Modelling the Sociocultural Contexts of Science Education:

The Teachers' Perspective

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Abstract

A growing body of research argues that teachers' beliefs and practices should be studied within the sociocultural contexts of their work because the relationship between their beliefs and practices is both complex and context-dependent. There is a need for further research in this area in understudied contexts such as developing countries, in order to promote effective education in schools and the professional development of teachers. This paper argues that if this 'black box' of sociocultural contexts in which science teachers are embedded is better understood, it may be

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possible to identify specific aspects of these contexts related to educational organizations that act as either supports or barriers to pedagogical reform or to implementing innovations in science education. Consequently, the main purpose of this study is to explore the sociocultural contexts of ten Egyptian science teachers and to what extent these sociocultural contexts help in understanding teachers' pedagogical beliefs and practices. This paper, by utilizing a multi-grounded theory approach and qualitative methods, reveals a variety of sociocultural contexts that are related to teachers' pedagogical beliefs and practices.

Introduction

Research indicates that educational beliefs and practices are not context-free or separated from the wider sociocultural contexts that teachers are embedded in (Briscoe, 1991; Rogoff, 2003; Ash, 2004; Robbins, 2005). These studies also argue that teachers' beliefs and practices cannot be examined outside of the sociocultural context, but are always situated in a physical setting in which constraints, opportunities or external influences may derive from sources at various levels, such as the individual classroom, the school, the principal, the community, or the curriculum. In a community, 'individuals are not simply free to change their minds. The reality is that we depend on one another for our survival, and all cultures reflect the fact by making the viability of beliefs contingent on their consequences for the community' (Lemke, 2001, p. 301). It is, therefore, necessary to take into account the contextual factors that have shaped and formed certain beliefs. The importance of studying this framework is supported by Olson (1988): 'What teachers tell us about their practice is, most fundamentally, a reflection of their culture and cannot be properly understood without reference to that culture' (p. 69). In this respect, a study by Briscoe (1991) points to the significance of the mental images that teachers use as sources of knowledge when constructing roles for themselves. In Briscoe's study, the teacher used images of typical schools which he had recalled from his past experiences, as a basis for developing his practices.

Most of the studies related to teachers' knowledge, beliefs, and making sense of the world have been carried out in western cultures, not in an Arab-Islamic culture such as Egypt. More importantly, many topics typically included in science education are acknowledged as controversial, e.g., evolution or cloning, and indeed these issues pose problems for science teachers, especially in Islamic countries, owing to their perceived conflict with the Islamic-religious view. In this respect, social constructivism emphasizes the importance of culture and context in understanding what occurs in society (Derry, 1999; McMahon, 1997). Social constructivists view learning as a social process. It does not take place only within an individual, nor is it a passive development of behaviours that are shaped by external forces (McMahon, 1997). Meaningful learning occurs when individuals are engaged in social activities. This approach assumes that theory and practice do not develop in a vacuum; they are shaped by dominant cultural assumptions (Martin, 1994; O'Loughlin, 1995).

A key question for this study was asked by Lemke (2001) 'What does it mean to take a sociocultural perspective on science education?' Essentially, he answered, it means viewing science, science education, and research into science education as human social activities conducted within institutional and cultural frameworks (p. 296). Another question from Lemke was, 'What does it mean to view the objects of our concern as "social activities"?' From a research perspective, he claimed, it means first of all formulating questions about the role of social interaction in teaching and learning science and in studying the world, whether in classrooms or research laboratories. Additionally, it means giving substantial theoretical weight to the role of social interaction: regarding it, as in the Vygotskyan tradition to be central and necessary to learning and not merely ancillary. Similarly, it means seeing the scientific study of the world as itself inseparable from the social organization of scientists' activities (p. 296).

Essentially, science education studies argue that we can know nature only through culturally constituted conceptual or epistemological frameworks, enabled and limited by local cultural features such as discursive practices, institutional structures, interests, values, cultural norms, and so on (Turnbull, 2000). In this respect, Kesamang and Taiwo (2002) identified that in Botswana, as in many African nations, specific local sociocultural factors shaped significantly the thinking of the average Motswana child. In the same vein, Ogunniyi (1988), (cited by Jegede and Okebkola 1991) states that every human being:

. . . tends to resolve puzzles in terms of the meanings available in a particular socio- cultural environment, the baseline is that the meanings become firmly implanted in the cognitive structure and manifest themselves habitually and may act as templates, anchors, or inhibitors to new learning. (p. 276)

The role of context is important in learning and changing beliefs and practices, therefore, its impact should not be ignored. Vygotsky focused on the roles that society plays in the thought development of an individual. Vygotsky (1978) believes that human thought developed from the social to the individual - humans beginning as social beings and culminating in inner individuality. In this respect, Wells and Claxton (2002: 2) argue that the way minds grow is not, fundamentally, through didactic instructions and intensive training, but through a more subtle kind of learning in which people pick up useful (or useless) habits of mind from those around them and receive guidance in reconstructing these resources in order to meet their own and society's current and future concerns. In this sense, Butt, Raymond, McCue and Yamagishi (1992) argue that to understand how a teacher thinks, acts, feels and intends, and how a teacher knows what s/he knows, it is essential to understand relationships and tensions in context and the teacher's life experiences. Also, to understand a teacher's classroom practices, the contexts within which s/he works need to be understood. According to this perspective, a fledgling teacher learns to teach as he or she learns to become a member of a particular department, school, and culture.

According to Vygotsky (1978), humans are born into a pre-existing world of culturally established tools and artefacts, which are the material embodiment of important cultural ideas and adaptations, passed down through history, which extend the reach of human activity and understanding. Vygotsky posits that humans use these tools and other cultural artefacts to act upon the world to satisfy needs and achieve goals which, in turn, transform our psychological being which, then in turn, affects how we develop as individuals, a society (culture) and, ultimately, a species (Scribner, 1985). In this sense, Vygotsky is best associated with the principle that the distinguishing characteristic of specifically human psychological functions is that they are culturally mediated (Cole & Engeström, 2007). In this study, my focus is on the relationship between cultural context and individual belief, and practices. In other words, the research focus is on exploring and understanding the socio-cultural mediators of teachers' beliefs and practice.

Background to the Educational System in Egypt

School education in Egypt

The school system in Egypt consists of three Stages: the primary stage which spans six years for children aged six to 12 years; the preparatory stage, which lasts for three years for students aged 12 to 14 years and the secondary stage which lasts for three years with students aged 15 to 17 years. The Ministry of Education is the only authority determining the educational curricula, syllabuses, methods of teaching, educational targets, and the roles of the teachers and learners. Curriculum guidelines for science are set through a system of committees at the state level. The science subject committee is composed of consultants, supervisors, experts, professors of science education and experienced science teachers. Once the committee reaches agreement, the curriculum guidelines are then referred to the Supreme Council of Pre-University Education for official release. Each

governorate is responsible for implementation of the guidelines (International Affairs, 2000). Science has been a basic subject in the central National Curriculum (NC) since 1960, having traditionally included general science at primary and preparatory levels, and separate disciplines (chemistry, physics and biology) at the secondary level.

