significant interrelation between teachers’ knowledge about the use of inquiry-based approach and their knowledge and their beliefs about using the history of mathematics is justified by the fact that the use of the inquiry-based approach in education is presented and suggested to teachers without relating it directly with the use of the history of
mathematics. However there are indirect interrelations, as teachers’ adequate knowledge about the inquiry-based approach is related with their beliefs about using the inquiry-based approach. At the same time teachers with high knowledge about using the history of mathematics have positive beliefs about using it.

4.2 Teachers’ practices during inquiry-based teaching with the use of the history of mathematics

The observation of two teachers enabled us to concentrate more qualitatively on the practices they followed in order to use the inquiry-based approach on their teaching when they decide to use the history of mathematics which is presented in the textbooks. Firstly we present briefly the observations and then the related parts of the follow-up interviews which concentrated on dimensions which are related to the instructional practices.

The teacher of the 2nd grade presented to her students a picture with ancient Egyptians who were farmers and at the background of the picture there were symbols on the wall of their houses. She told the students that ancient Egyptians used to engrave symbols on the walls or papyrus and she asked them to study the picture in their book and guess which numbers were possible. She actually preferred to pose an open question which guided them to many different accepted answers. Many right answers were given and only one wrong. In fact the mistake was made by a student who presented an unexpected answer with three-digit numbers. He claimed that the first number was 310, the second 502 and the third 106. The teacher told him “we have not learnt three-digit numbers yet, we will not discuss this mistake now”. She spent almost 10 minutes on the specific activity with the ancient Egyptians in the textbook and then she asked students to imagine that there were ancient Egyptians and they had to construct and propose their own symbols. Each group of two students had to decide 3 to 4 symbols and they had to present to their classmates few numbers in order to guess the value of each symbol. Students found the activity creative and all the pairs wanted to present their work. The most common mistake was the insufficient information which was given to their classmates in order to guess the value of the symbols. The teacher preferred to justify this mistake by making the comment to the students “you had preferred to pose an open problem, an exploration”. During the interview she justified this behaviour by saying that “it was an exploration and I didn’t want to kill students’ enthusiasm by pointing out that they worked wrongly. I wanted them to feel free to create in mathematics rather than feeling fear of making mistakes”. She justified the absence of feedback in the case of the three-digit numbers, which were presented above, by saying that “I do not have the time to discuss everything and most students would be unable to understand something from this discussion”. What was impressive and unexpected was that she continued with activities of place-value at two digit numbers without any reference to the similarities and differences of the two arithmetic systems.
At a question during the interview asking her to explain why she had not discussed the importance of the absence or the presence of zero at the arithmetic systems, she said “the history of mathematics can be used just as a fairy tale. It has to be used in the same way you can use literature in order to introduce a concept. We have no time to insist more. This could be done in the upper grades of education, not at the 2nd grade”. The parts of the interview which are indicative of her beliefs about the use of the history of mathematics and about the inquiry-based approach are presented below.

- How often do you use the inquiry-based approach in the teaching of mathematics?
- I always do the investigations which are presented in the textbooks and sometimes the explorations.
- Why are you not using all the explorations?
- I do not have enough time. It is difficult to concentrate your students’ attention on a specific concept when the framework is open.
- Why did you decide to use the exploration with the ancient Egyptians?
- This was interesting but you saw that I did not continue to discuss the three-digit numbers. I would have problem with the time.
- Have you ever used something from the history of mathematics which is not presented in the textbook during an activity of exploration?
- No, I didn’t know many things about the history of mathematics and it is too difficult to relate the historical concepts with the knowledge you want them to learn today.

At a relative question about the attendance of any course related with the history of mathematics or the inquiry-based approach during her studies or any pre-service training program she claimed that she did not know anything about the use of the history of mathematics and she had attended the obligatory in-service training about the use of explorations and investigations which was organized by the Ministry of Education. She underlined the necessity of developing programs of training at the school in real teaching situations, especially in order to enforce the use of the inquiry-based approach.

It is clear from the discussion which is presented above that the teacher felt the pressure of the syllabus which had to be taught; she indicated negative self-efficacy beliefs in managing the time and the unexpected situations derived by students who performed well in mathematics. At the same time the lack of knowledge about the content of the history of mathematics and the value of using it as a teaching tool is obvious, while the teacher was convinced about the value of using of the inquiry-based approach in daily-life framework.

