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nes to science, many of today's children experience narrow and
l learning opportunities, which, as professor Judah Schwartz writes
e to this book, lead ulitmately to a mere caricature of science. One
problem is the wrong—terribly wrong—belief that science is an
subject for early elementary education and certainly for kinder-
tion.

to this prevalent and unfortunate situation, this well-written and
oking book presents the state-of-the-art in science education for
and primary schools. It begins with a thorough theoretical discus-
t is incumbent on the science educator to teach science already at
childhood. It goes on to analyze and synthesize a broad range of
pproaches and themes such as: inquiry-based teaching; learning
entic problems; scaffolding; situated learning; learning through
-verbal knowledge; and informal learning. The book also presents
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erous examples illustrating how the theories presented may be
practice are provided.

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Science Literacy in Primary Schools and Pre-Schools

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SCIENCE LITERACY IN PRIMARY SCHOOLS AND PRE-SCHOOLS

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CHAPTER 5

BRIDGING IN-SCHOOL AND OUT-OF-SCHOOL LEARNING: FORMAL, NON-FORMAL, AND INFORMAL

To understand fully children's science learning, one should look not only at learning that takes place in the kindergarten and primary school, but should also at the learning that takes place out-of-school. This is very important considering the fact that 85 percent of the time children are awake is spent outside of the classroom (Medrich *et al.*, 1982). Children's life experiences, both in and out of school have profound effects on their achievements in school and their functioning in society (Resnik, 1987). Support of the importance of informal experiences can be found in the National Science Education Standards (National Research Council, 1996), which state that museums and science centers "can contribute greatly to the understanding of science and encourage students to further their interests outside of school" (p. 45). Museums and science centers are just examples of out-of-school learning and one may broaden this idea to other forms of learning of this type. Gardner (1991), goes even further to argue that whereas schools have become increasingly anachronistic, museums have retained "the potential to engage students, to teach them, to stimulate their understanding, and most important, to help them assume responsibility for their own future learning" (p. 202). Indeed, Stevenson (1994) reports that as opposed to a normal museum visit where visitors typically display fatigue after 30 minutes, Launch Pad science museum visitors usually displayed little or no reduction in concentration even after 60 minutes.

Before moving on to describe and discuss the advantages of out-of-school learning, it is also important to consider the critiques. In responding to Stevenson's findings, Rennie and McClafferty (1996) raise the following questions: are visitors concentrating because they are learning the scienctific concepts that are portrayed by the interactive exhibits or are they just having fun? In searching for answers to such questions some researchers "used the term 'edutainment' to describe science centers, politely suggesting that perhaps the entertainment dimension is more successful than the educational one" (Rennie and McClafferty, 1996, p. 55). Shortland (1987) and Wymer (1991) suggested that education loses out when entertainment become a major consideration. Shortland bluntly said that "When education and entertainment are brought together under the same roof, education will be the looser" (p. 213). Ansbacher (1998) argues in this regard that placing emphasis on museum learning being fun may be antithetical to the learning outcomes desired by teachers. Citing Dewey, he reasoned that if the experience is mainly fun, the learner may have learned something, but not necessarily what the teacher or museum is that visitors may learn to pursue further fun rather than further learning. The 'fun-emphasis' problem was already mentioned by Champange (1975), a quarter of a century ago, when he described a six hour visit to a science museum as entertaining, but unfulfilling. Champangne raises the following 4 reasons to his dissatisfaction:

1. the real meaning was obscured,
2. some of the demonstrations involved 'sloppy science',
3. science and technology were presented as ethics-free, and
4. science was dishonestly presented as easy and unproblematic.

The last reason is very serious because firstly, it obscures what science is really about: the asking and answering of questions about how the world works, and secondly, such presentation suggests that scientists are very smart and possess superhuman intellectual capacities, which enable them to accomplish anything — just point them to the target and in a short time they will get there. This may also insinuate that science is not for all students.

Parkyn (1993) also argues that "scientific phenomena are presented not within a conceptual framework but as an endless series of unconnected, entertaining magical events" (p. 31). These criticisms do not seem to have been refuted: in fact they have been reiterated (Rennie and Williams, 2002).

With that said, one should bear in mind that in spite of the critiques, most science centers do believe that the visits to the center enhance visitors' understanding, or at least awareness of science. Indeed, Falk and Storksdieck (2005), based on past and present literature, claim that whereas only a few years ago it could be briefly stated that it was unclear whether visitors to museums truly learned, that is not the case today. However, Griffin and Symington (1997) found that unfortunately, teachers who themselves planned scientific fieldtrips to science centers, displayed little recognition of the different learning environments or learning opportunities that museums present. Furthermore, the authors found that teachers may not necessarily have explicit goals for the visit, and are unable to connect the experience to the classroom curriculum. They suggest that teachers might feel intimated when they take classes to museums. They also have many management concerns: losing children; risking the reputation of their school; not knowing where to go; and being asked questions which they cannot answer. These are probably some of the reasons why students participating in teacher-led school fieldtrips, in many cases, are not aware of any specific goals that these visits may hold and thus may subsequently be unprepared for learning (Griffin and Symington, 1997; Orion and Hofstein, 1994; Stroksdieck, 2001).

This chapter, which thoroughly examines the idea of out-of-school learning, aims at providing educators, especially those who work in K-2, with an insight to the topic both theoretically and practically, so that they will be able to fully exploit the potential that field trips may offer. In the following I will discuss the difficulty in defining out-of-school learning and then I will raise the question of whether we should deal with out-of school learning in the *in-school* systems.

WHAT IS INFORMAL LEARNING? TOWARD A DEFINITION

There is some sense that in-school learning is formal learning and out of school is informal *tout court*. For example, Gerber, Marek, and Cavallo (2001) argue that,

> in essence, the informal learning can be defined as the sum of activities that comprise the time individuals are not in the formal classroom in the presence of a teacher. (p. 570)

Resnick (1987) differentiates sharply between the nature of "school learning" and "other learning." Based on the literature Gerber *et al.* (2001) argue that while formal learning environments are characterized by their highly structured nature, the informal learning environments are less structured, and managing the learning is shifted from the teachers to the students. I do not agree with such a comparison. Let's consider for instance a field trip to a science museum. First, it is outside the classroom, so learning in the museum is, according to the above definition, indeed, informal learning. Indeed, the children may more than likely be invited to free, unguided visits, in which they may approach different exhibits as they desire. Yet, in many cases, part of the museum field trip includes a highly structured visit. The children may conduct experiments, fill pre-prepared work files and follow a guide. I agree with Dierking (1991), that such sharp distinctions between formal and informal learning are inappropriate, as he sees the physical setting as only one of a number of factors governing learning. According to the author, "learning is learning, and it is strongly influenced by setting, social interaction, and individual beliefs, knowledge, and attitudes" (p. 4). Gilbert and Priest (1997), argue that "if teachers in school and adult companions during museum visits both see themselves promoting meaningful activity by means of focused conversation, then it does seem very likely that the learning taking place would be similar in type and quality" (p. 750).

The problem of distinguishing between formal and informal learning may also be found in Hofstein and Rosenfeld (1996) who argue that,

> There is no clear agreement in the literature regarding the definition of informal science learning . . . . The major difficulty in defining informal science learning is determining whether or not informal science learning can take place within formal settings. In other words, does the term have distinct, clear-cut attributes of its own (in which case it may occur in formal as well as informal settings) or must this term be understood as necessarily contrasted with formal learning (in which case it cannot occur in formal settings)? (pp. 88–89)

A better distinction, in my opinion, is one that takes into account not only physical differences, i.e. in or out of school, but rather includes other factors as well, such as motivation, interest, social context and assessment to distinguish between three types of learning: formal, informal, and non-formal (Maarschalk, 1988, in Tamir, 1990).

Non-Formal Learning

Non-formal learning occurs in a planned but highly adaptable manner in institutions, organizations, and situations beyond the spheres of formal or informal education.