Science teacher training in Egypt

There are two kinds of pre-service science teacher training programmes in the faculties of education in Egypt. One programme prepares elementary science teachers to teach in primary schools (ages 6-12) and this takes four years and leads to a BSc in Primary Education, whereas the second one prepares science teachers for teaching in both preparatory (ages 12 to 15) and secondary education (ages 15 to 18). It has two departments: one is the Physics and Chemistry Education department, which prepares science teachers to specialize in physics or chemistry teaching in secondary schools whilst the second is the Biology Education department, which prepares science teachers to specialize as biology teachers in secondary schools. The latter programme also takes four years, and leads to a BSc in Secondary Education. Graduates from this programme begin their teaching career in preparatory schools and are later promoted to secondary education.

The Focus of the Study

Teachers are 'agents of change' of educational reform, and their beliefs must not be ignored. Indeed, their pedagogical beliefs are at the 'core of educational change' (Mamlok-Naaman et al, 2007). Sociocultural research can enhance our understanding of science teachers' pedagogical beliefs and how science teachers learn from their experiences in different contexts, such as the university pre-service course, the practicum, and the school in which they are employed (Goos, 2008). Exploring the roles of sociocultural contexts in order to understand teachers' pedagogical

beliefs and practice, in a manner grounded in empirical research, would enable evaluators to properly contextualize their findings and track cultural phenomena as both mediating and outcome variables and also would give programme planners and policy makers the tools to better understand their institutions and the ultimate effects of investments in reform (Hora, 2008). The main aim of this study is to provide an answer to these research questions:

What are the sociocultural contexts in which Egyptian science teachers are embedded?

To what extent do these sociocultural contexts help in understanding Egyptian science teachers' pedagogical beliefs and practices?

Methodology

Research sample

This study is a follow up to another study (see: Mansour, 2007) which studied the nature of science teacher preferred methods of teaching and orientation. I have invited the science teachers who participated in my previous study (Mansour, 2007) to take part in the current study. Twenty-five teachers from preparatory schools in Gharbia Governorate in western Egypt responded positively to participating in the study, and subsequently ten teachers out of the 25 were selected by the researcher to take part. The sampling was designed to include a broad variety of informants' experiences based on gender, unique teaching situations, a variety of teaching expertise, and various experiences teaching at different preparatory grade levels. The ten participants chosen for this study were gleaned from different preparatory schools, and represented all the grade levels, as well as a diversity of age and both genders. More specifically, the participants consisted of five males and five females, with teaching experience that varied from 12 to 34 years of teaching, and with ages ranging from the mid-thirties to early fifties.

I used alphabetical letters in referring to them so as to preserve the anonymity of the participants. Their backgrounds are as follows:

- Teacher A obtained his Bachelor of Science and Education (Physics & Chemistry) in 1988, a special diploma in Education, 1990, and diploma of teaching science in English, 1997. He had been teaching science for sixteen years and had been sent to the UK to King's College London in 1997 for three months' training, and moreover, he had attended many training workshops, e.g. a training in The National Standards for Education in Egypt and their application, internet and computer training plus a three day programme on using teaching methods to teach science.

- Teacher B obtained his Bachelor of Science and Education (Physics & Chemistry) in 1991, and had been teaching science to preparatory school students for 14 years: five years in private schools, six years in public schools and three years in Saudi Arabia.

- Teacher C obtained his Bachelor of Science & Education in 1984. He was a senior teacher in the preparatory stage and his experience included a three-month scholarship to England, at the University of East Anglia, Norwich and he had also attended a workshop on the effective use of teaching methods and another one on the use of computers in science education.

- Teacher D obtained her Bachelor of Science & Education (Biology) in 1991, after which she taught preparatory science curricula and had been teaching science for 12 years.

- Teacher E obtained her Bachelor of Science and Education (Physics & Chemistry) in 1988, followed by a special diploma in Education in 1990, and had been teaching science for 16 years. She was sent to the King's College in London in 1997 for training for about three months. She attended many training workshops, e.g. training in The National Standards for Education in Egypt and their application, internet and computer training.

- Teacher F was 55 years old. She obtained two degrees (B.Sc. in Biology Education, 1976 and Bachelor of Chemistry, 1990). She taught science in the preparatory stage and chemistry in the general secondary school for 30 years.

- Teacher G obtained his Bachelor of Science and Education (Physics & Chemistry) in 1996, and a special diploma in Education in 1998, a Master of Education in psychology, and had been teaching science for eight years. He had attended a workshop about using teaching methods effectively.

- Teacher H obtained his Bachelor of Science and Education (Biology) in 1983. He had been teaching science to preparatory school students for 21 years and had attended many training programmes on the use of teaching methods in science education and different methods of evaluation in science.

- Teacher I obtained her Bachelor of Science and Education (Physics & Chemistry) in 1993, and a special diploma in Education/MA. She had been teaching science for 11 years. She had attended many training programmes about teaching methods to teach science, using computers to teach science, and the effective utilization of the science laboratory in teaching science.

- Teacher J obtained her Bachelor of Science and Education (Physics & Chemistry) in 1987, and also held a kindergarten diploma. She was awarded a three-month scholarship to study in England and Scotland. She had been teaching science for 17 years during which time she had attended many training workshops e.g., training in The National Standards for Education in Egypt and their application.

Research Methods

Interviews were the primary data source for this study. I chose to have a semi-structured interview where I would be able to remain open to any unexpected ideas that I would encounter, as I would

not be able to predict what would come from the participants' responses. Most of the interview questions were prepared in advance by considering the relevant literature. The order of the questions was modified and some questions were added or varied as each interview unfolded. The wording of the questions was also varied to ensure that participants grasped the meaning. The interviews were audio-taped and then transcribed into Arabic immediately after the interview, and then the transcripts were returned to each of the teachers before the start of the subsequent interview for their scrutiny, confirmation or criticism. After each interview, I also did an initial analysis of the material and made notes on a covering sheet to act as a framework for subsequent questions. In this way, the process was concerned with 'the unique, the idiosyncratic and the wholly individual viewpoint' (Guba & Lincoln, 1989: 155-156). All the interviews lasted approximately 30-45 minutes. According to Strauss and Corbin (1998), in grounded theory, data collection continues until theoretical saturation is reached. They define theoretical saturation: 'This means until (a) no new or relevant data seem to emerge regarding a category, (b) the category is well-developed in terms of its properties and dimensions demonstrating variation, and (c) the relationships among categories are well established and validated' (p. 212). During the third round of interviews, responses showed repetition of the emerging analytical categories and eventually, by the end of the fourth interviews, core categories seemed to become saturated, suggesting that little new information or insight would be gained by additional interviewing.

