

This article was downloaded by: [University of Western Macedonia], [PETROS KARIOTOGLOU]

On: 28 March 2013, At: 05:27

Publisher: Routledge

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



International Journal of Science Education, Part B: Communication and Public Engagement

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/rsed20>

Links Between Teachers' Beliefs and Their Practices in a Science and Technology Museum Visit

Maria Karnezou^a, Sofia Avgitidou^b & Petros Kariotoglou^b

^a Science Centre and Technology Museum of Thessaloniki (NOESIS), Themi, Greece

^b School of Education, University of Western Macedonia, Florina, Greece

Version of record first published: 28 Mar 2013.

To cite this article: Maria Karnezou, Sofia Avgitidou & Petros Kariotoglou (2013): Links Between Teachers' Beliefs and Their Practices in a Science and Technology Museum Visit, International Journal of Science Education, Part B: Communication and Public Engagement, DOI:10.1080/21548455.2013.773467

To link to this article: <http://dx.doi.org/10.1080/21548455.2013.773467>

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: <http://www.tandfonline.com/page/terms-and-conditions>

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae, and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand, or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

Links Between Teachers' Beliefs and Their Practices in a Science and Technology Museum Visit

Maria Karnezou^a, Sofia Avgitidou^b and Petros Kariotoglou^{b*}

^a*Science Centre and Technology Museum of Thessaloniki (NOESIS), Themi, Greece;*

^b*School of Education, University of Western Macedonia, Florina, Greece*

There is a growing body of research examining the impact of science field trips on pupils' learning in science education and the factors that influence their success. However, there is a limited number of studies that focus on the way teachers' beliefs influence their practices in an informal science-learning venue. This research aimed to investigate teachers' practices, when they plan, implement and comment upon the outcomes of a school visit to a science and technology museum in relation to their beliefs regarding the value of informal education, ways of supporting learning in an informal science-learning venue and the importance of familiarity with the venue. We studied 14 primary and secondary education teachers with respect to a visit they conducted with their class to a science and technology museum within a case-study approach. Interviews with the teachers, both prior to and after the school visits, and observations of the field trips were used to collect and verify our data. We applied a mixed analytical process, both inductive and deductive, to reveal different relations between teachers' beliefs and practices. Results show that there are close links between teachers' beliefs regarding the value of informal education and the learning processes within informal settings that influence their goals, roles and actions before, during and after the school visit. These results are discussed in light of teachers' need for in-service education regarding informal science education.

Keywords: *Teachers' beliefs; Teachers' practices; Informal science education; Science and technology museums*

Introduction

Science and technology centres have been closely linked to both cognitive as well as socio-emotional benefits for pupils in recent years. Specifically, science centres are

*Corresponding author. School of Education, University of Western Macedonia, 3rd Km of Forina—Niki, Florina 53100, Greece. Email: pkariotog@uowm.gr

discussed as the ideal setting where scientific knowledge is socially negotiated (DeWitt & Storksdieck, 2008). In addition, students' achievement in science and their understanding of the nature of science is enhanced by organized visits to science centres (Bell, Blair, Crawford, & Lederman, 2003). Lastly, individuals are empowered to act as informed and active citizens, while scientific literacy is promoted through field trips to science centres (Rennie & Williams, 2002).

The field trip is probably one of the most common out-of-classroom learning experiences offered to students (Kisiel, 2006). With this term we refer to out-of-school visits that teachers plan and implement with their classes to settings, such as science centres and museums, zoos, botanical gardens, aquariums and other informal educational institutions. Teachers believe that these visits will complement and enhance their students' understanding of aspects of the world that may or may not be part of the classroom-based curriculum (Anderson, Kisiel, & Storksdieck, 2006). Over the past 30 years, research on this aspect of informal science education has tried to identify the potential cognitive aspect of such activities and their link to school-based education. Moreover, researchers study the sort of learning outcomes and the factors that can impact the effectiveness of field trips as learning experiences (DeWitt & Storksdieck, 2008). However, what have not been studied thoroughly yet are teachers' beliefs, and the way they might relate to their practices in the context of a school museum visit. For that reason, we carried out a piece of research to identify teachers' beliefs and their practices and the possible links between them before, during and after a science and technology museum visit.

Field Trips and Teachers' Practices

A number of reviews of the literature (Anderson et al., 2006; DeWitt & Storksdieck, 2008; Griffin, 2004) describe a series of critical factors that fundamentally influence the cognitive outcomes of a field trip, including students' prior knowledge and interests, students' experiences during the visit, pre- and post-visit activities, orientation to the learning environment, the social context of the visit, teachers' beliefs about curriculum fit and obstacles to field trip planning. Researchers point to obstacles that teachers encounter, when they plan and implement field trips to informal education venues, such as curriculum constraints that do not allow teachers to spend adequate time on field trip preparation and/or post-visit activities. In addition, management requirements and health and safety concerns may hinder teachers from focusing on the pedagogical aspects of a visit (Anderson et al., 2006; DeWitt & Storksdieck, 2008).

Among the factors that influence the cognitive outcomes of a field trip, teachers' beliefs about curriculum fit and pre- and post-visit activities appear to be the most frequently cited factors that affect the cognitive gains from school visits to informal science-learning venues (Ellenbogen & Stevens, 2005).

Linking the visit to the curriculum is a prerequisite when the visit is cognitively oriented (Olson, Cox-Petersen, & McComas, 2001). However, according to Anderson et al. (2006) these out-of-school activities are placed in a broader educative context,

even when they have no cognitive orientation or explicit link to the curriculum. With respect to the goals teachers set for a visit to an informal science-learning venue, there is considerable evidence to suggest that teachers justify these visits in terms of curriculum fit as well as considering them as opportunities for social and affective learning (Kisiel, 2005; Storksdieck, Werner, & Kaul, 2006). However, there is little evidence that teachers actually integrate the field trip experiences into the curriculum. Tal, Bamberger, and Morag (2005) studied 30 teachers in four natural history museums in Israel. They found out that only one-third of these teachers provided specific purposes for conducting the museum visit, explaining how the visit was connected to the school curriculum. Most of the teachers gave general answers about the purpose of the visit, while in many cases teachers stated that others had planned the visit and they were unaware of the purpose.