It shares the characteristic of being mediated with formal education, but the motivation for learning may be wholly intrinsic to the learner.

Informal Learning

Informal learning applies to situations in life that come about spontaneously; for example, within the family circle, the neighborhood, and so on. These are reflected in what a person is reading, viewing and listening to, and also in his or her hobbies and social life (Maarschalk, 1988, in Tamir, 1990, p. 34). Informal learning is distinguished from the other two by having no authority figure or mediator. The learner is motivated intrinsically (Csikszentmihalyi and Hermanson, 1995) and determines the path taken to acquire the desired knowledge, skill, or abilities. Table 1 summarizes some of the differences among these three types of learning. Dividing of out-of-school learning into informal and non-formal categories help to achieve a better understanding of the characteristics of out-of-school learning. Yet, a variety of institutions are still hard to categorize as non-formal, because they are still different despite the fact that their activities might share some similarities. One striking difference concerns the degree by which one may manipulate the exhibits.

As opposed to other non-formal locations, museums and scientific centers include, to a large extent, interactive science exhibits. Rennie and McClaffery (1996) distinguish between 'interactive' and 'hands-on' exhibits. According to the authors, hands-on exhibits require the visitor to have some physical involvement with the exhibit. However, while hands-on exhibits are passive, interactive exhibits are active and respond to the visitor's actions. Consider for example, a visit to the planetarium. Here, the visitor usually enters a room and the explainer, by pressing different buttons, displays the star system. The explainer shows different patterns in the sky for example, the Ursa Major, by lighting up different areas of the room's ceiling, which

TABLE 1. Differences between Formal, Nonformal and Informal Learning

Formal	Non-Formal	Informal
Usually at school	At institution out of school	Everywhere
May be repressive	Usually supportive	Supportive
Structured	Structured	Unstructured
Usually prearranged	Usually prearranged	Spontaneous
Motivation is typically more extrinsic	Motivation may be extrinsic but it is typically more intrinsic	Motivation is mainly intrinsic
Compulsory	Usually voluntary	Voluntary
Teacher-led	May be guide or teacher-led	Usually learner-led
Learning is evaluated	Learning is usually not evaluated	Learning is not evaluated
Sequential	Typically non-sequential	Non-sequential

represents the sky. The visitors themselves are not active and the exhibit does not respond to any of the visitors' actions. Another example is a visit to the zoo or to the aquarium. Here again, no one expects an animal to respond to a visitor's action, which may, at times, be forbidden. Yes, the visitor may, sometimes, feed the animal or touch its fur; but usually it is the animal that decides how it wants to respond, if at all, to the visitor. This contrasts with museum or science center exhibits which are usually designed to be interactive: for instance, the visitor may interact with a model representing an airplane. He or she may change the angle of one the airplane's model wings and as a result, the airplane might change its position.

By responding to the visitors' actions, interactive exhibits invite more actions from the visitors and provoke further interactions, and a kind of *man-machine dialogue* is developed. According to Rennie and McClaffery (1996), an important difference between hands-on and interactive exhibits is that hands-on does not necessarily mean 'mind-on'. The authors cite Lucas (1983), who pointed out that, "It is false to assume that any physical manipulation of an exhibit provokes intellectual engagement" (p. 9).

Borun and Dritsas (1997), identified seven exhibit characteristics that attract and hold the attention of family groups. These describe the desired characteristics of interactive exhibits that are usually placed in science centers, not in nature, parks or zoos. The characteristics are:

- Multisided: the family can cluster around the exhibit.
- Multiuser: interaction is allowed for several sets of hands (or bodies).
- Accessible: comfortably used by children and adults.
- Multioutcome: observations and outcomes are sufficiently complex to foster a group discussion.
- Multimodal: appeals to different learning styles and levels of knowledge.
- Readable: text is arranged in easily understood segments.
- Relevant: provides cognitive links to visitors' existing knowledge and experience.

In summary, the terms out-of-school learning and informal learning in the literature are usually interchangeable. I argued that defining informal learning as learning which occurs out of school is too simplistic. A better distinction, which captures the characteristics of out-of-school learning, is between informal and non-formal learning. I also claimed that we can distinguish between two institutions where non-formal learning takes place: those that possess hands-on exhibits and those that include interactive exhibits as well. Another distinction which might provide insight as to the nature of out-of-school learning is based on the frequency to which we attend the place where the learning occurs. In my view, since informal learning occurs spontaneously, it is more likely to occur in places within our day-to-day routine, such as homes, yards, parks or streets, and even at school — especially at break times. Since we only visit places such as museums, zoos, planetariums, or aquariums occasionally, it is more likely that non-formal learning will happen there — it is more likely that these visits are prepared to some extent. We also tend to participate in structured activities in those institutions, especially if the visit is in the framework of a school scientific fieldtrip. Fig. 1 summarizes the differences described above.

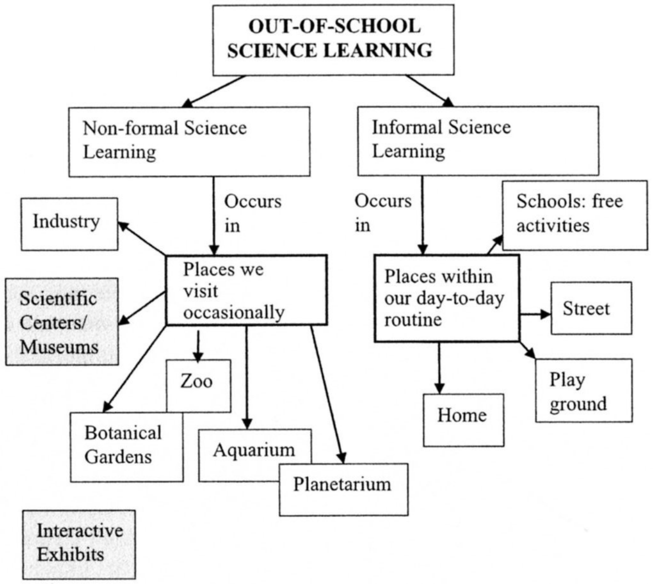

Figure 1. Informal and Non-Formal learning.

The title of the current chapter, *Bridging in-school and out-of-school learning: Formal, Non-formal and Informal*, implies that we should bridge between out-of-school and in-school learning. In the following section I would like to take a step back and ask, should we indeed, bridge the two?

WHY HAVE OUT OF SCHOOL ACTIVITIES DURING SCHOOL TIME?

As stated earlier, whether we plan it or not, informal learning occurs everywhere and all the time. We cannot avoid it. In addition, visits to museums, aquariums, zoos, etc., have become part of our way of life; so, the questions here are: if we experience informal learning anyway, why put effort into doing so during school time? Isn't it a waste of money? Wouldn't it be a waste of precious school time? I also mentioned that teachers have real difficulties when planning and carrying out scientific field-trips. Some of these difficulties stem from their lack of knowledge about organizing and conducting science field trips. These questions might be illustrated by results of a recent study that evaluated docent-led guided school tours at the museum of natural history (Cox-Petersen *et al.*, 2003). The study included observing about 30 visiting school groups in Grades 2–8. Some of their findings show that:

1. Tours focused on facts or stories rather than extensive ideas or concepts.
2. The scientific and historical vocabularies used during the tours were often too advanced for students.

3. Sensitivity to individual and cultural differences was rarely observed.
4. Closed and/or factual questions that did not require complex responses from students were observed. Questions were asked without follow-up, elaboration, or probing.
5. The structure and content of the tour provided minimal connections between the content of exhibit halls and the lives and prior knowledge of the students. Docents seldom provided analogies, information, or examples related to students' life outside the museum.