The interviews included questions focused on exploring the sociocultural contexts that teacher consider when teaching or planning the science lessons. Also, some interview questions aimed to explore the impact that these contexts might have on teachers' perspectives on science education. Examples of the interview questions are:

1. There are many controversial issues within science education for example, evaluation, cloning, test tube babies etc.

- What role (s) should a science teacher be adopting in teaching these lessons e.g. cloning?

- What do you think the role of the student in learning this lesson e.g. cloning?

- What the teaching methods you use to teach this lesson? Why

- What are your activities and resources to teach this lesson?

- Do you have the confidence to teach this lesson? why

- What do you think the factors that can help you to teach this lesson well e.g. evaluation or cloning?

- What are the considerations you put in your mind when you teach this lesson e.g. evaluation or cloning?

- What are the factors affect your teaching?

2. Are there any things at the local/ school/ state levels that influence the way you teach? What are some examples of this?

3. What things would encourage you or make it easier for you to use a particular pedagogy or to include a topic in your classroom during the upcoming academic year?

4. Why did you choose this career? Why did you decide to become a science teacher?

5. In what ways did your teacher education programme influence on your perspective to science, science education and they the way that you teach?

6. Describe any role models that have influenced the way you teach and describe any impact these experiences may have had on your teaching?

7. How would you describe the school setting and the student population? Do you feel there are restrictions?

8. What areas of science do you want to cover in your classes? Why?

9. How would you describe the current curriculum you are using in science?

Interviews were carried out in Arabic since both researcher and participants were native speakers. In this way, the participants were able to express their beliefs comfortably without any language barrier. The data were also analyzed in Arabic so as not to lose the actual meaning of the participants' explanations in the translation process. The parts quoted in the final report of the study

were translated into English at the end of the data analysis process. The quality and meaningfulness of these translations were checked twice; firstly by a native Arabic speaker who had specialised in English at university and then by a native English speaker for a further edit.

Data Analysis and Findings

Grounded theory (GT) offers a pure approach, in contrast to a theory-driven deductive analysis. Stem (1980) pointed out that grounded theory provided a method for investigating previously unrehearsed areas. The original grounded theorists warned against reading literature concerning other theories before performing data collection and data analysis (Glaser & Strauss, 1967, p. 37). GT has been criticised for this pure emergent procedure (Ezzy, 2002; Goldkuhl & Cronholm, 2003; Lind & Goldkuhl, 2005). In particular, development of an isolated theory, as in GT, does not acknowledge that the development of knowledge is a cumulative process. In this study, a Multi-Grounded Theory (MGT) approach which involves both 'empirical grounding' and 'theoretical grounding' was used to analyse the data. MGT is a sophisticated model of grounded theory that deepens both inductive and deductive methods of theory generation (Ezzy, 2002).

As shown in Figure 1, the data analysis included four processes:

1. Inductive coding, which corresponds to open coding in GT;

2. Conceptual refinement, where critical reflection on empirical statements is conducted;

3. Building categorical structures, which involves combining categories into theoretical statements, corresponding to axial coding in GT;

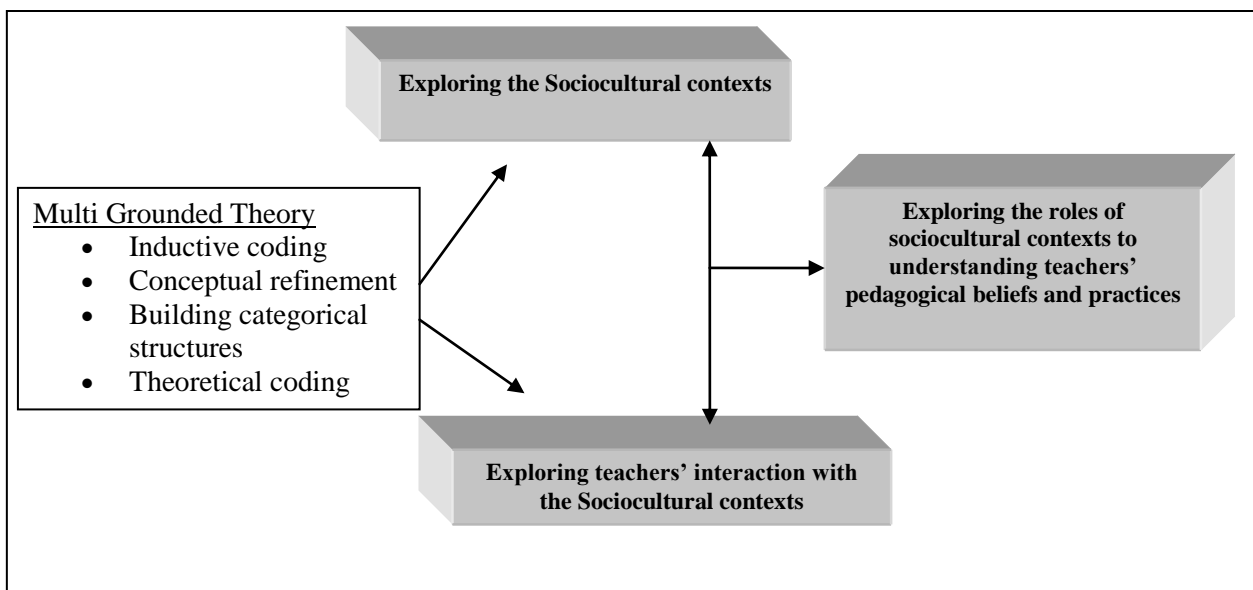4. Theory condensation, which matches selective coding in GT.

Figure 1: Procedures of the data analysis

The data analysis looked at the data from two perspectives: 1- Exploring the sociocultural contexts in which Egyptian science teachers are embedded; 2- Examining the relationship between teachers' experiences within these contexts and their pedagogical practices.

The next section will explain the process of data analysis in order to achieve the aims of the study:

Data analyses related to exploring the sociocultural contexts

What are the sociocultural contexts in which Egyptian science teachers are embedded?