By the end of the twentieth century, research on museum education had adopted a sociocultural perspective, placing emphasis on the learners and their active involvement in the learning processes, with special emphasis on social interaction (Cox-Petersen, Marsh, Kisiel, & Melber, 2003; Falk & Dierking, 2000). From this perspective, it is vital that teachers who visit the museum with their class adopt a certain role, prior to, during, and after the visit, thereby offering their students a meaningful learning experience (Hein, 1998). More specifically, a teacher's role is to facilitate pupils' learning, ensuring that they are provided with stimulating and motivational experiences that challenge their existing beliefs and involve them actively in the learning process (Gil-Pérez et al., 2002). However, the role of the museums is crucial in terms of supporting teachers to plan appropriate activities and take advantage of the special features of the venue (DeWitt & Osborne, 2007).

According to research studies, the facilitation of pupils' learning in the museum is hardly ever adopted by teachers (Anderson et al., 2006; Griffin & Symington, 1997). Teachers deal mostly with class management; their goals for the visit are often poorly defined and connected to diminished learning experiences. Moreover, the integration of field trips in the classroom curriculum and the implementation of learner-centred, inquiry-based approaches that enhance the sociocultural context of these activities are difficult to find among most teachers' choices (Griffin, 2004).

Practices such as extensive preparation and follow-up activities are not usually observed among the majority of teachers (Griffin, 2004; Karnezou & Kariotoglou, 2004; Kisiel, 2003). On the other hand, when teachers do include some sort of preparation in their agenda for the visit, they usually focus on practical issues including the timeline for the visit and class management (Griffin & Symington, 1997; Tal et al., 2005).

After the visit, the assessment of this out-of-school experience seems to be rather problematic for the teacher. Anderson et al. (2006) ran three independent investigations, studying teachers in three different informal science-learning venues. The vast majority of the teachers identified a connection to the curriculum as an important motivating factor for conducting a field trip. The researchers also point out that teachers may not necessarily have a common perception of what curriculum fit means. For example, it could range from activities that integrate the visit experience to the

current unit of study, to some sort of implicit connection that teachers expect to be obvious to students. Still, despite these variations, only a small number of them reported that a successful field trip was connected with the curriculum. Most teachers judged the success of their visits in relation to students' enjoyment and other affective criteria. The researchers underscore that this discordance between field trip success and curriculum fit is indicative of the fact that teachers have multiple goals for their museum visit and that quite often this connection is difficult to achieve, due to constraints in the school system (Anderson et al., 2006).

The kind of visit students experience is profoundly influenced by the way teachers perceive the learning aspect of the visit, their expectations, the previous knowledge of the venue and their attitude towards it (Anderson et al., 2006; Davidson, Passmore, & Anderson, 2010). To put it differently, teachers' agendas for a field trip may influence their practice and pupils' learning experience (Kisiel, 2003).

Summing up, we can say that among the factors that affect a school museum visit, issues such as a visit's link to the curriculum, a teacher's agenda for the visit, a teacher's role, and the goals for a visit, pre- and post-visit activities, have already been studied. However, from a broader perspective, despite previous findings, research on teachers' roles and practices in a museum is undoubtedly limited compared to corresponding research in class (Anderson & Zhang, 2003).

Teachers' Beliefs and Practices

The relation between beliefs and practices has been argued in recent research. Specifically, beliefs are described as filters through which prospective teachers acquire and interpret new information (Richardson, 2003). A teacher's actions are guided by and gain their meaning, once interpreted in a personal system of beliefs (Bybee, 1995).

Research findings either confirm or refute the relation between teachers' beliefs and practice. Lederman (1999) studied five in-service biology teachers' understandings of the nature of science and found that they did not necessarily influence classroom practice. On the other hand, Appleton and Asoko (1996) looked into the ways in which primary teachers implemented their perceptions of constructivist ideas about learning in their teaching of a topic and pointed out that they were influenced by their views of science and of learning. After studying primary teachers, Levitt (2001) ascertained that some of the beliefs expressed by the teachers came about as a result of implementing a programme of science education reform, pointing out that beliefs and practices interact in an on-going way and changes in one can bring about changes in the other. Samuelowicz and Bain (2001) sought the teaching and learning beliefs of 39 academics, who represented a range of disciplines, as well as their dispositions to teach in particular ways. The researchers underscored that the belief orientations they reported in the study reflected the participants' dispositions to teach in particular ways. Other studies depict a partial relation between beliefs and practice, though with some contradictions. In their research, Abell and Roth (1995) observed a primary teacher and attempted to

interpret the teaching and learning of a life science concept in the classroom. They concluded that the teacher's behaviours were at times in conflict with his/her beliefs.

From a broader perspective, according to Cornett, Yeotis, and Terwilliger (1990), teachers' decisions, both about the curriculum and their practice are based on their personal theory (personal practical theory) and not only on their beliefs about teaching and learning. A teacher's personal theory comprises a set of beliefs, namely about the aims of education, the learning processes, the roles of the teacher and the pupils, the curriculum and the nature of knowledge (Kagan, 1992; Pajares, 1992).

It is interesting that a teacher's personal theory may be differentiated when the learning venue changes, since teaching beliefs which comprise a part of a personal theory are context-oriented (Samuelowicz & Bain, 1992). Thus, a teachers' transition to a new environment, for example, a science and technology museum, may influence their personal theory with respect to the goals, the learning processes, their role and their expectations from their pupils. Additionally, the learning environment influences the self-image a teacher has as an educator (Peretz, Mendelson, & Kron, 2003). Therefore, teachers may see themselves as 'non-expert' in the museum and refrain from undertaking an active role in the novel educational venue.

The research findings mentioned above clearly show that there are various and complex patterns of relationships between teachers' practices and beliefs ranging from contradiction to consistency with no standard links between them.