Moreover, in her recent review article on school group visits to museums, *Research on Students and Museums: Looking More Closely at the Students in School Groups*, Griffin (2004) concludes that,

> in general, school students still look, act, and are treated differently from children in family groups in museums (Hein, 1998, in Griffin, 2004). Their personal relationships within the group are limited, different expectations and constraints are placed upon them, and personal controls over their own movement, rest, and learning styles are often minimized. The school group is generally referred to and largely treated as a single entity rather than a group of individuals and the group's characteristics and needs are considered over the characteristics and needs of the individuals. (p. s67)

Considering Cox-Petersen *et al.*'s report as well as Griffin's conclusion, one may answer negatively the question of whether schools should also partake in out-of-school activities. Yet Griffin (2004) herself argues that with appropriate treatment, student learning can be facilitated. It seems as if there is a gap between the feeling that great potential may lie in school field trips, and some of the recent research results indicating that this potential is not fully achieved.

So far, I presented the voice of researchers or policy makers, such as those in national reports regarding their views toward informal learning. In most national reports it is advocated that informal learning should be pursued. Also, despite the gap mentioned earlier, most researchers would probably call for improving informal learning activities rather than give up and leave informal learning solely in the hands of families. To understand the reasons for this, it might be worthwhile to look for more theoretical explanations. But, before moving on to the theory, let me first present the voice of the teachers, the students, and the non-formal institutions staff.

Teachers' Perspective

Kisiel (2005) investigated the motivation that comprises teachers' agendas when leading student fieldtrips to science museums or similar sites. Eight motivations were identified. Included in the descriptions of these motivations, are the views of Ms. Meg Norton, a primary class teacher, who was a subject of investigation in Lucas's (2000) study; which aimed at describing the involvement of teachers and their students in a class visit to the science center.

1. Connect with the curriculum — teachers see fieldtrips as opportunities to reinforce or expand upon the classroom curriculum by providing an additional perspective, or a more meaningful connection, that can help them with part of the school curriculum. They also believe that students can gain knowledge, curriculum related or not, as a consequence of the visit. This is exactly what Lucas (2000) found

regarding Ms. Norton's agenda for the science center visit. According to the author, it appeared to be quite clear: she aimed to present the students in her class with many opportunities to learn about science and technology topics which they had already learned in class, and new topics which they hadn't.

2. Providing new learning experiences — teachers see the fieldtrips as opportunities to provide firsthand, rich, novel and entirely new learning experiences to students who may not otherwise have the opportunities. These experiences are believed to have a positive impact on student's development and future learning.
3. Providing a general learning experience — teachers see fieldtrips as opportunities to provide memorable learning experiences.
4. Fostering students' interest and motivation — teachers see fieldtrips as events that spark interest in some topics or concepts; hence, foster students' curiosity, motivation and will to discover more.
5. Providing a change of setting or routine — teachers see fieldtrips as opportunities to get out of the classroom and change the routine.
6. Promote lifelong learning — teachers see the fieldtrips as opportunities to show students that learning is possible beyond school, among friends and family. In this regard here is Ms. Norton's view,

I have just tried to develop them personally into learners, and I think as a teacher that's probably the most important job I have to do: is to try and make them life long learners and to understand how they learn. (Meg, in Lucas, 2000, p. 531)

7. Providing students with enjoyment or reward — teachers recognize that the fieldtrip should be a positive and enjoyable experience for the students.
8. Satisfying school demands — teachers are expected to conduct fieldtrips, due to school policies or pressure from their colleagues.

According to Kisiel (2005), of all the above fieldtrip motivations, curriculum connection was the one most often mentioned most. However, teachers had different views about the nature of the connections. The following concepts of connections were identified by the author: *curriculum-related experiences* — students gain "hands-on" experience related to curriculum; *curriculum-related learning* — students gain content knowledge related to the curriculum; *connection to language skills* — students utilize language skills in an interesting real-world setting; *point-by-point connections* — students are directed to see how different aspects of the museum relate to different parts of the curriculum; *curriculum unit integration* — the museum experience is an integral part of a particular topic currently being studied in class, and the experience is directly related to current activities or projects; *curriculum unit introduction/review* — students are introduced to a curriculum topic which they have not yet begun in class, or they are reminded of a curriculum topic which they have already finished; *implicit/opportunistic connections* — students naturally relate their museum experience to their classroom experience. Teachers, if aware of these views about the variety of interpretations of *curriculum connections* are better able to decide what kind of connection they might seek for a specific visit, and plan the visit accordingly.

Students' Perspective

In reading the literature, I found scant evidence about students' perspectives on non-formal learning experiences. Usually, researchers are not interested in questions such as what the child thinks he will gain from his or her science field trip, or whether they think the field trip is important. Researchers are usually interested in and focus on children's attitudes and attitude changes toward science as a result of the fieldtrip, most often to a specific science center. An exception was Lucas's (2000) study. While investigating teachers' agendas for a class visit to a science center he also studied their students' anticipations. The author explored the students' perceptions of why they were being taken to the science center by their teacher and what they expected to do there. Here are some of the students' responses: Tom reasoned that his teacher was trying to make "science learning fun 'cause doing all the experiments and hands-on stuff like that is kind of different from just literature and writing it all down" (Tom, in Lucas, 2000, p. 532). Stuart said that "instead of writing it down and having to remember it, you go and test it out" (Stuart, in Lucas, 2000, p. 532). Bill said that boys "could learn more about science . . . in different ways" (Bill, in Lucas, 2000, p. 532). The researcher asked students who had already been to the science center what they thought they would do there with their classmates. Body stated that, "Umm, we'll split up into groups first and then we'll go around and, umm, if someone in the group doesn't understand how it works, we'll sort of, 'cause the theory sheets maybe too complicated for them, we'll explain it, explain to them what it does if we know ourselves" (Body, in Lucas, 2000, p. 532). Ian said, "just go round in groups and just explain to each other if we don't know, you know, if someone else knows, and just, you know help each other to understand it if they don't — 'cause we're going in groups — and just learn a lot more 'cause we're in groups than just with our family which, you know, you're always with your mum and dad telling the same things. But when you're going in groups you can learn a lot more" (Ian, in Lucas, 2000, p. 532).

In summary, the author concluded that students knew that they were expected to learn. They were equipped with a range of learning strategies, and they anticipated that the learning would be fun.

The above research has made me curious as to what my own children would say about science museums. I have 13 year old twins — a boy, Omry, and a girl, Shaked, and a 9 year old son, Ohad. I held a conversation with each one of them separately. Although they all like science, they do not want to become scientists. Omry prefers learning economics and Ohad wants to become a pilot. Shaked had the most original answer. She told me that, "science is *doing* and I'm a *being* person. I'm interested in more philosophical questions." At first thought it seemed that she missed the point. However, after deeper thought I can understand that this is probably her view because of how she has been educated. Science, to her, is indeed connected to doing. In museums she interacts with exhibits, at school she does experiments. In our conversation she repeatedly mentioned that science is related to facts. Facts that she probably perceived as acquired through doing. No one has yet emphasized the "*being*" part of science to her — that science does indeed deal with philosophical problems. This agrees with Champagne's (1975) critique of science museums, which I mentioned earlier, according to which science is dishonestly presented as easy and unproblematic; nothing to do with "being." One should not only relate this critique to science centers, but rather to the problem of formal science education as well. She might still not want to become a scientist after realizing that science is more than doing; however, she might change her views regarding science. Regarding museums, she said that she enjoys visiting museums since you "learn about the world; about phenomena. You learn how the world works." As for her friends, she said that she thinks that most of them "probably enjoy going to museums because it is a kind of change in the routine; a kind of a "day off." I don't think, though, that they like what is going on there. They do not understand science and do not really like science." Both, Omry and Shaked told me that there was never any connection between the curriculum and the science fieldtrips. The science teacher didn't even join their trips, but rather their class teachers who also organized and led the trips. Omry mentioned that he would prefer it if the science teacher would talk in class about what they saw in the museum. Ohad, the youngest, said that the most enjoyable thing to him is playing around with the different machines. He also mentioned that he enjoys building models in the museum, and that he loves going with his friends because they play together with the different machines and talk about them.