This level of analysis occurred in three stages. Table 1 exemplifies the first stage of the analysis and outlines how the theoretical coding of 'sociocultural contexts' emerged from the data. In the initial process of data analysis, an incident-to-incident coding technique was used (see some examples of the open coding in Table 1). The second process of the analysis at this stage was 'conceptual refinement' (Lind & Goldkuhl, 2006). The main aim of this process was to understand how teachers make sense of the sociocultural contexts. In this stage of the analysis there was an indication that

the participants had a commitment to act on, or carry out, their interpretations, experiences or perceptions (see some examples of 'the conceptual refinement' process in Table 1).

The third process of the data analysis dealt with building categorical structures. In this stage, the data analysis was guided by what Glaser called 'The Six Cs': Causes, Contexts, Contingencies, Consequences, Covariances and Conditions (1978, p. 74). The fourth process 'condensing categories' or 'theoretical coding' was conducted during the stage of developing empirical theory 'sociocultural contexts'. In this stage, some of Glaser's theoretical coding families were used in the process including analytical categories such as 'social contexts', 'consequences', and 'cultural'. As shown in Table 1, theoretical codes emerged as: personal religious beliefs, teachers' own school experience, and the institutional context of education.

Table 1: The elements of sociocultural context (SCC)

Inductive coding 'Open coding'	Conceptual refinement	Building categorical structures 'Axial coding' Context and Cultural tools	Theoretical coding
Science research is following religious concerns	Teachers' religious beliefs are the core of other beliefs	Religious context	Personal religious beliefs
Religious influence	Religious explanation is acceptable and logic		
Religious orientation of Science content	Teachers view of the integration between science and religion		
Controlling role of the Islamic society of technology	Teachers' beliefs are infected with the controlling role of the society to the technology		
Negative control of the Islamic society to research in science	Teachers' rejection of the negative control of the society to research in science		
Learning science and school trips	Teachers' views of the importance of informal science education	Out-of-school classes	life-in- school-education
Science and society	Teachers' beliefs of how science serve society		
Science and technology	Teachers' views of the application of science in society		
Experiences with ex-teachers	Teachers experience with previous teachers act agent for their action	Teachers' schooling	
University education	The negative influence of the superficial teacher education.	Teachers' higher education	
Training abroad	Teachers reflect their influence with the other countries cultures	Cross-cultural experience	
Examination system	Examination system controls both teachers and students.	Educational management context	Institutional context of Education
Top-bottom policy of developing the curriculum	No involvement from the teachers in developing the curricula		
Content of the exams	The cognitive domain of the exams		
The control of textbook	Teachers' responses to the guides		
Fixed syllabus	Teachers have to stick with content		
Providing resources	Teacher use of the facilities		
Teacher under supervision	Teachers aware of their supervisors' requests		
Science education aims	Teachers' interpretations of the science education aims		
The influence of teacher's peer	Teacher's peer form his self esteem, efficacy beliefs	School context	
School resources	Teachers reflect controlling by the limitations of resources		
Financial support	Teachers' reaction to the lack of financial support		
Administration constraint	Teachers ' traditional practices as an action for the school action		
Students' concern with the results of final exam.	Examination environment influence	Classroom context	
Students' concern with achievement	Teachers' reflections of the influence of students' needs.		
Students' opinions	The influence of students' opinions on teacher decision		
Students' habits	The powerful influence of what the students used to do.		
Limited time	Teachers have to accommodate to the available time		
Student motivation	Students' motivation guides teacher's motivation		
Class size	Teachers used alternative teaching methods		
Student-student interaction	Limited by the teaching methods and students' knowledge		

Data analyses related to teachers' experiences of sociocultural contexts and their pedagogical beliefs and practices

To what extent do these sociocultural contexts help in understanding Egyptian science teachers' pedagogical beliefs and practices?

Evidence for the sociocultural contexts and how teachers' experiences with these contexts can be used as a framework to understand their pedagogical beliefs is illustrated by examples of the verbatim quotations from the transcripts which are set out below in three sections. These show the sociocultural contexts which have formed the background of ten Egyptian science teachers and how these contexts can be used as a framework for understanding teachers' beliefs and practices.

Personal religious beliefs

 The findings of the analysis suggested that it was not the religious context but it was mainly teachers' personal religious beliefs that shaped their pedagogical beliefs and practices. These are some comments of the participants:

   Personal religious beliefs and pedagogical practices. Seven teachers articulated that if an opinion relates to religion, there is no controversy about it, and the religious belief is propounded directly. Aside from religious affairs, it was felt that the teacher should not impose his/her opinions on the students. Teacher D said:

   I myself don't force my opinion during the discussion with students, so students can express their opinions freely without being affected by my voiced opinion. However, if the opinions of scientists disagree with religious view, I present only the opinions that conform to our religion and society (T/D).

Teacher C held the view that the religious orientation of society is one of the factors that can guide us to make pedagogical decisions, especially in relation to scientific issues related to religion, in order to transmit Islamic religious values and principles to students:

   The main consideration I have in mind is that our society is an Islamic one which should drive our behaviours. For this reason, if I am teaching a lesson like cloning, I should initiate the lesson on

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cloning with an Islamic introduction beginning with the Qu'ranic verse that explains that there should be husbands and wives or males and females (T/C).

Additionally, teachers' religious beliefs affected their pedagogical beliefs in general and their subject-specific pedagogical beliefs in particular. Teacher E had used co-operative learning within a 'drugs' lesson because she wanted her students to learn the Qur'anic concept of co-operation. In the classroom and at the end of discussion of 'the drugs issue', she again mentioned to them the importance of their co-operation in gaining and understanding new information when dealing with the problem from different aspects, and she referred to the verse:

"And help each other in righteousness and piety, and do not help each other in sin and aggression. And fear Allah. Surely, Allah is severe at punishment" (Qur'an, 5, part of verse 2).

Personal religious beliefs and views about ICT. Six teachers held the view that the use of the internet to teach a controversial issue like cloning in Islamic countries is very dangerous. For example, teacher G said:

I do not recommend the use of the internet because we are Muslims and have special opinions concerning controversial issues. When students surf the internet, they may come in contact with people from other religions. The student in this age cannot discriminate between what's good and what's bad. … I start with the students' opinions and after this I present my opinion. I'll present my opinion from a religious perspective because we're an Islamic society. (T/G)

Personal religious beliefs and gaining knowledge. Teacher H described how, upon finishing a lesson and leaving the classroom, he was challenged by one of his students, who asked why they were learning science. The teacher argued with him, putting forward the religious view that it is a responsibility and a duty to pursue knowledge. Teacher H mentioned that the Hadith literature (teachings of the Prophet Mohamed) is

full of references to the importance of knowledge and to our duty to seek that knowledge. He pointed out that:

> The Prophet Mohamed said "Seek knowledge, even in China". It is worth mentioning that in the era of the Prophet Mohamed, people walked or used horses or donkeys to travel, so travel from Saudi Arabia to China might take many months. The Prophet Mohamed also said "Seek knowledge from the cradle to the grave", and "Verily the men of knowledge are the inheritors of the prophets". (T/H)

Teachers' 'life in school education' context

This contextual level represents teachers' experiences with both their formal and informal education at schools and university and teacher training. This level includes: teachers' past school experiences, experiences outside school, cross-cultural teacher training, and the teachers' own education.