The teacher at the 3rd grade started the lesson by asking students to imagine that they were archaeologists and they had to understand the numbers which were written on the stones (Figure 2). He asked them to cooperate with the classmate who was near them in order to solve the two exercises on page 19. He spent only 3 minutes in order to correct their answers. He asked three students to write the three numbers on the board and he evaluated students’
understanding by asking them to raise their hand if they knew how to translate the numbers 5328 and 2008. He asked from a child who did not raise his hand for translating the second number to go on the board in order to “help him to think together” the solution. When he realized that the child was confused because of the presence of “0”, he asked him to find the respective solution for the number 110 by presenting it firstly with the dienes cubes and then by using ancient symbols. Then he asked for the translation of numbers 101 and 1001.

During the interview he claimed that the inquiry-based approach is useful, especially for students with low performance in mathematics as it reveals their misunderstandings and misconceptions. However he underlined the difficulty to work at the same time with all the students during an investigation. He knew few things about the history of mathematics, mainly about geometry and non-Euclidean geometry, which he had been taught at university but he could not imagine anything else beyond the arithmetic systems that could be used in the teaching of mathematics in primary education. He believed that the history of mathematics could be useful in gymnasium in order to enable students to honor the ancient Greeks who discovered mathematics. He did not remember other mathematicians except for Pythagoras and Euclid. It is obvious that this specific teacher preferred to use a guided investigation. He insisted on students’ mistakes by using the strategy of simplifying the problem. He did not know the philosophy and pedagogy of using the history of mathematics in order to introduce a mathematical concept.

5. DISCUSSION

European reports will continue to call for inquiry-based teaching approaches in mathematics in order to urge students to think critically and creatively and to enable them to solve authentic real-life problems. Teachers are expected to actively engage students in open-ended learning experiences in order to foster an environment of inquiry. The current study provided evidence that although teachers have positive beliefs about the importance of the history of mathematics for the introduction of mathematical concepts, they do not apply its features into their teaching practice satisfactorily, because they do not have the necessary and sufficient knowledge. Teachers feel more confident to teach the way they were taught and they seemed not having adequate experiences in learning mathematics through the exploration of the respective history. We have to rethink at least the role of in-service training programmes and the respective experiences which are built through them. In pre-service or in-service training we have to equip teacher with methods and techniques for incorporating historical materials in their own teaching, with experiences in inquiry-based teaching approaches and with strategies of managing flexibly the time and their students’ misunderstandings. In order to enable teachers to adopt inquiry-based approaches which use the history of mathematics for the introduction of mathematical concepts, we have to develop pre-service and in-service training programs which use the progressive inquiry approach in order
to affect their knowledge on the specific domain, their masteries experiences and consequently their self-efficacy beliefs in respect to Bandura’s theory (Bandura 1997). Attempts to incorporate the history of mathematics in education might benefit from keeping in mind that teachers need to be helped to develop knowledge that is both useful and usable for the work of teaching mathematics.

It is extremely important that teachers who adopted an experimental epistemological perspective about the nature of mathematics by understanding the dynamic development of the specific science throughout the centuries, believed in the value of exploring and investigating the mathematical concepts. This is an indication that their experiences as learners during their training courses at universities with the development of the mathematical concepts by using an inquiry-based approach will probably enable them to believe in the value of using the inquiry-based approach and the benefit of using the history of mathematics in order to humanize them.

The present study is just the starting point of investigating a piece of this puzzle which is related with the history of mathematics and the inquiry – based approach and more research has to be developed in order to relate the teachers’ knowledge and beliefs about the use of the history of mathematics with their beliefs and knowledge about the inquiry-based approach. Emphasis has to be given on studying further teachers’ difficulties in implementing the inquiry-based teaching approach in general and in the case of using the history of mathematics in particular. Studies have to be developed to examine their practices and difficulties in real classroom actions. A future study could concentrate further on the investigation of teachers’ practices in classroom context by observing more instructions and investing on changes which would be the result of teachers’ own self-reflection on their teaching behaviour when difficulties are faced during an attempt to implement an innovation.

REFERENCES


Areti Panaoura is associate professor in Mathematics Education at the Frederick University in Cyprus. She has BA in Education, MA in Mathematics Education and PhD in Mathematics Education (University of Cyprus) and MSc in Educational Research (University of Exeter). Her main research interests are about young pupils’ metacognitive abilities in mathematics, the self-regulation, the affective domain in mathematics, the use of different representations for the teaching of mathematical concepts and the inquiry-based teaching and learning approach.