In summary, from this section it can be seen that children enjoy going on scientific fieldtrips. They are aware that they are expected to learn from the trip, and that it should not only be a "fun day", but rather a day where they enjoyably learn science.

Staff Perspective

Rennie and Williams (2002) interviewed, in the first stage of their research, a sample of 28 science center staff regarding their: understanding of science, where their ideas about science came from, what kind of image of science they thought the center portrayed, how it did this, and how successful it was. These included staff working in Administration, Education, Exhibit Design and Development, Visitor Services, and Explainers. The following are some of the main results relevant to this chapter:

1. Nearly half of the interviewed staff thought that part of the center's role was simply to display science and applications of science, with the aim of making people more aware of modern development, the history of science, and its role in modern day life.
2. Two thirds of the interviewed staff thought that part of the center's role was to influence the image that visitors held of science prior to their visit. They hoped that visitors would leave the center with a "more positive feeling about science," and would believe that science could be fun, interesting, easy to understand, and can benefit humans in their everyday life.
3. Over half of the interviewed staff mentioned that the center should provide visitors with the opportunity to gain more scientific knowledge, particularly through the interactive exhibits. Some staff members thought that it was important to recognize that people gain different understandings from exhibits, and that learning may not occur immediately, but rather the visitors' experiences may be expressed in the future.

It is interesting to mention that all but one of those who were asked whether they thought the center was successful in achieving its mission thought that it was successful to some degree.

In the second stage of Rennie and William's (2002) study, the researchers distributed a questionnaire to both the visitors and the science center staff members. Some interesting differences were found (the reader may need to read the original paper to gain a better understanding of this topic) between the staff members and the visitors. Staff members were more likely than visitors to respond that ordinary people can understand science and that the exhibits do not have enough explanations on science. In addition, there are some findings which may concern educators who plan visits to science centers. After the visit, visitors were more likely to respond that scientists always agree with each other, scientific explanations are absolute, science has the answers to all problems, and it is not likely that scientific knowledge will be misused.

From this discussion it appears that the reasons that teachers, science-center staff and children provide as to why scientific field trips to science centers are important, may be divided into two aspects: cognitive and affective. I will now focus on these two aspects of out-of-school learning.

A CLOSER LOOK: THE COGNITIVE AND AFFECTIVE ASPECTS OF NON-FORMAL LEARNING

A thorough comprehension of both non-formal and informal learning, must refer to the affective and cognitive axis of human behavior. I will now discuss how out-of-school learning impacts those two domains.

The Affective Domain

Scientific field trips to science centers can generate a sense of wonder, interest, enthusiasm, motivation, and eagerness to learn, which are much neglected in traditional formal school science (Pedretti, 2002; Ramey-Gassert *et al.*, 1994). Further, informal science centers provide opportunities for active science in non-evaluative and non-threatening environments that invite girls to take on the challenge of a subject that is traditionally viewed as male-dominated (Ramey-Gassert, 1996). Therefore, scientific fieldtrips may play a significant role in inculcating positive attitudes toward science among children, in boys and even more importantly, in girls. In this regard, Hodson and Freeman (1983) state that "the image of contemporary science and of scientists which is presented to young children (under 12) is . . . of great importance in forming their attitudes and determining their choices." Positive attitudes toward science as early as kindergarten and primary school are tremendously important as many latent scientists appear to make early decisions about their careers (Blatchford, 1992). This concurs with the finding of Musgrove and Batcock (1969), who found in their study that a third of 338 science and engineering students at the University of Bradford, unlike their social peers, had made the choice to study science by the age 12 and had remained committed to this decision. In addition, it is well recognized today, that there is a strong association between attitudes toward science and a child's performance in the science class. It was found, for instance, that children with more positive attitudes toward science showed increased attentiveness to classroom instruction and participated more in science activities (Germann, 1988). It is interesting to note that a stronger correlation between achievements in science and attitudes toward science was found for girls (Weinburgh, 1995). In the following, I will briefly describe some research which examined the influence of scientific fieldtrips on students' attitudes toward science.

On reviewing six studies conducted in informal settings, Falk (1983) found that they generally resulted in enjoyable and long-lasting memories. Harvey (1951, in Hofstein and Rosenfeld, 1996) found that an experimental group that underwent a series of geological field trips, out-performed the control group which discussed ecological concepts in a regular classroom, on the standard Caldwil and Curtis Scientific Attitude Test. This effect was attained even after short field visits. Jarvis and Pell (2002) examined attitude changes of children 10–11 years of age, after visiting the Challenger space simulation. They found that immediately after the Challenger experience, most of the children's attitudes were more positive. Twenty four percent of boys and girls became more positive about wanting to follow a scientific career in the future. The authors also found that this change in attitude was maintained to a certain extent for several months. These children also showed a statistically significant increase in science enthusiasm and an appreciation of its social context. In a later study Jarvis and Pell (2005) found that a visit to the UK National Space Center was an important factor in promoting higher interest in space for most children, and improved the children's attitudes toward science for some. One important result of this study was that the teachers' personal interest, preparation, actions during the visit, and follow-up were important factors in influencing children's short-and long-term attitudes. They also argue that the challenge of educators is to decrease the proportion of children, particularly girls, for whom the visit has little effect. They provide some suggestions to help teachers better exploit the potential of the scientific fieldtrip to impact positively on students' attitudes toward science. I would personally consider the out-of-school learning to be a success, even if non-formal learning environments only succeed in this domain, i.e., they only improve children's attitudes toward science and inculcate them with the passion to know more about science.

The Cognitive Aspect

While some researchers found that learning in scientific fieldtrips is ineffective (Anderson, 1994; Kubota and Olstad, 1991), others have argued that students constituted extremely valuable learning outcomes (Ayres and Melears, 1998; Ramey-Gassert *et al.*, 1994); outcomes that persist over time (Rennie, 1994; Wolins *et al.*, 1992). For instance, two studies conducted in the Singapore Science Center, one by Lam-Kan (1985) and the other by Fishon and Enochs (1987), found that students who interacted with the exhibit at the center, predominantly outperformed students who had no experience with the exhibition, regarding the concepts that underlined the exhibits. Realizing that children gain knowledge as a result of their visit to a science center is important. However, I feel that it is also important to seek out a theoretical explanation as to the potential for

increased understanding of scientific concepts as a result of scientific fieldtrips. After all, no educator will stop taking his or her students on scientific fieldtrips just because a specific researcher found that students didn't gain the knowledge that they were expected to gain. Theoretical understanding might help educators to improve their designing of scientific fieldtrips to be more efficient. The Constructivism theory supports this.

Constructivism and Non-Formal Learning. Some researchers have argued that the hands-on activities in science centers, which are related to real-world objects and events, may be considered ideal learning environments according to the constructivism theory of learning (Falk *et al.*, 1986; Ramey-Gassert *et al.*, 1994). It is important to note that the views concerning learning and instruction, can sensibly be categorized in terms of *cognitive, social or cultural* constructivism (Windschitl, 2002). Cognitive constructivism is a system of explanations which deals with the manner in which learners, as individuals, adapt and refine knowledge (Piaget, 1971). I claim that meaningful learning is rooted in the idea that a person idiosyncratically restructures knowledge, actively basing it on his or her prior knowledge. As opposed to cognitive constructivism, social constructivism views knowledge as a primarily cultural product (Vygotsky, 1978). This is well expressed in the following citation:

> An interpersonal process is transformed into an intrapersonal one. Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological) . . . . All the higher functions originate as actual relations between human individuals. (Vygotsky, 1978, p. 57)