Summing up, in this short review of the literature, we emphasize two points: the first concerns the study of teachers' practices in museums and the other, the study of teachers' practices in relation to their beliefs. Regarding the first point, we showed that there are research-based theories concerning how to design and conduct a school visit in an informal science-learning venue, in order for it to become a meaningful experience for pupils. Yet, it seems that the majority of teachers do not adopt them either because they are unaware of them or ignore them (Griffin, 1994). However, there is the possibility that they do not adopt particular practices, because they are hindered by their contexts (Anderson et al., 2006).

Concerning the second point, beliefs may affect teachers' practices, though they often do so in ways that are not straightforward. However, there is limited research that relates teachers' beliefs and practices in informal education in a systematic way. Most of these studies were carried out in English-speaking countries (USA, UK and Canada) with many years of experience in museum education, so it is worthwhile studying them in the Greek context. It is crucial that further research disentangles the relationship between teachers' beliefs and practices in informal educational settings. It is our belief that looking into the relationship between beliefs about teaching in an informal learning environment and corresponding practices, can help us proceed towards a more realistic understanding of the complex practice a teacher is expected to deploy within informal education. The understanding of this context can then guide us, when organizing

teacher in-service programmes concerning informal education and museum education specifically.

The Purpose of the Study and Research Questions

The study reported here seeks to explore teachers' beliefs regarding informal education and school visits in a museum, as well as links between these beliefs and teachers' practices before, during and after the school visits. Our aim is to focus on the teachers' goals and expected outcomes from the visit, the identification of the roles of all those involved in the field trip (teacher, guide and pupils), the structure of the visit (activities planned and implemented before, during and after the visit), and teachers' satisfaction from the outcomes of the visit. By examining the aforementioned features, we attempt to gain an insight into how teachers plan, implement and assess school visits to informal science education venues, and thereby obtain a better understanding of their practices in relation to their beliefs. Our research questions are:

- (1) What are teachers' beliefs and practices when planning, implementing and commenting upon the outcomes of a school visit to a science and technology museum?
- (2) In what way do teachers' beliefs affect their practices when they plan, implement and prepare post-visit activities within a field trip to a science and technology museum?

The Setting

This investigation took place in the Technology Museum of Thessaloniki (TMT), which was situated in the industrial zone of Thessaloniki, the second largest city in Greece. Recently, the museum has been renamed to The Science Centre and Technology Museum of Thessaloniki—NOESIS—and has moved to new premises. At the time of the research, it was one of the very few museums dealing with science and technology in Greece and most probably the only one in the northern part of the country. Initially, it was established to preserve and exhibit science and technology artefacts. Soon, its educational role prevailed and thousands of students from all over the country started visiting it. On weekdays, the museum offered guided tours which were carried out by museum personnel within a specific structured format.

The tours took place in the main exhibition hall with exhibits linked to specific thematic units, for example, telecommunications, PCs, and old science set-ups. There was also an interactive exhibits gallery, based on concepts from electricity, fluids, mechanics and optics. A typical school visit would last approximately an hour, according to the museum agenda for school visits. After a short introduction carried out by a museum guide, a 20–30-minute guided tour would take place in the main hall. For the remaining 30 minutes, pupils were free to interact on their own with the interactive exhibits.

One of the researchers (first author) worked as a guide, on a part-time basis, at TMT for two years. This offered her intimacy with the context of the study, knowledge of the norms and procedures of the museum and the opportunity to build a relationship with the participants in this study, that is, the teachers visiting the museum with their pupils.

Method

This investigation is both descriptive and explanatory in nature. It attempts to describe a phenomenon, such as a school visit to a museum, from a teacher's perspective and offer an understanding concerning the different teachers' beliefs and practices.

We performed an empirical study (Lincoln & Guba, 1985) in order to observe teachers concerning the context they act in, namely the museum, as the context is directly related to what happens in it and impacts upon it (Lincoln & Guba, 1985). Specifically, we selected the case-study method, to investigate in-depth teachers' beliefs and practices from a holistic perspective (Yin, 1994). We chose the multiple case-study method in particular, in order to investigate different teachers' beliefs and practices when they plan, implement and comment upon the outcomes of a school visit to a science and technology museum. Semi-structured interviews were conducted with each of the participants, both prior to and after the visit, in order to verify the consistency or reveal some sort of discrepancy in their assertions.

We studied 14 primary and secondary education teachers in terms of the way they plan, implement and comment upon the outcomes of a visit with their class to the TMT in Greece. School groups included 25–30 pupils, whose ages ranged from 10 to 14 years old. There were 10 classes with 10–12-year-old pupils (primary education) and four classes with 12–14-year-old pupils (secondary education). The teachers fell into two categories: primary teachers, who are all subject matter specialists in Greece and secondary teachers of science or technology. Specifically, there were 10 primary teachers and four secondary teachers (one science teacher and three teachers of technology). The teachers were selected from among those who visited the museum with their classes during a school year and were willing to participate. Therefore, we chose a 'convenient sample' (Cohen & Manion, 1997), based on a population with a common feature (their willingness to be part of the study). The final number of participants was determined once we realized a repetition of observed patterns in both teachers' beliefs and practices, so that no new data input was necessary. Our sample included both male and female teachers who represented a variety of years of teaching experience. They were interviewed before and after the visit, using two protocols of closed and open-ended questions that were developed for the needs of our research (Appendix 1).

The interview questions were developed after drawing from two propositions (Joyce, Weil, & Showers, 1992; Tobin, Tippins, & Gallard, 1994), adjusted to meet the needs of our research. Literally, we adjusted the axes the specific researchers used in their research to describe teaching models in a school context to study

teachers' practices in an informal learning venue. Additionally, we added two issues/axes that are of great importance regarding the success of a visit to an informal learning venue, goals and expected outcomes. We ended up with five axes that comprise a teacher's agenda when planning a field trip with his/her class. These are:

- the syntax (the visit structure, thus teacher's practices before, during and after the visit)
- the social system of the visit (the roles of the teacher, the guide and the students)
- the goals for the visit
- the perceived outcomes by the teacher and
- a teacher's support system (teacher's knowledge about the venue and its content together with his/her perceived needs within a professional development course on informal education).

The aforementioned axes, their content and indicative questions included in the questionnaires we developed, are shown in Table 1.