'Life outside school' experiences. Teachers' experiences of extra-curricular activities were influential, not only on their views about science but also with regard to how science subjects should be taught and learnt. Teacher F shared her experiences of visiting different factories, such as the Oil and Soap Company and the Coca-Cola Company. She said:

> It was amazing for me to see what the workers were wearing to protect themselves from harm, and how the chemicals reacted together. It was the first time for me to see real science. This experience made teaching abstract concepts so easy for students to learn. (T/F)

Teacher F also commented that these experiences affected not only her views about teaching and learning science but also her practice, and cited an example from her teaching experience. She said:

> When I came to teach the 'Refining oil' unit, which is considered one of the difficult units not just for my students but for me as well, I used to organise a trip to an oil refinery. The intention behind that

trip was to make the students realize the hazards of establishing oil refineries in densely populated districts and to make them feel they should play a role in alerting the people around them to the hazards of establishing oil refineries in populated areas. (T/F)

Teachers' own school experiences. Analysis of teachers' interviews revealed that the past school experiences of the participants had strongly shaped their views about science teaching and learning. Positive and negative experiences that had occurred at different times during teachers' lives as students characterized their pedagogical beliefs. For example, Teacher I commented on her negative experience:

I experienced all kinds of teachers in different subjects during my school and university education. Some of these teachers used to teach using lectures, or copying the activities in the textbook onto the board for the student to copy these activities again into their notebooks, which was boring for me and for the others. So when I became a science teacher I always tried to avoid using lectures and I used teaching methods to help students have fun when they are learning science. (T/I)

Six teachers stated that the knowledge level and interest in the subject among their previous teachers was the key to their positive memories of school and their own roles in the classroom. Teacher G commented:

I will never forget my science teacher in secondary school – he was an encyclopaedia on his subject. I think this made him a successful teacher. I want to be like him in my teaching. That is why I try to read and read even more before teaching and transfer this to my students. (T/G)

Teacher E's beliefs and practices had been greatly influenced by her experience with her past teachers. She explained:

The professors of chemistry and physics from the Faculty of Science made me like science and believe in its value. Those professors were symbols to me as they devoted their lives to studying phenomena in the laboratory. They persisted in getting us to apply what we learnt. For instant, a physics professor

used to tell us, 'You, as a physics teacher should be capable of repairing any broken machine in your house'. (T/E)

Cross-cultural teacher training. Six out of the ten teacher participants in the study had received training in universities in the United Kingdom and this experience had clearly exercised positively a strong influence on their pedagogical beliefs and practices. Most of these teachers reported that even their pedagogical beliefs had been changed radically; they couldn't put their beliefs into practice for various constraints. Teacher A gave brief details about his experience during his three months' training in the UK and how these experiences had affected his beliefs. He remarked:

In England, they focus on the practical side and on doing experiments. There, every student does experiments by himself to the degree that the results of a given experiment differ from one student to another and it isn't a must that the results conform to the results in the textbook. That is why after I came back to Egypt I tried to do the same, but I couldn't because there are no materials and no time … In England, the teacher prepares worksheets and distributes them to the students. Students have to solve the problems on the worksheets either by doing an experiment or by brainstorming. I believe that in this way the teacher obtains a lot of information from the students. This enhances retention because students build on their knowledge, but unfortunately I couldn't practice what I learned in UK because I am not the only one who is responsible for education in Egypt. The system in Egypt is top-down. Everything comes from the people on the top and we as teachers are just practitioners. We are like actors for the roles the decision-makers have already created for us. (T/A)

Teacher F explained how her teaching style changed from teacher-centered to student-centered:

Before I went to England I had to do all the teaching by myself using the lecture style. Now I base my teaching on the students themselves. Also, all science classes in England are taught in the lab and students do experiments themselves. The teacher only observes and guides. When I tried to apply this

in Egypt, the administration objected, stating that this was not suitable in Egyptian schools due to limited resources and space. (T/F)

Teacher E explained how her training in England had influenced her teaching performance greatly. She explained:

During my short stay in England, I visited classrooms and saw that there was a teacher and a co-teacher who helped the main teacher in following up the activities with the students. When I came back from England, I asked my colleagues to come to the classroom with me, especially in the cooperative learning classes. This type of teaching can be of great help to the weaker students. I also noticed in England that teachers use several aids (e.g., the computer, the video, and demonstrations) in explaining lessons. This arouses the interest of the students and breaks the ice in the classroom. (T/E)

Teacher training context. All the teachers emphasised the gap between theory and practice. They emphasised that the teacher preparation programme does not prepare the science teacher to deal with real life problems related to science. Teacher I noted:

Academic subjects (physics, chemistry, biology etc.) were purely theoretical without any practical aspects supplementing them. Besides, what we studied in academic subjects was insufficient because students in the Faculty of Education are taught smaller portions of academic subjects than students who are in the Faculty of Science. This has influenced my teaching for many years. I used to ask my students to recall science from things they had learnt by heart, believing in the importance of the science content until I started my master course which challenged my beliefs about science and teaching and learning science. I started to use the inquiry strategy with my students and encouragement to teach my students. (T/I)

Five teachers reported that their university tutors influenced not only their beliefs about science but also the way they taught science to their pupils. Teacher H noted that the teaching at the university depended on the lecturer and that this had affected his beliefs about the lecture method and how he could improve it. He said:

> Lecturers who tried to convey information directly and in a short time affected me greatly. Some academic subjects had a considerable effect on me, such as the anatomy course, the distribution of plants on Earth course, the functions of organs course, and when drawing slides. This last had the biggest effect on me, as drawing begins from something ambiguous … One of the professors who impressed me greatly was a professor of heredity who had studied abroad for his PhD degree. That professor, unlike others, used to make everything fun. He was an extrovert and I learned how to deal with students from him. (T/H)

The educational-contextual levels (institutional context)

Teachers do not operate in a vacuum, and their beliefs are shaped by both the immediate and wider educational contexts in which they work. These contexts include three levels: the educational management contextual level, the workplace (school) contextual level, and the classroom contextual level.

Educational management context level. The educational system in Egypt is extremely hierarchical with the Ministry of Education at the apex. It is also renowned for being bureaucratic, teacher-centered, authoritarian, and extremely competitive (Amer, 2003).