Social constructivism, in the case of science museums, might be a good framework to help to understand what kind of learning processes occur during the dialogue among museum visitors and their manipulations with exhibits. Indeed, according to Gilbert and Priest (1997) "a group of visitors composed of individuals of varying experience of the phenomena involved, are able to share prior and present understanding through focused conversation, thus engaging in the social construction of knowledge" (pp. 750–751). This, according to the authors, is what makes museums so valuable in this regard. The authors argue that social context shapes individuals' mental models development. There is evidence in the literature that learning was indeed achieved through social interactions. For instance, Rahm (2004), based on the literature, argues that "through interaction of multiple voices (students and teachers) reflecting diverse interpretations, understandings, and personal experiences, knowledge is taken as essentially 'talked into being' " (p. 225). Moreover, Tunnicliffe (1997, 2000) who examined children's talking in museums, zoos, and botanical gardens, as well as Guberman and Van Dusen (2001), who examined children's investigations in a science discovery center, found that children, even without adult guidance, spontaneously engage in scientific thinking. However, it should be noticed that parents offer richer scientific learning opportunities to their children than their peers (Crowley and Callanan, 1998). One main component of social constructivism is the discourse that takes place among children, teachers, parents, or science center explainers. Gilbert and Priest (1997) went further, by identifying critical incidents, to analyze a discourse that took place during and after a visit by a class of 8–9-year olds at the Science Museum, London. The authors define a critical event to be:

> an event that is sufficiently coherent and apparently significant, as reflected in the discourse which takes place, to permit inferences to be made about the formation, use or development of mental models, as presented in the form of expressed models, by individuals in a social group. (p. 752)

Here are some types of critical incidents identified by the authors:
Discourse initiation
- Recognition of an object as being familiar
- Introduction of an element of surprise and providing an associated task
- Insertion of a question to focus pupils' attention

Discourse continuation
- Suggestion of ideas for post-visit activities
- Linking of generalized and particular
- Linking of objects
- Sustained attention provoked
- Successful consultation of text

Discourse closer
- Unsatisfactory nature of accompanying text.

By being aware of these, educators will be better able to plan conditions to foster efficient critical incidents that promote conceptual gain.

So far I referred to two aspects which, in my opinion, are crucial aspects of non-formal learning: the cognitive and affective. The literature offers some models for explaining out-of-school learning. I will now refer to two such models. One is the *contextual model* (Falk and Dierking, 2000); the other is the *three factors model* (Orion and Hofstein, 1994). I will first describe these models, and then critique them while arguing that a deep explanation should use the cognitive/affective division explicitly.

MODELS EXPLAINING SCIENTIFIC FIELDTRIP LEARNING

The Contextual Model

Learning is viewed by Falk and Dierking's (2000) *contextual model* as an effort to create meaning to survive and prosper within the world; an effort that is best viewed as a continuous, never-ending dialogue between the individual and his or her physical and socio-cultural environment. The authors identified eight key factors that affect learning within three contextual domains: personal, socio-cultural, and physical. They contended that if any of the eight principles are neglected, meaning making in the museum becomes more difficult.

The Personal Context

The personal context represents the sum total of personal and genetic history that an individual carries with him/her into a learning situation. From the personal context perspective one should expect learning to be influenced by:

1. Motivation and expectations
2. Prior knowledge, interests, and beliefs
3. Choice and control

The Social Context

The underlying assumption of the social context is that humans are extremely social in culture and hence, one should expect museums (and other forms of informal learning) always to be socio-culturally situated. Learning, according to this context, is influenced by:

4. Within-group socio-cultural mediation
5. Facilitated mediation by others

The Physical Context

The assumption here is that learning, which occurs within the physical environment, is in fact, always a dialogue with the environment. Thus, learning is influenced by the following environment components:

6. Advanced organizers and orientation
7. Design
8. Reinforcing events and experiences outside the museum

Orion and Hofstein's (1994) Three Factors Model

Orion and Hofstein's (1994) three factors model suggests that the following factors influence learning during scientific fieldtrips in natural environments:

- teaching factors, such as the location of the field trip in the curriculum structure, didactic methods, teaching and learning aids, and quality of teachers;
- field trip factors, such as the learning conditions for each learning station, duration and attractiveness of the trail, and weather conditions during the field trip; and
- student factors, such as previous knowledge of associated topics; previous acquaintance with area in question, previous experience with field trips, previous attitudes to subject matter, previous attitudes to field trips, and class characteristics (e.g. grade, size, and study major).

Critique of the Two Models

The teaching factor from Orion and Hofstein's model is not explicitly mentioned as one of the contexts in the contextual model. I believe that a model which can help teachers to better plan scientific fieldtrips should refer directly to the teaching context before, during, and after the visit. After all, it is too simplistic to see the fieldtrip as only occurring at the science center itself. It begins, in my opinion, with the preparation for the trip. Indeed, Folk and Dierking (2000) relate, in the physical context factor, to reinforcing events and experiences outside the museum; but this does not, in my opinion, explicitly put the teaching context where it is supposed to be. A good case to demonstrate this point can be taken from Lucas's (2000) paper. In this paper the author describes how he explained to the teacher that he wanted to attend the last lesson before the visit to the science center, to observe how she prepared the students for the visit. Her reply was, "you're probably already too late." At first he was surprised, but then he began to understand. The "visit" began several months before the actual trip. It also didn't end when the students left the science center. A good visit also includes activities that take place after the visit. A good model can not ignore the before and after visit activities. Orion and Hofstein, on the other hand, did not explicitly mention the social aspect as a factor which influenced the scientific fieldtrip, which is, in my opinion, rather surprising. Furthermore, it is my view that an efficient model is one which divides factors impacting the scientific fieldtrip into the cognitive and affective domains. These should not appear implicitly "in-between" the lines, but rather as categories according to which the other model's keys would fit. I present such an explanation here. Figure 2 illustrates my explanation. As described in Fig. 2, there are four factors which influence non-formal learning: personal, physical, social, and instructional. Each of these factors contains cognitive as well as affective components. For instance, the personal factor includes the child's prior knowledge, and belongs to the cognitive category. The personal factor also includes the child's agenda for the visit, his or her attitude toward science, as well as their efficacy beliefs. All of these factors belong to the affective domain. The social factor includes the interpersonal interaction which results in cognitive gain, as was explained previously by the cultural constructivism theory. Further, the social factor contains the influence of others (e.g. peers, teachers, family members, museum explainers) in the affective domains. Sometimes the interaction increases the motivation of the person to interact with a specific exhibition, which he or she might have otherwise ignored, had he/she been alone and vice versa. At first glance the reader might be surprised to find that the physical factor may also influence both the cognitive and affective domains; but, if he/she gives it some thought, he or she can realize that, for instance, the appearance of the exhibit, its color, the ease of manipulating it etc. may bear some influence on the affective domain. However, the degree by which one can manipulate the exhibit and how well it demonstrates scientific ideas, belong to the cognitive domain. Of course, the instructional factor also influences both on the cognitive and affective axes. As was previously discussed, the manner in which the teacher prepares students for the fieldtrip may

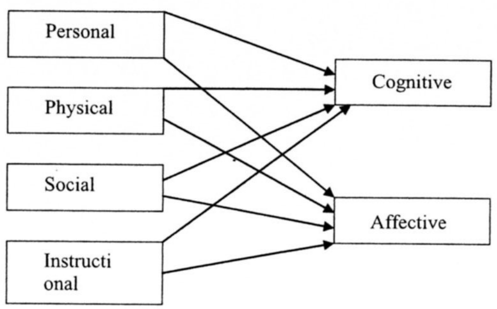

Figure 2. Factors influencing out-of-school learning each containing cognitive and affective domains

help children gain better understanding from the visit as well as prepare them emotionally.

I do not see my explanation as a kind of a model, but rather as something that organizes the factors already found in the literature, regarding the cognitive and affective domains. I would now like to discuss the *novelty phenomenon* from the standpoint of the previous explanation. It is an important phenomenon which is strongly associated with non-formal learning. Dealing with such a phenomenon through the eyes of this explanation might demonstrate its power.