Observation was carried out by one of the researchers and observation notes served to verify the teachers' claims in the pre-visit interview. After each pre-visit interview, there was an observation protocol developed for each participant, based on what he/she claimed he/she would do in the museum. The researcher checked the practices she observed according to this protocol to ensure they were in line with what the participant had claimed in the pre-visit interview. Additionally, the researcher wrote down any inconsistencies she noticed between the teacher's claims and his/her actions. In other words, observation notes were used to verify teachers' claims about their practice in the museum. The observations lasted for the duration of the visit, namely approximately 60 minutes.

Interview data were analysed initially through content analysis of already given categories from the synthesis of Joyce et al. (1992) and Tobin et al. (1994). However, we discovered that this analysis (primarily via a descriptive account) could not utilize

Table 1. The axes used to develop the questionnaires, their content and indicative questions

Axes	Content	Questions
Syntax	Pre-visit practices Practices in the museum Post-visit practices	Did you do anything in class before the visit? Have you planned any activities during the visit? Do you intend to do anything after the visit?
Social system	Teacher's role Guide's role Students' role	What will your role be like in the museum? What is a guide's role like? What is your pupils' role in the museum?
Goals		What are your goals for the visit?
Assessment of outcomes		What are the outcomes of the visit?
Support system		What do you know about the museum and the exhibits?

relations between data and provide an explanatory framework for teachers' specific practices. For example, studying the teachers' interview protocols, we saw that, though a teacher's preparation for the visit seemed to be related to the goals for the visit, the teacher's role during the visit as well as his/her beliefs about informal education, these interrelations could not be highlighted through content analysis. Thus, we applied methods from a grounded theory approach, an inductive method of constant comparison data analysis (Glaser & Strauss, 1967). Following the steps of this method of data analysis, we codified teachers' responses, and this resulted in 23 categories of teachers' beliefs and practices (Appendix 2). At the same time, specific themes emerged from the observed relations between the categories. These themes provided us with a framework that allowed us to interpret the different teachers' beliefs and practices when planning, implementing and commenting upon the outcomes of a visit with their class to a science and technology museum. These themes are presented below in detail.

Results

Teachers' Beliefs and Practices

The analysis of the interviews, using a constant comparative method, resulted in the emergence of three major themes that interpreted differentiated teachers' beliefs and practices. These themes are: (a) teachers' beliefs about the value of informal education, (b) teachers' beliefs about how to support learning in an informal setting and (c) teachers' beliefs about the importance of familiarity with the venue. These beliefs comprise a substantial part of a teacher's personal theory in an informal venue, and as we will show, affect teachers' practices before, during and after the field trips.

Teachers' beliefs about the value of informal education. With respect to the first theme, teachers' beliefs about the value of informal education, we identified two cases among the teachers we studied. In the first case, teachers perceived the affective aspect of informal education to be of great importance. The majority of the teachers we studied (10 out of 14) shared this perspective of informal education. They set primarily affective goals and some goals related to general learning outcomes expected to occur in the museum, relying on the mere presence of the exhibits for their accomplishment:

It was a good thing that there are exhibits, so that children can have direct access and first-hand experience. I believe that they'll be impressed and retain this memory for a long time
(primary teacher/pre-visit interview)

Before the visit, the 10 teachers either announced to their pupils the place they were going to, or focused on behaviour instructions:

... We (the teacher and the pupils) worked on a behaviour protocol—after discussing it with me, the pupils wrote down the way they thought they should behave in the museum ... (primary teacher/pre-visit interview)

In the museum, they either planned nothing or asked pupils to keep notes on their impressions:

... I asked them to write down what would attract their attention. We always do this when we go to a museum or anywhere else, because they will write a composition back at school, and they will need this information. (primary teacher/pre-visit interview)

Back at school, they carried out an activity focusing on the affective outcomes of the visit, most often a discussion or a written essay on what they remembered from the museum visit.

In the second case, the teachers had a cognitive and affective perspective for the visit. A small number of the teachers we studied (4 out of 14) shared this perspective. They expected pupils to link school knowledge to specific exhibits and set primarily cognitive goals about school knowledge supplemented by images from the visit:

... I teach them Physics and I think in the museum we are actually going to see many of the things we talked about in class. This will help kids understand them better, and I can use this afterwards and refer to them in class (secondary teacher/pre-visit interview)

Before the visit, the teachers linked it to the science textbook and informed the pupils about the museum and the exhibits:

... I tried to make them (the students) understand that in the museum we would see some of the things we analyzed in class. I told them we would see a lot of interesting stuff about electricity—we are doing the electricity unit in class at present. I excite their curiosity, so that once in the museum they'll look for the things we talked about in class ... (secondary teacher/pre-visit interview)

During the visit, some of the teachers who focused on the cognitive elements of the visit facilitated their pupils' interaction with the exhibits:

... I talked to some students and tried to make them interact with the exhibits, read the instructions, realize some things and not just play in there ... (primary teacher/post-visit interview)

After the visit, the teachers who set primarily cognitive goals commented on to what degree were affective and cognitive outcomes:

... I guess no specific category of goals is favoured in the museum ... Cognitive goals are attained once affective ones are achieved, as well (primary teacher/post-visit interview)

or that there were definitely affective gains and cognitive ones that the pupils may have not realized:

... Everybody enjoyed it (the visit). As for the cognitive part, I believe that everyone gained something, even though he/she may not have been aware of it ... (secondary teacher/post-visit interview)

During post-visit activities, the teachers who set cognitive and affective goals mediated their pupils' experiences and tried to link them to school knowledge:

... Back at school, we discussed their impressions. I asked them 'what did you like the most and why?' I got a lot of answers, accepted them all and kept the ones that suited me more in order to help them connect these answers to school knowledge ...
(primary teacher/post-visit interview)

Summing up, we can say that the description of these two cases of teachers' beliefs and practices shows that teachers' beliefs about informal science education, either stressing or combining its cognitive or affective value, seem to be linked to the teachers' goals (either mainly affective or cognitive) and the structure of the visit (teachers' practices before, during and after the visit).

Teachers' beliefs about how to support learning in an informal setting. According to the second theme, teachers' beliefs about how to support learning in an informal setting, teachers either supported that exhibits provide opportunities for learning and the guide is responsible for transmitting knowledge or that learning is promoted through teacher mediation.