The school system in Egypt works using a core curriculum, which is a predetermined body of skills, knowledge and abilities, taught to all students. This core curriculum assumes that there is a uniform body of knowledge that all students should know. The core curriculum is limited to basic academic subjects like Arabic, maths, science and social studies, together with other activities such as music, gymnastics, drawing, etc. The curriculum is built on a mandated core, which is defined and designed outside the classroom and through which all students are taught a common set of knowledge, skills and abilities. Academic content

remains the primary focus of the core curriculum. Instruction is based on defined core content (Khouzam & Aziz, 2005).

Teachers' workplaces - schools - are situated within the wider context of an educational system. The educational management context level includes all the administration and management factors related to the teachers' work which comprise the officially stated educational polices and routines that encompass the educational system. This level also includes national polices and formal teacher training, the examination system, content, etc.

An assessment-based culture. All teachers expressed the view that the educational policy in Egypt is centralised by exams. All teachers indicated that an emphasis on student assessment influenced students' motivation and how teachers teach. Also, they emphasised that the current content is imposed on the teacher and any drifting away from it is seen as a 'crime'. One teacher said:

If the teacher does drift away from the current curriculum to give examples, he may face trouble with the supervisors and parents who consider this a drift from the syllabus. Besides, students won't show the due attention to this as their primary concern is on exams. One can say that science teaching in the preparatory stage is controlled by the exam culture….I'm required to teach the curriculum in a given time-span and use specific evaluation techniques. Supervisors pay frequent visits to schools to make sure the teacher adheres to this. (T/J)

Teacher G worked in a small school with poor material resources. The focus of the school was on the cognitive success of the students. Teacher G was not responsible for the examinations, which were organized by the senior teacher for all classes in the school. This focus on examinations created a competitive environment among students, with each other and also among the teachers. Teacher G said:

As a teacher, I am controlled by an examination system which is imposed on me. (T/G)

Another comment from Teacher G highlighting the importance of exams for the students was:

In my opinion, mentioning the word 'exam' causes more agitation to the students than any other thing. Caring for exams is something rooted in the Egyptian culture. As a teacher I have to adapt to this cultural and follow its rules. (T/G)

School resources and teachers' performance. Eight teachers mentioned that there were not enough materials and voiced concerns over how they could interact with 70 students in a classroom where the students could not find enough seats, and, moreover, the condition of science laboratories was disappointing. (During the field study, I noticed that each school had a room called 'Knowledge Resources'. This room had one computer, one overhead projector, one cassette player, one video, and one television set). Every teacher from all the different subject areas had to use it once a week, not for teaching his/her subject but just to use it and to record that s/he had used it.

Workplace (school) contextual level. This contextual level refers to the influence of the people with whom teachers were involved, at school during the educational process, such as the school administration and science inspectors, and educational decision-makers.

A culture of controlling teachers' own performance. **All** teachers highlighted that pressure comes from the evaluation of their own performance by the school and inspectors. Teacher E mentioned that the inspectors were one of the main reasons why there was a mismatch between her beliefs and her practices in some aspects of her classroom methods:

The inspectors have the power. They always visit the school but not to say anything good for the teachers or to give them prizes. They only come to assess us and to catch our mistakes. When they come everything has to be perfect and they watch to see whether or not we follow the textbooks. (T/E)

Another influence on teaching was the formality of planning as illustrated by Teacher M in her interview,

The inspectors are mainly concerned with the formality of lesson planning. They are more interested in such points as the inclusion of behavioural aims in the lesson plan than in actual teaching inside the classroom. (T/D)

In addition, the administration submitted formal reports to higher bodies that concealed facts and problems; in other words a picture was presented that differed completely from reality. In this way, aspects of weakness remained unchanged and accordingly so did the levels of both the teacher and the learner. Teacher E commented on the current role of the administration:

The administration is mainly concerned with the teacher's preparation notebook. And it is only a formal concern. Thus, it cares about such trivial elements as the date of the class, the elements of the lesson plan, the title of the lesson, etc. The concern is not placed on the content of the lesson or its importance for the students. All teachers are treated this way. (T/E)

Conforming to the educational policy. Teachers highlighted that they experience pressure to conform to the educational decision-makers' objectives. Seven teachers claimed that the aims and expectations set by the educational decision-makers, represented by the Ministry of Education (MoE) influenced the way they put their beliefs into practice. The MoE set objectives, which teachers had to achieve and adhere to, i.e. they were not free to teach the topics they wanted to teach. Teacher A said:

I'm obliged to follow a specified teaching plan and am given topics. This plan is specified on the part of the Ministry of Education. Any drift away from this plan is a kind of violating the law. Any violation of this plan subjects the teacher to retribution. (T/A)

Teacher H gave clear expression to the apparent lack of correspondence between the declared educational aims of the MoE and the hidden aims the teachers have to follow and work for:

There are aims set by the Ministry of Education. One of these aims is the students' employment of scientific content in real life. But such aims are formal, i.e., they are the declared aims, but the hidden ones which the ministry advocates focus on knowledge at all its levels. This can be noticed easily by examining models of exams and exercises presented to the students in all the educational stages. (T/H)

Classroom contextual level. This contextual level includes the interaction of the elements of the classroom environment, which comprises teachers' views and attitudes toward students, teachers' knowledge about the subject matter, class size, work overload, the learner and learning motivation, teachers' backgrounds and experiences, etc.

Class size. The classrooms in Egypt are so overcrowded that some students cannot find seats. The usual science class in Egypt contains 50 students, and thus movement of students is restricted, and the teacher has no space to move and has to remain close to the blackboard. The large number of students does not allow for the use of individual teaching techniques or even cooperative learning, or deducing scientific knowledge by discovery. Teacher E said:

How can I use innovative pedagogies that encourage interaction and dialogue among students with so many students (50 students)? How can I listen or discuss with students who have different views about socio-scientific topics in the classroom e.g. genetic engineering, global warming, etc.? I do not have the time. However, I try to do my best within the limited time and resources. (T/E)

On the same subject, Teacher G explained why he believed in the lecture as a good strategy for teaching science considering the context of his school. He said:

I have around 40 to 50 students in my classes. If I wanted simply to use discussion and to encourage students to debate a scientific issue and give their opinions freely and if I were to give just one chance to ten students and give two minutes to each one, that would be ideal and impossible. (T/G)

Teachers' perception of the students. In addition to demands from school authorities, class size, and lack of resources, teachers indicated that they behaved differently depending on the students. Seven teachers mentioned that their choice of teaching strategy depends on the students' motivation and learning habits. Teacher H explained that these are powerful factors in his teaching activities on the classroom:

I teach science to a certain class − four sessions a week and they attend other sessions for different subjects, and most of their teachers emphasise the content and teach by direct method 'lecturing'. The atmosphere of learning and teaching is oriented towards the content and the exams. By this process the students form habits and attitudes toward learning. To change that, we need co-operation among all the teachers of different subjects. What we need in order to teach science through the interaction between science, technology and society approach is to reform the students' learning habits. To achieve so, we need to change the teaching culture at school. (T/H)

Teacher A commented on the familiarity of students with the traditional styles of teaching and learning science. He said:

Students are used to memorising all the subjects, since the school system still puts the primary emphasis on memorisation, from the early beginning at the pre-school until the university level (T/A).