The Novelty Phenomenon

Research on informal learning reveals a strong association between the novelty of an unfamiliar location stimuli, and visitor behavior (Falk, 1983; Falk and Balling, 1982), particularly in school groups. Balling suggests that: "The novel field situations produce an adaptation or adjustment on the part of the student which direct their behavior toward the environment and away from the structured learning activities" (p.128). According to Lucas (2000), high levels of novelty are reported with high levels of "off-task" behavior, at least in terms of teachers' objectives for students during a visit to a science museum or similar location.

Reviewing the literature, Burnett, Lucas, and Dooley (1996) identified three novelty-reduction approaches:

1. increasing students' familiarity with the physical location.
   In this regard, Orion (1993) argues that,

> Students should be prepared for the field trip. The more familiar they are with their assignment (cognitive preparation), with the area of the field trip (geographical preparation) and the kind of event in which they will participate (psychological preparation), the more productive the field trip will be for them (p. 326).

2. Insuring that students have the appropriate level of knowledge of the topics or focus of the exhibits/activities.
3. Providing preceding opportunities for students to practice relevant skills.

A unique manner of implementing these suggestions was reported in an interesting paper: *One Teacher's Agenda for a Class Visit to an Interactive Science Center* (Lucas, 2000). The author reports on how one teacher: Ms. Norton (whose views were also mentioned in the teachers' perspective section), invested considerable time and effort in the weeks leading up to the visit, to preparing the students for the visit by having them construct their own "exhibits." In her own words,

> The science centers got the equipment, and everything's set up, and lots of great learning experiences, but we're able to generate that ourselves probably on a lesser scale, so I just wanted to link the two, so that they understood that we had a mini-science-center. By the time we'd been through the process of building it, explaining it, showing how things work, and the way they do, that they would understand that's what the exhibits were for, it's not an entertainment. As much as it's fun, it's not like a time zone where they just go to get entertained. (Meg, 81097–234, in Lucas, 2000, p. 531)

This literature review reveals that the novelty effect influences children's performance on both the cognitive (this is also supported by the work of Kubota and Olstad, 1991; Riley and Kahle, 1995) as well as the affective (this is also supported in the work of Rennie; Riley and Kahle, 1995) learning outcomes. The students, when entering an unfamiliar location, might develop anxiety, and as a result be involved in off-task activities which may distance them from executing the learning tasks at hand. In addition, as was described, the teaching factor is strongly connected to the novelty factor. If teachers prepare their students for the fieldtrip beforehand, the children will feel much more comfortable, while experiencing less anxiety from their exposure to the new situation, and as a result will be more willing to learn. From what has just been said, to comprehend the novelty phenomenon, one should look through a pair of glasses which are comprised of one cognitive lens and one affective lens. In addition, the instructional factor should definitely be considered and seen as one that may help deal with the novelty phenomenon.

The benefits of non-formal learning both on the cognitive and affective axes also explain, using Howard Gardner's (Gardner, 1983, 1993) idea of multiple intelligences, why it may fit the needs of different people (Rennie and McClafferty, 1996).

The Multiple Intelligence Idea and Museum Learning

Howard Gardner's idea of multiple intelligences suggests a pluralistic view of the mind, with seven intelligences, rather than the traditional single intelligence implied by a single IQ score. Here is a brief description of the seven intelligences:

Interpersonal intelligence is concerned with the capacity to understand the intentions, motivations and desires of other people. It allows people to work effectively with others. Scientific fieldtrips usually require some degree of collaboration with others. Children usually work in groups to manipulate a specific exhibit. Thus such learning may fit those who have a strong interpersonal intelligence. Of course, it might develop such intelligence in those who weren't originally graced with it. In this case I would argue that because of the affective benefits of non-formal learning, the interpersonal intelligence might be addressed and undergo development.

Bodily-kinesthetic intelligence entails the potential of using one's whole body or parts of the body to solve problems. It is the ability to use mental abilities to coordinate bodily movements. Howard Gardner sees mental and physical activity as related. Of course, manipulating exhibits requires one to coordinate his or her body movement to perform a specific task and thus in such fieldtrips, those who possess a high level of such intelligence, might find themselves succeeding in the tasks even better than those who are usually considered the good science students. This might, of course, contribute to the improvement of one's self image in science.

Spatial intelligence involves the potential to recognize and use the patterns of wide space and more confined areas. According to Rennie and McClafferty (1996), the visitors in museums are usually involved with some kind of spatial or kinesthetic experience, and often work better with more than one person. In addition, I argue that in fieldtrips, the children have to navigate in unknown surroundings as well as manipulate 3-dimensional exhibits. These tasks require spatial abilities; thus, such learning might develop spatial intelligence.

Logical-mathematical intelligence consists of the capacity to analyze problems logically, carry out mathematical operations, and investigate issues scientifically. Many tasks in the scientific fieldtrip may require one to deal with problems, to provide an explanation for the unexpected behavior of a system, etc. These activities will probably attract those who have a high level of logical-mathematical intelligence, and, will contribute to its development in those who choose to deal with these kinds of tasks.

Linguistic intelligence involves sensitivity to spoken and written language, the ability to learn languages, and the capacity to use language to accomplish certain goals. This intelligence includes the ability to use language effectively to express oneself rhetorically or poetically as well as a means to remember information. Although science centers do not deal with languages, they do encourage one to express him or her self when explaining a phenomenon demonstrated by the exhibits. Thus, in some sense those who possess a high level of such intelligence might find themselves involved in an "explaining" role.

Intrapersonal intelligence entails the capacity to understand oneself, to appreciate one's feelings, fears and motivations. A fieldtrip is always an irregular occurrence. Thus, it might involve emotions toward the different gained experiences. The teachers may ask the students to think of things like: how they felt in the field trip and why? What parts they enjoyed and what parts they didn't. What did they learn and how? This means that non-formal learning might provide an opportunity to develop the intrapersonal intelligence, as well as to give those who have a high level of such intelligence a chance to demonstrate their ability.

Musical intelligence involves skill in the performance, composition, and appreciation of musical patterns. It encompasses the capacity to recognize and compose musical pitches, tones, and rhythms.

To summarize this point, non-formal learning can appeal to a range of intelligences, promoting the likelihood of engagement by people with different strengths and preferences for learning.

ON THE NEED TO BRIDGE

Thus far I discussed primarily non-formal learning. Indeed, most research of out-of-school learning relates to non-formal learning. But non-formal learning is only one possible form of out-of-school learning. Informal learning is another. It is not surprising that not much research has been carried out regarding informal learning. Places where informal learning takes place are out of teachers' and researchers' territory. One area of informal learning which drew the attention of some researchers is home learning, especially the connection between home and school learning. In this section, I describe some of this research. It is important for this chapter, which aims at bridging in and out of school learning. In addition, I suggest implementing the well known idea presented in the following phrase: "If Muhamed cannot come to the mountain, bring the mountain to Muhamed." By this I mean that if we wish to extend the use of scientific fieldtrips to science museums, and if bringing the children to the museum is complicated, then, in addition to the visit to the museums, the museums can visit the children. I will also present the idea of the "scientific kindergarten" which may also strengthen the connections between in and out of school learning.

Bridging Home and K-2 Classes

Solomon (2003) argues that "no one would deny the influence of home and families on the education of our children" (p. 219). Being aware of the significant influence that the home might have on learning, some educators sought after ways to establish stronger relationships between home and school. The SHIP (Solomon, 1993, 1994, 2003) project is one such an attempt. It aims at providing schools with banks of examples of simple activities which teachers could select as appropriate for children ages 5–10 years, to take home and carry out with their parents. The equipment used in the project is composed of simple objects and materials found in any household. Solomon (2003) claims that to understand science in the home, everything used should come from the home. The findings indicated that most parents showed real enjoyment of at least some of the activities provided by the project. In addition, in at least half of the investigations, the child had enough confidence to make some original contribution to the investigation. According to the author,

> In this way, they made the investigation at least partially their own, which rarely happens at school. They spoke easily with their parents and were encouraged, joked with, scolded, or ignored in a manner that clearly seemed familiar to them. (p. 229)

The author closed his paper saying that "a far greater reward from these activities with parents in their homes was the possibility of implanting the enjoyment of science into the home culture, and through this into the child's self image and future" (p. 231).