In the first case, the teachers asserted that learning was facilitated with the mere presence of exhibits and the guide who transmitted knowledge (10 out of 14):

... the fact that they (the pupils) will see the things we talked about in class, will help them gain deeper understanding ... (primary teacher/pre-visit interview)

They remained inactive and either focused on discipline matters or became those who helped the guide:

... since there is a guide, I can stay backstage and be the one who helps him/her with discipline matters and pupils' understanding ... (primary teacher/pre-visit interview)

The guide was the one in charge of the educational process in the museum:

... His/her role is clearly educational. He/she should transfer to the pupils what he/she knows (primary teacher/post-visit interview)

The pupils were expected to become actively involved in the learning process and have more freedom in what they do:

... I want them to listen carefully, ask questions to the guide and link the exhibits to what we have already learned in class ... (primary teacher/pre-visit interview)

With respect to teachers' practices, before the visit, the practices either included a pupils' briefing about the venue or behaviour instructions. While in the museum, the pupils were expected to keep notes on their impressions, and back at school, activities focused on the affective outcomes, usually in terms of a discussion or a written composition about pupils' impressions from the visit.

In the second case, where teachers stated that learning from a museum experience is promoted through teacher mediation (4 out of 14), they linked the visit to the science textbook and informed pupils about the museum and the exhibits:

... I told them that the visit was connected to Physics and gave them information about the exhibits. Linking theory to practice will help students learn better ... (secondary teacher/pre-visit interview)

In the museum, the teachers did facilitate the pupils' interaction with the exhibits, urging them to read the labels and showing them how to follow the instructions:

... children want and should have fun with the interactive exhibits ... However, if we want them to see or do something in there that would help them learn, then we should act ... I tried to show some students what to do, reading some instructions and then getting engaged in using an exhibit ... (secondary teacher/post-visit interview)

Additionally, they occasionally prompted their pupils to recall things they knew from school:

... I tried to make them (the students) recall things we had said in class, asking them 'What did we say about it in class?' or 'What word did we use for this?' ... (secondary teacher/post-visit interview)

After the visit, they mediated their pupils' experiences and tried to link them to school knowledge:

... (in the interactive exhibits gallery) pupils gain experiences. If we leave them unprocessed, unexplained, they will last only for a while and then they will vanish ... so we talked about the things that impressed them in the museum connecting them, whenever we could, to the science textbook and the energy unit they are taught at this moment. (secondary teacher/post-visit interview)

They presumed that the guide had a leading role because of his/her expertise and they did not think cooperation between them was feasible mostly due to time constraints:

... practically this (cooperation) might be inapplicable. For me it means more time, inconvenience ... and most probably for the guide, as well ... (secondary teacher/post-visit interview)

Interestingly, as we mentioned above, the teachers who expected exhibits to provide opportunities for learning during the visit, stated the same opinion about a guide's role.

The teachers who stated that learning is promoted through teacher mediation, claimed that the pupils should have an active role in the learning process, while they were entitled to have more freedom in what they do in the museum than in class:

... I want them to enjoy it (the visit). I'd rather see some children having fun and feeling more comfortable than standing quietly as they do in class (secondary teacher/pre-visit interview)

Likewise, we saw that teachers who believed that the exhibits provided opportunities for learning and the guide is responsible for transmitting knowledge shared the same opinion about their students' role.

Summing up, we can say that teachers' beliefs about how to support learning in an informal science-learning venue were, either that the exhibits provide opportunities

for learning and the guide transmits knowledge, or that learning is promoted through teacher mediation. These beliefs were consistent with teachers' practices before, during and after the visit, which were generally supported by what the researcher noted during her observations. Also, teachers' beliefs about how to support learning in an informal setting were in line with their own role in the museum, while all the teachers shared the same belief about the role of the pupils and the guide.

Teachers' beliefs about the importance of familiarity with the venue. According to the third theme, teachers' beliefs about the importance of familiarity with the venue, teachers were differentiated between in-depth and superficial levels of familiarization with the venue. When the teachers believed in the importance of familiarity with the venue (4 out of 14), they were well informed about it, and they actively participated during the visit and facilitated pupils' understanding and their interaction with the exhibits. The goals, though non-specific, were mainly cognitive in the sense that they were related to the curriculum:

My goals are in unison with the curriculum. The field trip is definitely an educational activity, not a recreational one. However, it includes a number of recreational features, as well ... (primary teacher/pre-visit interview)

After the visit, they expressed satisfaction while commenting upon the outcomes of the visit and linked them to their practices:

I'm glad that my goals were attained. Everything went as planned. Back at school, we talked over their impressions from the visit and I realized that they (the pupils) enjoyed it, too. Unless we had worked on their impressions, there wouldn't have been any cognitive gains from the visit ... (primary teacher/post-visit interview)

On the other hand, when the teachers knew little about the venue and the exhibits (10 out of 14), they simply escorted their class to the museum and focused on pupils' behaviour management:

... since there will be guides, I will be responsible for the kids' behaviour and make sure they cooperate. (primary teacher/pre-visit interview)

The goals they set were either affective or cognitive, but they were not specific:

Well, actually, my goals are not specific. You see, I believe that what the visit can do is help the kids gain a friendly attitude towards Physics ... (primary teacher/pre-visit interview)

After the visit, most of the teachers we studied and who had known little about the venue and the exhibits argued that the outcomes of the visit were mainly affective and non-specific. After their experience at the museum, some of the teachers linked the outcomes either to their own inadequate preparation:

... if I had visited the museum recently, I might have used the proper terms to talk to the children before the visit. For example, I could have talked about holography, using the right words ... (primary teacher/post-visit interview)

or the vague goals they set:

... I did not have specific cognitive goals. Had I, things might have turned out differently
 ... (primary teacher/post-visit interview)

Overall, the teachers' beliefs about the importance of familiarity with the venue, whether in-depth or a superficial, were linked to their support system: their knowledge about the venue and its content, the role they undertook in the museum, the goals they set and the perceived outcomes of the visit.