Significantly, Eight teachers believe that when we start from students' background knowledge, students will be more involved and aware of the problem and furthermore, when we give students new information, they will receive it with pleasure. One teacher said:

Today's student deals with various technologies out school like the computer, the internet, TV, the dish, etc. For this reason, they explain phenomena differently. This pushes me to read and search for information to improve myself academically and professionally. That is, I do my best to cope with the development of the modern age. (T/E)

Discussion

The following paragraphs discuss teachers' perspectives of the sociocultural contexts around them and these sociocultural contexts help in understanding teachers' pedagogical beliefs and practices.

Data analysis found that teachers' perceptions of the Islamic-religious context guided their criteria or basis for interpretation; of their roles, the students' roles, the aims of science and their teaching methods were strongly shaped by personal religious beliefs derived from the values and instructions inherent in the religion. In addition, analysis of the interviews showed that teachers' personal Islamic-religious beliefs imbued their beliefs concerning the role, nature, purpose and function of teaching science. In this respect, the study supported the idea that teachers were not just simply formed or socialized by their religious context; they were, in fact, active participants in interpreting these experiences (Sexton, 2004). According to Knowles (1992), the particular interpretation assigned to an experience was transformed to a 'schema', which he defined as 'a way of understanding or a cognitive filter and a basis for teacher-centred classroom practices' (1992, p. 138). In this respect, the results of the present study coincide with the arguments of Knowles and Holt-Reynolds (1991), that teachers' prior experiences had moulded their educational thinking, and that, through the interpretation of these religious experiences, teachers formed the beliefs they used directly to evaluate their own teaching practices (Mansour, 2008a). Loo (2001) argues that Islam, as one of the world's major religions, clearly has had, and will continue to play, a very important role in adjudicating the interaction between the philosophical and the social/cultural/religious environments of science.

Organizational theorists and practitioners alike are divided between two theoretical camps. Some claim that a strong principal and factors within the school can move teachers toward a shared commitment to the school's philosophy and method (a natural -system model). Others suggest that convergent beliefs among school staff including teachers are more strongly shaped by the school's environment, including diversity within the local community or fragmentation within the organization of school funding as structured by state and federal education agencies (an open-system model). An organization or a community like teachers may be able to maintain resilient boundaries and develop its own social values and ideology independent of the external environment (a natural system). The competing view argues that any organization or individual-to gain legitimacy and resources-must mimic the norms, beliefs, and social structures that predominate in the surrounding context (an open-system model) (Fuller & Izu, 1986). The current study finds that teachers' pedagogical beliefs and practices are responsive to their school settings which are sensitive to sociocultural forces, including students, parents, the Ministry of Education, Etc. Thus, in this sense, the Egyptian schools follow the open-system model; within this model and in order to maintain legitimacy, schools must teach the dominant values of the surrounding social environment (Fuller & Izu, 1986). Also, central to the open-system viewpoint is the idea of institutionalization; 'the process by which external pressures on an organization come to be viewed as acceptable and even wise' (Fuller & Izu, 1986, p. 507). In this respect, Tomlinson (1993) argues that the curriculum and instructional practices within an educational system reflect the dominant power in the society. In Egypt, school textbooks and curriculum documents are written mostly in a deterministic style that validates the prescriptive and authoritarian structure of teaching and learning science. At the same time in schools, teachers and students in Egypt are relay heavily on these textbooks. In this sense, Wells and Claxton (2002) argue that the ability of a group of people to carry out an activity together effectively resides not only in their individual knowledge and skills, nor just in their ability to collaborate; it is also distributed across the artefacts that are to hand together with the 'affordances' and also constraints provided by the learning environment. These artefacts, affordances and constraints work together as sociocultural tools that coordinate participants' actions and construct their understanding of the principles involved. However, Harley et al (2000) noted that these conditions unquestionably encouraged a teacher-

centred pedagogical approach. This might explain the mismatch in some cases between teachers' pedagogical beliefs and practices.

A close scrutiny of the research findings highlighted the perception that the Egyptian examination system acts as a constraint upon teachers, students and administrators to perform freely. Hargreaves (2001) explains how examinations in Egypt affect the whole educational system, commenting that whilst they serve an important certificatory and selective role for students, parents and teachers, the submission of exam results fulfils an accountability purpose for government, along with reports from inspections which result in the Egyptian government occupying a pre-eminent position over individuals in schools. The findings of the study indicated that exams in Egypt create a competitive atmosphere which places the emphasis on the accountability of individual schools and individual teachers, instead of on the monitoring of national standards in Egyptian education. Clearly, as teachers reported in this study, examinations in Egypt are critical and influential factors on all the people involved in the educational process in Egypt, decision-makers, curriculum makers, teachers, students and parents. The objective of these examinations, as Hargreaves (2001) notes, has never been for individual learning in any sense other than to be instrumental in the government's selection of, and admission to, the effective and functional ruling elite. From the sociocultural perspective the examination system acts as a culturally organized activity. In this sense and from the sociocultural framework for exams, it is important to acknowledge the complexity of interactions among students, teachers and exams. Factors such as student perceptions of how testing impacts on them, student and teacher confidence in the veracity of test results, and the differences in the student and teacher perceptions of the goals of assessment all need to be considered (Gipps, 2002).