In another interesting study, Hall and Schaverien (2001), described what happened as children carried out scientific and technological inquiries, first as they were developed in school and then as they were pursued by children and families at home. The chosen topic was a flashlight, and the children, at the beginning session at school, demonstrated what they already knew about flashlights, how they worked and their everyday uses, recording these in the form of drawings and stories. The children were encouraged to ask questions and to develop their understanding of how flashlights might work. Each day, kits containing equipment such as batteries, wires, bulbs and switches were available for children to take home. The paper provides ample examples of learning situations which occurred at home. For instance, an example taken from one of the parents is the following story:

> that evening a friend called in — he's an engineer — and the three of them spent ages together, connecting circuits and blowing light bulbs. (Hall and Schaverien, 2000, p. 465)

On that occasion, George's father went further to challenge his son to making light bulbs of varying brightness; a challenge that George and his uncle, two weeks later, "were very enthralled — trying to solve the challenge" (p. 465). Another story tells how one parent, David's father, expressed surprise at his son's capability, explaining,

"This is great — I have an aversion to the science side of life — I think it is actually fear — I might get it wrong . . . . [David] has a 14-year-old brother who gave him a bit of help . . . he was playing with a little flashlight that he has." The authors did not know what David's brother did to help his understanding, but two weeks later David persisted in pursuing his own ideas, successfully connecting his complex circuit.

These two studies show that involving parents in science activities at school might result in good collaborative work in science and technology. This might have an important positive influence on students' attitudes and self image concerning science. It is important to mention, though, that in order to succeed in such efforts some guidance should be provided to families both pedagogically and scientifically.

Bringing Science Centers to the Class — Mobile Museums

As mentioned earlier, taking children to scientific centers might be problematic. First, science centers are not located everywhere. For instance, I was invited to conduct a workshop on *Inquiry Events* in Onsekiz Mart University in Çanakkale city. I was surprised to discover that they do not have any science centers in the entire area. This is only one example and there are probably many more places all around the world which do not have science centers. I thus argue that in places that don't have science centers, one can bring the science center to the class. It is my opinion that bringing the museum to the class is also good even in places where there are science centers. In such places, however, the role of the traveling museums will not be to replace the visit to museums. On the contrary, they can be used as a tool to prepare for the fieldtrip. An example of such a traveling museum is the Science on the Table program which was developed by Technocat in Israel. First, the table is big enough to hold many interesting apparatuses designed specifically for K-2 children, but at the same time, it is compact and small so that it can easily be moved to different corners of the classroom, and also can be transferred from school to school. The table includes different drawers, each containing different apparatuses on a certain topic. Figure 3 shows the table and the front drawers. The table also has big drawers on its sides.

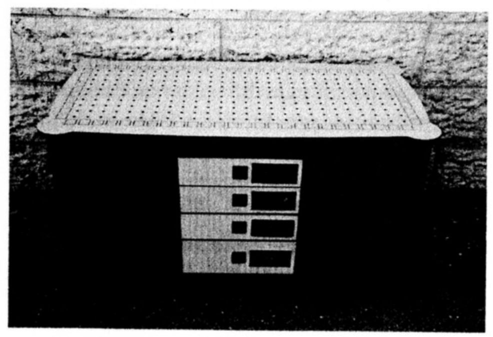

Figure 3. The science table from the science on the table program.

Figure 4. Children playing with the balance scale from the Science on The Table program.

Here are some examples of its content: (1) An inclining plane which the children can play with and alter its angle. There are different planes made of different materials with different friction coefficients, such as carpet-like materials, veneer, or plastic. The children release different objects onto the plane, some with wheels and some without, and take note of the differences in the distances which they advance in relation to the type of material and the angle of the plane. They can measure the distance using the holes on the table. (2) A balance scale (see Fig. 4) and a set of four separate weights: a whole weight, three quarters, half, and a quarter. The children can hang the weights on opposite sides of the scale, and can see, for instance, that they need to hang two identical weights at the same distance from the center of the scale in order to balance it, but the balance will be broken if the two weights are placed at different distances. Also, they see that the closer the weight is to the center, the heavier the weight needed to balance with a weight further from the center on the other side. For instance, 1 quarter on the full distance, is balanced by 1 half at a halfway distance etc. (3) A set of cogwheels (see Fig. 5) which can be connected to the holes on the table. The children can investigate different reactions of the wheels to different setups. There are other apparatuses present in the table, including lenses and mirrors, a jukebox that works on cogwheels etc.

Creating Suitable Scientific Centers for K-2 Children

This chapter has shown the benefits of non-formal learning. I didn't, however, ignore the difficulties of such learning. For instance, I mentioned that research has found that visits to science centers often focus on facts or stories rather than substantial ideas or concepts. In addition, the vocabulary used during the tours might be too difficult for children to grasp. Also, there is little sensitivity, if any, to students' prior

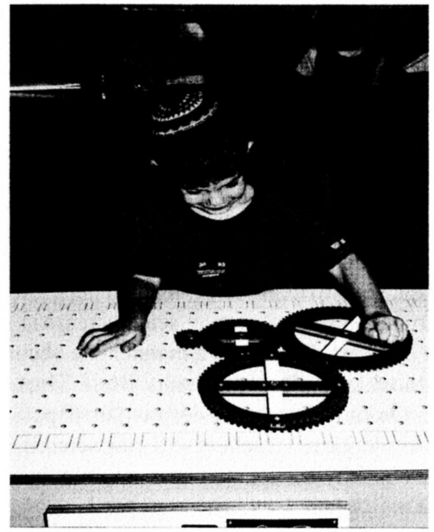

Figure 5. A child playing with the cogwheels from the Science on the Table program.

experiences, as well as their individual and cultural differences. These factors might have an even greater impact on K-2 children than on older children. A creative way to solving such a problem is to build a special science center for small children. In Israel, there are several such centers. We used to call them Scientific Kindergartens. Now, unfortunately, they changed the name to Enrichment Centers. I think that the name Scientific Kindergartens is good since it emphasizes that this is a place especially for kids where science is the learning focus.

Characteristics of the "Scientific Kindergartens"

First, each scientific kindergarten serves several regular kindergartens from the surrounding areas — usually between 10–20 kindergartens. Each of the surrounding kindergarten's children visits the scientific kindergarten about 4–5 times a year, where each visit is devoted to activities on a specific topic. Typical topics are: sound and voices, optics, air, stones and rocks, electricity, and agriculture. The scientific kindergartens are usually highly equipped with advanced technology such as microscopes, dark rooms, pipes, and other instruments which are needed for their activities. In some scientific kindergartens the yards are also equipped so that science activities can be done outside. The person in-charge of the scientific kindergarten is usually a kindergarten teacher who has specialized in science throughout the years in in-service courses. There are, of course, advantages and disadvantages to this situation. A person who is a kindergarten teacher by profession definitely understands what the children's needs are, as well as the kindergarten teachers' needs. That person is also aware of the pedagogical methods appropriate for K-2 children and knows how to present the scientific topics to the children. Moreover, it is also expected that good working connections may develop between the scientific kindergarten teacher and the children's preschool teacher. The scientific kindergarten teacher meets the regular kindergarten teacher at the beginning of the year. In this meeting she describes what the topics, which are to be covered during the school year, are. She also provides some suggestions for preparing the kids for the meetings. In addition, after the children attend the scientific kindergarten, their teacher is provided with follow-up activities which she can conduct at her kindergarten. Furthermore, the scientific kindergarten teachers also visit the children in their kindergarten during the year. She may see a scientific activity during these visits or even conduct one herself. In such a manner she becomes a familiar figure in the lives of the children, as well as the center itself. Thus, the novelty effect is expected to minimize. On the other hand, despite participating in some scientific courses, the scientific kindergarten teachers still lack scientific knowledge. To help these teachers they can usually be assisted by a scientist who serves as a kind of consultant for the center.