Patterns of Teachers' Beliefs and Practices

Studying the themes that emerged from the categories of teachers' beliefs, two patterns were revealed about teachers' beliefs in relation to their practices in light of a school visit to a science and technology museum. In the first pattern, the cognitive and affective pattern, teachers focus on the cognitive goals and outcomes of the school visit without ignoring its affective gains. With respect to the support of learning in the museum, teachers belonging to the first pattern claimed that they could mediate their pupils' experiences and make them contribute to cognitive gains. Therefore, they became prepared for the visit, so that they could act as mediators and facilitate their pupils' learning. In turn, they prepared their class, so that pupils knew in advance what they would see in the museum. Back at school, after the visit, they mediated their pupils' experiences and tried to link them to school knowledge, or performed an experiment based on an interactive exhibit.

In the second pattern, the affective pattern, teachers placed emphasis primarily on the affective outcomes of the visit, and secondly, on some general learning outcomes expected to occur at the museum. With respect to the support of learning in the museum, teachers expected that, when the learning context changed, pupils' interest would be excited and learning processes would be automatically fostered. Teachers counted on the guide to transfer knowledge to the pupils, and they restricted themselves to escorting their pupils to the museums. In light of the importance of familiarity with the venue, teachers either knew little or nothing about the museum and the exhibits, as they simply accompanied their class to the museum and expected mostly affective outcomes from the visit. The two patterns and their components (the themes) are shown in Table 2.

Discussion

In our research, we studied 14 primary and secondary education teachers' beliefs and practices related to the planning, implementation and perceived outcomes of a visit with their class to a science and technology museum. Our results showed that teachers' beliefs and practices before, during and after the visit to a museum may vary, but, these mainly fit into two models. Each model emerged by finding clear differences among teachers' beliefs and practices regarding each one of the five axes of our research, namely: the goals, syntax, social system, outcomes of the visit and support system.

Table 2. Patterns of teachers' beliefs and practices

Patterns	Themes			Practices
	Teachers' beliefs about informal education	Teachers' beliefs about how to support learning in an informal setting	Teachers' beliefs about the importance of familiarity with the venue	
Cognitive and affective (4 teachers—2 primary and 2 secondary—out of 14)	Cognitive gains (prevalent)	Learning is promoted through teacher mediation	Very good knowledge of the venue and the exhibits	Teacher prepares pupils for the visit, fosters interactions with exhibits and organizes post-visit activities
Affective (10 teachers—8 primary and 2 secondary—out of 14)	Affective gains/ attitudes (prevalent)	The exhibits provide opportunities for learning and the guide transmits knowledge	Poor knowledge of the venue and the exhibits Lack of knowledge of the venue and the exhibits	Teacher announces the visit, stresses appropriate behaviour, escorts pupils during the visit, depends on the guide and asks for pupils' impressions after the visit Teacher announces the visit, is distant from the whole process during the visit, intervenes for discipline matters and may not organize a post-visit activity

In the first model (the affective model), the most commonly observed in our study (10 out of 14 teachers), teachers wanted children to enjoy the visit, have fun in the museum and gain new experiences. The general affective goals set by the teachers do not require teachers' good knowledge of the venue beforehand, and the understanding of specific aims by pupils before the visit. Thus, teachers profiled in the first model had a poor knowledge of the museum and simply referred to the place they were about to visit or were concerned with class management issues prior to the visit. In the museum, these teachers either planned nothing, relying on the guide's presence or asked pupils to keep notes on their impressions. Previous findings on teachers' practices when they organize and implement a field trip to an informal science education venue, point to the fact that teachers usually deal with behaviour issues and the itinerary of the visit (Griffin & Symington, 1997; Tal et al., 2005).

Teachers do not usually exploit opportunities that museums offer for social interaction and free choice of activities by pupils (Anderson et al., 2006; Griffin, 2004). Back at school, most of the teachers carried out an activity focusing on pupils' impressions from the visit. This is in accordance with other research regarding follow-up activities, which shows that focus on the cognitive outcomes of the visit is not common among teachers' practices (Kisiel, 2003). After the visit, the teachers commented that the outcomes of the visit were mainly affective because of their own inadequate preparation or the vague goals they set prior to the visit.

In the second model (cognitive and affective), teachers set primarily cognitive goals, meaning that they emphasized children's reinforcement of school knowledge within the museum visit. Regarding the goals set by teachers before a visit to an informal science-learning setting, research shows that they are most often linked to the science curriculum, as well as to affective learning (Kisiel, 2005; Storksdieck et al., 2006). Teachers in the second model knew the content of the museum well and linked the visit to the science textbook, although another study shows that the connection between the field trip and the curriculum is usually missed (Tal et al., 2005). Prior to the visit, teachers informed the pupils about the museum and its content. Teachers profiled in the second model, facilitated their interaction with the exhibits and asked their pupils to keep notes based on their experiences. During follow-up activity at school, they mediated their pupils' experiences and linked them to school knowledge. After the visit, the few teachers that had set primarily cognitive goals expressed their satisfaction about the outcomes of the visit that were both cognitive and affective. Thus, teachers were satisfied with the outcomes of the visit, since they perceived that their goals were successful.

With respect to the primary and secondary teachers in our sample study, there were no differences between their practices and the beliefs they stated that would allow us to conclude that there is a distinction between them.

Our findings should be considered in light of the constraints that teachers encounter in the context in which they are expected to act. Specifically, in our study, the museum agenda for the school visit and the existence of a guided tour was given as a reason that the teachers avoided planning specific activities while in the museum, as some of them stated in their interviews. Thus, in our interpretation of data, we should not neglect the fact that teachers are expected to plan and implement field trips while facing a number of curriculum constraints, as well as some practical issues about the planning of a field trip (Anderson et al., 2006; DeWitt & Storksdieck, 2008).