The current study emphasises that teachers' interactions with their sociocultural contexts formed their experiences, and the study supports the view that teachers were not just simply formed or socialized by the sociocultural contexts in which they operate but, they were, in fact, active participants in the interactions with these sociocultural contexts, which created the conditions for how they teach in schools. Teachers' interactions with, and internalisations of, their sociocultural experiences were transformed in many cases

into teaching practices. This observation has validated many authors' arguments, e.g. Ringer (2001) who claimed that the educational system transmits, confirms, validates and perpetuates the knowledge, ideas, and concepts that have emerged as dominant. By the same token, Shore (1996) argues that individuals internalize information and experiences from their physical and sociocultural environment; they become deeply embedded in the cognitive processes of the brain through repetition, reinforcement, and attachment to key life events or emotions. In this respect, the results of the present study coincide with the arguments of Knowles and Holt-Reynolds (1991) in that teachers' prior experiences had moulded their educational thinking, and that through the interpretations of these experiences, teachers formed the beliefs that they used directly to evaluate their own teaching practices. In this vein, the findings concur with Wertsch et al (1993) that what individuals believe, and ultimately, how individuals think and act, is always shaped by cultural, historical, and social structures that are reflected in mediational tools such as literature, art, media, language, technology, and numeracy systems. In this sense, the study concludes that teachers are in a continuous process of constructing and re-constructing views about their pedagogical beliefs and practices in relation to others involved in a range of sociocultural contexts. This continuous process of interacting with the sociocultural contexts will lead to forming teachers' professional identities. Lave (1996) states it this way: "Crafting identities is a social process, and becoming more knowledgeably skilled is an aspect of participation in social practice, who you are   becoming shapes crucially and fundamentally what you know. (p. 57)". However, transforming teachers' beliefs and ideas into real practice in the classroom depend on other contextual factors, e.g., constraints, school environment, teachers' personal religious beliefs and experiences, and teacher's identity (Mansour, 2008a). That conclusion is supported by Schoenfeld (1998) who claimed that teachers' beliefs shaped what they perceived in any set of circumstances; what they considered to be possible or appropriate in those circumstances; the goal they might establish in those circumstances; and the knowledge they might bring to bear in them.

From a social perspective, teachers in this study are understood to enter their science classrooms with prior knowledge, beliefs, and experiences that they can then employ to make sense of their students, instructional practices and school contexts (Saka et al, 2009). Abstracting from Vygotsky's (1978) notion of

internalization, it could be said that teachers themselves have internalized what a 'teacher' is and what a 'student' is in relation to how classes are conducted. Prior to starting on this career path, these individuals were students themselves and had assimilated, over time, similar assumptions about the roles of teacher and student in the institution of academia (Mansour, 2008b). The outcomes and inferences of this study concur with Sexton (2007) in that entry-level teachers did remember their time spent in the classroom as students. It was those memories of actions, both taken and not taken, by teachers that influenced the type of teacher they did, and did not, want to become.

Conclusions and Implications

In this article, I have argued that teachers as active agents in society might be restricted by sociocultural forces (e.g. the examination system, lack of time, work overload, high student density in the classroom, lack of resources or materials, the content, etc.) that set strict limits on what these teachers can achieve (Giddens, 1984). Human actions are largely determined by the social structures that people inhabit (Hodkinson, 2004). Similarly, Dirkx, Kushner & Slusarski (2000) argue that teachers are profoundly influenced by the social structures in which they operate and that these shape their future choices. Rogoff (2003) argues that "people develop as participants in cultural communities. Their development can be understood only in light

of the cultural practices and circumstances of their communities – which also change. (Rogoff, 2003,

pp. 3-4). The study's findings showed that there were certain people with whom teachers dealt during the educational process, e.g., the school administration and science inspectors, educational decision makers and their aims, the family, and the learners themselves. Since all these people affected teachers' beliefs and practices in one way or another, there is therefore a need to investigate the role played by the beliefs of faculty/staff, administrators, principals, and students' parents.

It is important to note that this study argues that cognition, beliefs, views and attitudes are distributed across science teachers as they participate in culturally relevant activities, working with and transforming specific cultural tools and artefacts, practices, and contexts in which they engage (Rogoff & Chavajay, 1995). Thus,

rather than being a universal skill, developing or changing a belief is very much contextually specific, guided by others, and mediated by particular cultural tools and artefacts (Robbins, 2005). The study shows that science teachers are part of a complex dynamic; their beliefs, knowledge, values and actions shape and are shaped by the structural and cultural features of society and school cultures. While it is true that teachers are not simply pawns in the reform process - they are active agents, whether they act passively or actively - their actions are mediated by the structural elements of their sociocultural setting, such as the resources available to them, the norms of their school, and externally mandated policies (Lasky, 2005; Datnow et al, 2002). Overall, this study provides science teacher educators with insights into how teachers view their professional roles, in the aspiration that this will help them determine the types of experiences that are important for these teachers as they enter the profession. The findings of the study showed that teachers alone cannot be responsible for the quality of their classroom practices; external contextual factors can be a barrier for teachers in putting their theories into practice. These constraints are socially constructed and can be modified, if not deconstructed and reconstituted. In order to achieve this change, many things should be changed at different levels, starting with the objectives of educational decision-makers, the examination system, teacher professional development, science curricula, etc. Also, decision-makers should consider teachers' views and perspectives of the educational policy and educational system when they implement changes or reforms related to science education.

In addition, the study highlights how previous personal experiences and religious beliefs influenced teachers' views about teaching and learning prior to their admission to the teacher training programme. Thus there is a need to identify the beliefs about teaching and their role as teachers brought by pre-service science teachers to their teacher training programme. As Pajares (1992) argues, it would be useful to explore the effects of these beliefs beyond the pre-service experience. Therefore, future studies could use a similar methodology to examine the religious beliefs of pre-service science teachers and the influence of these beliefs about teaching science.

The study used grounded theory based on self-report on the part of the teachers (in interviews). That is, there were not classroom observations or other means of seeing the teachers' actual practices as opposed to their own mental images of their practices. The study used the self-report approach to explore how teachers make sense of the sociocultural contexts in relation to their pedagogical beliefs and classroom practices. Even this represents a limitation on matching teachers' pedagogical beliefs to their practices. The interview protocol helps teachers to reflect on their practices supported by examples. In addition, it is worth to clarify that this study did not seek to explore the consistency and inconsistency between teachers' pedagogical beliefs and practices. Instead, the study seeks to report on teachers' reflection on the sociocultural contexts in relation to their experiences of these sociocultural contexts and how their experiences with these sociocultural contexts formed their pedagogical beliefs and guided their practices. However, using observation would be very useful for interpreting the data for this study. Therefore, I strongly recommend using observation alongside the interviews when carrying out studies about the relationship between pedagogical beliefs and practices. Using observation would give the research chance to gain a better understanding of teachers' teaching practice and the context in which they taught. Erlandson, Harris, Skipper and Allen (1993) state, "Through observations, the researcher gains a partially independent view of the experience on which the respondent's language has constructed those realities (p. 99). The observation technique is known as a useful method for validating people's beliefs of their practice (Bell, 1993). It helped the researcher to "move beyond the selective perception of others" (Patton, 1987, 73). Patton explained that as interviews reveal people's understanding of a particular question, they often respond with highly selective perceptions.

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