DISCUSSION

The first chapter of this book provided some justifications as to the importance of beginning the constitution of the child's scientific foundations as early as kindergarten. The subsequent chapters focused on approaches which I found suitable for science teaching at this age. Although these approaches are not restricted to only formal learning, no specific attention was given to the out-of-school learning. Without obtaining a specific and explicit understanding of out-of-school learning, which the present chapter deals with, one can not, in my opinion, fully comprehend K-2 science teaching. I chose this chapter for the ending of this book not because I hold out-of-school learning to be less important than formal learning, but because I thought that being equipped with the potential of formal learning, as well as being acquainted with the different approaches on how to teach it, is a necessary background before one carries on to the less-formal nature of non-formal and informal learning.

In understanding the importance of dealing with out-of-school learning, one should refer to the unfortunate fact that schools alone have not usually been successful in creating scientifically literate school leavers. As was discussed in this chapter, as well as is stated by Jarvis and Pell (2002), "the process of enabling young children to start a lifelong interest and understanding of science in the wider world may be improved by the provision of out-of-school science experiences" (p. 980). The authors find support for this view in the following citation:

> Unless the young people of the twenty-first century appreciate the importance of science, we stand no chance whatsoever of economic, social or cultural survival. In my view, science museums and science centers must play an appropriately active part in the educational programme on which this survival depends. (H. Kroto, joint winner of the 1996 Nobel Prize for chemistry, 1997, p. 14)

Howard Gardner, in his book *The Unschooled Mind, How Children Think and How Schools Should Teach*, even further emphasizes how important the science museums' roles are by his envision of the following learning environment:

> Imagine an educational environment in which youngsters at the age of seven or eight, in addition to — or perhaps instead of — attending a formal school, have the opportunity to enroll in a children's museum, a science museum, or some kind of discovery center or Exploratorium. As part of this educational scene, adults are present who actually practice the disciplines or crafts presented by the various exhibitions. Computer programmers are working in the technology center, zookeepers and zoologists are tending the animals, workers from a bicycle factory assemble bicycles in front of the children's eyes, and a Japanese mother prepares a meal and carries out a tea ceremony in the Japanese house. Even the designers and the mounters of the exhibitions ply their trade directly in front of the observing students. (p. 200)

The author continues and asks "Would we not be consigning students to ruination if we enroll them in museums instead of schools?", and he answers, "I believe we would be doing precisely the opposite. Attendance in most schools today does risk ruining the children."

I do not agree that sending children to schools today risks ruining them. I have found teachers in many cases to be doing wonderful work and advancing children cognitively and emotionally. They do, of course, still have room for improvement. This, however, does not mean that parents are doing something wrong by sending their children to school. I also think that such sharp criticism contributes to decreasing the teachers' status, which already suffers tremendously. This entire book was written from the point of view that teachers are doing important and crutial work, and invest a lot of effort: we educational researchers should help them to tunnel their efforts more efficiently. Also, I do not think that museums should replace schools in spite of their advantages. After all, reviewing the literature, this chapter revealed that museums have much to improve themselves. Also, one important factor of fieldtrips over schools is the fact that it somewhat changes the routine. So, I herein call that we should not ruin breaking the routine. It is my view that non-formal institutions should not replace schools. Schools should remain schools; but educators must construct bridges so that out-of-school learning, be it informal or non-formal, is better connected to the in-school learning. I am sure that teachers do not fully understand the role of out-of-school learning in science teaching. This is not surprising. Even searching *The Hand Book of Research on Science Teaching and Learning (Gable, 1994)* I did not find, to my astonishment, any explicit treatment of out-of-school learning phenomena. Hence, in the eyes of some educators, these phenomena might be interpreted as unimportant. Being aware of its importance, as well as being equipped with some suggestions as to how to bridge in and out-of-school learning, I hope that this book will bring the latter to where it belongs, among others — in the school.

I suggested in this chapter that four factors influence learning in non-formal learning environments: personal, physical, social, and instructional. Each contains cognitive and affective components. I argued that in order to ensure an efficient scientific fieldtrip, one should appropriately treat each of the above factors, on both the cognitive and the affective levels. To bring theory into practice and to apply what has been discussed in the chapter, one should consider the following when designing and executing scientific fieldtrips:

Implication to Education

- Decide what the purpose of the scientific fieldtrip is. For instance, is it a kind of enrichment experience that is not connected to the curriculum? Is it connected? In this case the teacher should decide whether its role is to introduce or motivate a learning topic, to summarize it, or to deepen and extend it. The purpose, of course, directs the way in which it will be conducted.
- Visit the fieldtrip location beforehand. Talk with the people in-charge of the educational program to inform them about the purpose of the visit and your expectations. Ask them whether they have any suggestions for activities you can do in the class before the visit and afterwards which, of course, fit the fieldtrip purpose.
- Share the purpose of the visit with the children before the visit and share your expectations of them. You can also ask the children whether they have any expectations of their own. In this regard it must be clear to the children that the visit is a learning experience.
- To decrease the novelty phenomena, the children can be presented with the structure of the day. In addition, the children may enter to the location's Internet site and become acquainted, to some extent of course, with the environment before the fieldtrip. In such a way they may feel safe not being afraid about being lost or not knowing what to do. This will also decrease concerns from the teacher's side.
- Conduct the relevant scientific activities in the class before going to fieldtrip. This is important because in this way the children will acquire both the skills and background knowledge they need in order to better benefit from the new experiences.
- Always provide some tasks to be conducted in the fieldtrip. This is very important because such tasks may help the children to notice things that could otherwise be ignored. It is suggested that the tasks be open-ended and require observation, discussion, and deduction of ideas or principles rather than a focusing on recording of factual information. Also, it is important not to overwhelm the children with too many tasks. In this regard more is not always better. In addition, it is important to bear in mind that the child should also have the opportunity to have free choices both in what exhibits or activities he or she wants to participate in and in what manner they want to conduct it.
- Involve parents and encourage them to join the trip. Remember, it was found that adults' help might stimulate them and lead to longer and deeper involvement with the exhibits. For this purpose, of course, parents with some scientific background might be a good fit.
- It is suggested that schools prepare some activities in advance; activities that may be good for parents to join. In addition, there should be some guidance on how parents can continue those activities at home. Such activities might encourage parents to conduct scientific activities with their children. This might have a positive affect on the child's motivation, attitudes, and self image concerning science.
- Schools and museums should cooperate and bring some scientific activities into the classroom. In such a way there might be more and stronger interactions between schools and museums.

- I also call for broadening the *scientific kindergarten* model. Such centers, that might even be part of science museums, might better fit the activities to the children's needs.
- In-service courses for teachers are needed first to increase their awareness of what out-of-school learning environments may offer and second to teach them how to execute scientific fieldtrips more effectively.

Considering the advantages and disadvantages of out-of-school learning, I find it has great potential to help people to learn, appreciate, and develop positive feelings toward science. This means that such a kind of learning has an impact on both the cognitive and affective axes. However, as was shown in the chapter, this potential is not fully exploited. The suggestions I have made might contribute to improve this situation. I also think that the out-of-school learning should be treated more in the science education literature. First, hand-books should handle such learning. Second, most of the research was done regarding non-formal learning environments, especially science centers and museums. We do need to know more about children's learning processes at home, with their parents. We need to know more about what they learn in playgrounds, nature excursions etc. Learning and teaching should be seen in a holistic way; hence, we should immerse ourselves, and I hope this book contributes in this matter, in understanding of in-school learning, as well as out-of-school learning.