However, the fact that we observed teachers' differentiated practices within the same context, begs for an explanation. This prompts us to the explanatory framework that our study suggests, based on the presentation of a set of three themes that are found to influence teachers' beliefs and related teachers' practices. The set of these three themes emerged from both an analysis of interviews with teachers prior and after the visit, as well as an analysis of observation protocols in relation to teachers' statements in their interviews. These themes are beliefs about the value of informal education, beliefs about how to support learning within an informal venue and

beliefs about the importance of familiarity with the venue. Specifically, teachers' beliefs about informal science education, whether emphasizing its cognitive or affective value, were related to the goals set by the teachers for the field trip, which were mainly cognitive or affective respectively, and teachers' practices prior, during and after the visit. Our assertions about teachers' practices before and after the visit are based on data from teachers' interviews. Teachers' beliefs about how to support learning in an informal science-learning venue, whether highlighting that the exhibits provide opportunities for learning and the guide is responsible for transmitting knowledge, or that learning is promoted through teacher mediation seemed to be related to teachers' perceptions regarding their roles during the visit, as well as their overall practices before, during and after the visit. Thus, for example, a number of teachers did not think that they would need to undertake any educational initiative to support and facilitate museum learning, or for that matter, reinforce their pupils' experience. On the other hand, a few teachers prepared so that they could mediate pupils' experiences and achieve cognitive outcomes. Finally, teachers' beliefs about the importance of familiarity with the venue, whether in-depth or superficial, were linked to their knowledge of the venue and its content, their role in the museum, the goals they set and the perceived outcomes of the visit. Therefore, drawing on our findings, we ascertain the link between teachers' practices and their beliefs (Cornett et al., 1990) and further specify the issues that might cause differentiations in teachers' practices during field trips.

It is our belief that our findings would be of value to Greek policy-makers, as well as teacher educators, since the Greek bibliography about informal education is limited, and the new Greek curricula place emphasis on school visits in out-of-school settings. Specifically, the science curricula in primary and secondary education promote informal education within a broader perspective by proposing the planning and implementation of school visits to various workplaces and factories, as well as scientific institutions. These visits are suggested to be related to pupils' vocational guidance, as well as meaningful experiences within informal education (Pedagogical Institute, 2012). Additionally, there is a specific reference in the curricula concerning teachers' in-service training in order to empower them to exploit the opportunities that the on-going development of technology, communication and information offers.

The results of our study may also help in the organization of the content of an in-service professional development course concerning informal science education. Courses should give ample opportunities to expand on existing teachers' beliefs about the importance of informal education and analyse the different kinds of goals related to a field trip. Teacher educators should explain and give examples of processes that support learning in an informal setting and sensitize teachers about the importance of familiarization with the venue. Such courses may help teachers clarify their goals and adopt practices that lead to meaningful out-of-classroom experiences offered to pupils.

Although the findings from a case-study research may be of limited value in terms of generalization, this study offers an explanatory lens to understand differences in

teachers' beliefs and practices in an informal science education venue, as well as the possible relations between them. Future research into the relationship between teachers' beliefs and their pedagogical practices in informal learning venues could initially involve a survey in a larger sample concerning their beliefs and systematic observations of their practices prior to, during and after the visit. Moreover, an action research project encouraging teachers to reflect upon their beliefs and practices concerning informal education would give us specific information about the processes of expanding or improving related teachers' beliefs and practices.

References

- Abell, S. K., & Roth, M. (1995). Reflections on a fifth-grade life science lesson: Making sense of children's understanding of scientific models. *International Journal of Science Education*, *17*, 59–74.
- Anderson, D., Kisiel, J., & Storksdieck, M. (2006). Understanding teachers' perspectives on field trips. *Curator*, *49*(3), 365–386.
- Anderson, D., & Zhang, Z. (2003). Teacher perceptions of field-trip planning and implementation. *Visitor Studies Today*, *6*(3), 6–11.
- Appleton, K., & Asoko, H. (1996). A case study of teachers' progress toward using a constructivist view of learning to inform teaching in elementary science. *Science Education*, *80*, 165–180.
- Bell, R., Blair, M., Crawford, B., & Lederman, N. (2003). Just do it? Impact of a science apprenticeship program on high school students' understandings of the nature of science and scientific inquiry. *Journal of Research in Science Teaching*, *40*(5), 487–509.
- Bybee, R. (Ed.). (1995). *Redesigning the science curriculum: A report on the implications of standards and benchmarks for science education*. Colorado Springs, CO: BSCS.
- Cohen, L., & Manion, L. (1997). *Research methods in education* (4th ed.). London: Routledge.
- Cornett, J. W., Yeotis, C., & Terwilliger, L. (1990). Teacher personal practical theories and their influence upon teacher curricular and instructional actions: A case study of a secondary science teacher. *Science Education*, *74*(5), 517–529.
- Cox-Petersen, A. M., Marsh, D. D., Kisiel, J., & Melber, L. M. (2003). Investigation of guided tours, student learning and science reform. Recommendations at a museum of natural history. *Journal of Research in Science Teaching*, *40*, 200–218.
- Davidson, S. K., Passmore, C., & Anderson, D. (2010). Learning in zoo field trips: The interaction of the agendas and practices of students, teachers and zoo educators. *Science Education*, *94*, 122–141.
- DeWitt, J., & Osborne, J. (2007). Supporting teachers on science-focused school trips: Towards an integrated framework of theory and practice. *International Journal of Science Education*, *29*(6), 685–710.
- DeWitt, J., & Storksdieck, M. (2008). A short review of school field trips: Key findings from the past and implications for the future. *Visitor Studies*, *11*(2), 181–197.
- Ellenbogen, K. M., & Stevens, R. (2005). *Informal science learning environments: A review of research to inform K-8 schooling (final draft)*. National Research Council Board on Science Education—Science Learning K-8.
- Falk, J. H., & Dierking, L. D. (2000). *Learning from museums: Visitor experiences and the making of meaning*. Walnut Creek, CA: Altamira Press.
- Gil-Pérez, D., Guisasaola, J., Moreno, A., Cachapuz, A., Pessoa de Carvalho, A., Torregrosa, J., . . . , Gallego, R. (2002). Defending constructivism in science education. *Science & Education*, *11*, 557–571.
- Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. New York: Aldine de Gruyter.
- Griffin, J. (1994). Learning to learn in informal science settings. *Research in Science Education*, *24*, 121–128.

- Griffin, J., & Symington, D. (1997). Moving from task-oriented to learning oriented strategies on school excursions to museums. *Science Education*, 81(6), 763–779.
- Griffin, J. (2004). Research on students and museums: Looking more closely at the students in school groups. *Science Education*, 88(Suppl. 1), S59–S70.
- Hein, G. E. (1998). *Learning in the museum*. London: Routledge.
- Joyce, B., Weil, M., & Showers, B. (1992). *Models of teaching* (4th ed.). Boston: Allyn and Bacon.
- Kagan, D. M. (1992). Implication of research on teacher belief. *Educational Psychologist*, 27(1), 65–90.
- Karnezu, M., & Kariotoglou, P. (2004). Teachers' practices when visiting a technology museum with their classes. *Themes in Education*, 5(1), 101–114.
- Kisiel, J. (2006). Making field trips work. *Science Teacher*, 73(1), 46–48.
- Kisiel, J. F. (2003). Teachers, museums and worksheets: A closer look at a learning experience. *Journal of Science Teacher Education*, 14(1), 3–21.
- Kisiel, J. F. (2005). Understanding elementary teacher motivations for school fieldtrips. *Science Education*, 86(6), 936–955.
- Lederman, N. G. (1999). Teachers' understanding of the nature of science and classroom practice: Factors that facilitate or impede the relationship. *Journal of Research in Science Teaching*, 36(8), 916–929.
- Levitt, K. E. (2001). An analysis of elementary teachers' beliefs regarding the teaching and learning of science. *Science Education*, 86, 1–22.
- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. London: Sage.
- Olson, J. K., Cox-Petersen, A. M., & McComas, W.F. (2001). The inclusion of informal environments in science teacher preparation. *Journal of Science Teacher Education*, 12(3), 155–173.
- Pajares, M. F. (1992). Teachers' beliefs and educational research. *Review of Educational Research*, 62(3), 307–332.
- Pedagogical Institute. (2012). Interthematic unified framework of programs of studies and curricula of compulsory education. Retrieved October 13, 2012, from <http://www.pi-schools.gr/programs/depps/>
- Peretz, M. B., Mendelson, N., & Kron, F. W. (2003). How teachers in different educational contexts view their roles. *Teaching and Teacher Education*, 19, 277–290.
- Rennie, L. J., & Williams, G. F. (2002). Science centres and scientific literacy: Promoting a relationship with science. *Science Education*, 86, 706–726.
- Richardson, V. (2003). Preservice teachers' beliefs. In J. Raths & A. McAninch (Eds.), *Teacher beliefs and teacher education. Advances in teacher education* (pp. 1–22). Greenwich, CT: Information Age.
- Samuelowicz, K., & Bain, J. D. (1992). Conceptions of teaching held by academic teachers. *Higher Education*, 24, 93–111.
- Samuelowicz, K., & Bain, J. D. (2001). Revisiting academics' beliefs about teaching and learning. *Higher Education*, 41, 229–325.
- Storksdieck, M., Werner, M., & Kaul, V. (2006). *Results from the quality field trip study: Assessing the LEAD program in Cleveland, Ohio*. Annapolis, MD: Institute for Learning Innovation.
- Tal, R., Bamberger, Y., & Morag, O. (2005). Guided school visits to natural history museums in Israel: Teachers' role. *Science Education*, 89(6), 920–935.
- Tobin, K., Tippins, J. D., & Gallard, J. A. (1994). Research on instructional strategies for teaching science. In D. L. Gabel (Ed.), *Handbook of research on science teaching and learning* (pp. 45–93). New York: Macmillan.
- Yin, R. K. (1994). *Case study research: Design and methods* (2nd ed.). Thousand Oaks, CA: Sage.

Appendix 1. Questionnaires

Pre-visit Questionnaire

- 1- What do you know about the museum and the exhibits?
How many times have you been there with your pupils?

- 2- What are your goals for the visit?
- 3- Did you do anything in class before visiting the museum? When, how, why?
- 4- What will your role be like in the museum?
- 5- Have you planned any activities during the visit?
- 6- What do you think about the interactive exhibits?
- 7- How would you reply to a pupil's question when (a) you know the answer (b) you don't? Would you answer the same way if you were in class?
- 8- What is your pupils' role in the museum?
- 9- What is a guide's role like?
- 10- Do you think that your pupils should have a certain cognitive background before visiting the museum?
- 11- Do you intend to do anything after the visit?
- 12- When would the visit be deemed a success?

Post-visit Questionnaire

- 1- How would you describe your role during the visit?
Was it your choice or was it determined by something else? (e.g. the way the visit is conducted)
- 2- Did you do anything back at school?
- 3- Do you want to comment on the role of the guide?
- 4- What are the outcomes of the visit?
- 5- Do you think with hindsight that your pupils should have a certain cognitive background to make the most out of the visit?
- 6- What would you like to be informed about during a professional development course on informal science education?

Appendix 2. Data Categories

- (1) Knowledge of the setting.
- (2) Knowledge of the content of the visit.
- (3) Class preparation for the visit.
- (4) Teachers' beliefs about the importance of the students' cognitive background.
- (5) Teachers' beliefs about informal education.
- (6) Teachers' beliefs about school science education.
- (7) Teachers' beliefs about the students' role in the museum.
- (8) Teachers' beliefs about their role in the museum.
- (9) Ways of teachers' responses in the museum.
- (10) Teachers' beliefs about learning in the museum.
- (11) Activities during the visit planned by teachers.
- (12) Teachers' goals for the visit.
- (13) Teachers' beliefs about successful visit criteria.
- (14) Teachers' beliefs about the outcomes of the visit.
- (15) Teachers' beliefs about the interactive exhibits.
- (16) Teachers' beliefs about the guide's role.

- (17) Teachers' beliefs about the students' behaviour in the museum.
- (18) Teachers' beliefs about their cooperation with the guide.
- (19) Activities after the visit planned by teachers.
- (20) Teachers' beliefs about the role they had in the museum.
- (21) Realization of post-visit activities.
- (22) Teachers' beliefs about the content of a professional development course on informal science education.
- (23) Teachers' beliefs about the museum agenda for school visits.