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childhood. It goes on to analyze and synthesize a broad range of
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Science Literacy in Primary Schools and Pre-Schools

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SCIENCE LITERACY IN PRIMARY SCHOOLS AND PRE-SCHOOLS

By

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CONTENTS

CHAPTER 4

FROM THE KNOWN TO THE COMPLEX: THE INQUIRY EVENTS METHOD AS A TOOL FOR K-2 SCIENCE TEACHING

In chapter 1, six justifications for science education in early childhood were discussed along with children's capability to think scientifically. So, the first chapter, I hope, convinced the reader that science education should begin at early stages of life. The next two chapters covered a variety of approaches and methods so the convinced reader might encourage teaching science at K-2. All of the previous chapters, however, concentrated on and emphasized the child's needs. The preschool teacher's needs were neither thoroughly nor explicitly considered. This chapter aims to rectify this situation. After all, we should remember that K-2 science education is primarily in the hands of the teacher. A science curriculum, as excellent as it may be and which may fit the children's needs perfectly, might fail because of the teachers. In this chapter I present a fresh idea: science curricula, at the K-2 level, should consider and emphasize the teacher's needs. I do not mean that one should neglect the children's needs: on the contrary, those should always be kept in mind. However, over the years, I have noticed that most curricula are built first from the outlook of the children's perspective, and only then do the designers search for ways to prepare the teacher to implement the program. The common assumption is that curricula should be designed for the children and that at the design stage teacher's needs are not considered. Only after the curriculum is ready is consideration given to its teachers. This, in my opinion, is wrong!

This chapter is divided into three parts. The first part discusses the idea of a curriculum driven by the teacher's needs and presents a teaching strategy that I developed and named *Inquiry Events* (IE), which uses this approach.

The second part describes a research which examined educators' changes in science teaching efficacy beliefs and science teaching outcomes after participating in a workshop on IE. This research also tested the educators' views about IE itself. After realizing that the IE method was well accepted by teachers, I felt it was time to test it in a kindergarten. The last part of the chapter presents a research done with my master's degree student, Liat Bloch, which evaluated the IE in two kindergartens.

PART A: THE NEED FOR A NOVEL TEACHING METHOD — THE INQUIRY EVENTS

Elementary grades have been cited as the weak point of science education (Gardner and Cochran, 1993). In most cases, only a small part of elementary school activities are related to science (Schoeneberger and Rusell, 1986). There is considerable evidence suggesting that K-2 science education worldwide is in a similar state (Mulholland and Wallace, 1996). It is reasonable to assume that even less attention is given to science activities in kindergarten. Two main factors may explain why both elementary and kindergarten teachers have difficulties in being effective science educators: a) teachers possess insufficient scientific background (Franz and Enochs, 1982; Hurd, 1982), and teachers hold anti-science attitudes (Koballa and Crawley, 1985). Shrigley (1974) discovered a low correlation between science content knowledge and teachers' attitudes toward science. These results suggest that addressing only the problem of insufficient knowledge and requiring additional science oriented courses, namely through mathematics and science departments, as part of pre-service and in-service teacher preparation, may not be the most appropriate solution to training competent elementary school science teachers. Moreover, I concur with Tosun (2000) that such courses may have a counterproductive impact on teachers.

Wallace and Louden (1992), wondered: "Why, after more than three decades on the reform agenda, elementary science teaching continues to disappoint. Is it because we haven't found the right 'formula', or could it be that we have an imperfect understanding of the problem and unrealistic expectations for the solution?" (p. 508).

Teachers gravitate toward tasks where they feel confident and competent (Cunningham and Blankenship, 1979). Although children's abilities and interests must be one working assumption while designing a curriculum, another is that science curricula must also consider teachers's interests and abilities. One such approach is called the 'Inquiry Events' (IE) teaching method. This method involves dealing with open-ended problems taken from real-life situations, encouraging investigating different kinds of issues (ethical, economic, aesthetic, etc.) which teachers at both kindergarten and elementary school consider and discuss. The method helps teachers to introduce scientific questions relating to those daily situations, which they would normally ignore or omit. The assumption is that by combining science with familiar day-to-day situations, teachers will feel that scientific knowledge has practical importance in everyday life. Moreover, since the scientific questions are only part of the whole problem, once the teachers feel confident, it is believed they will be more willing to go further to gain additional and necessary scientific knowledge. In this manner, it will be easier and more natural for a teacher to include scientific questions among other issues arising from a concrete real-life problem, rather than focusing separately on a problem which is somewhat fictitiously defined as a *scientific* one.

Stages of IE Design

Developing an inquiry event includes two main stages: choosing an appropriate inquiry event that fits some criteria which will next be described, and then expanding the inquiry event into suitable learning units. Fig. 1 illustrates these two stages. The upper part — part A, shows the first stage of the IE development. The lower part — part B, shows the second stage.

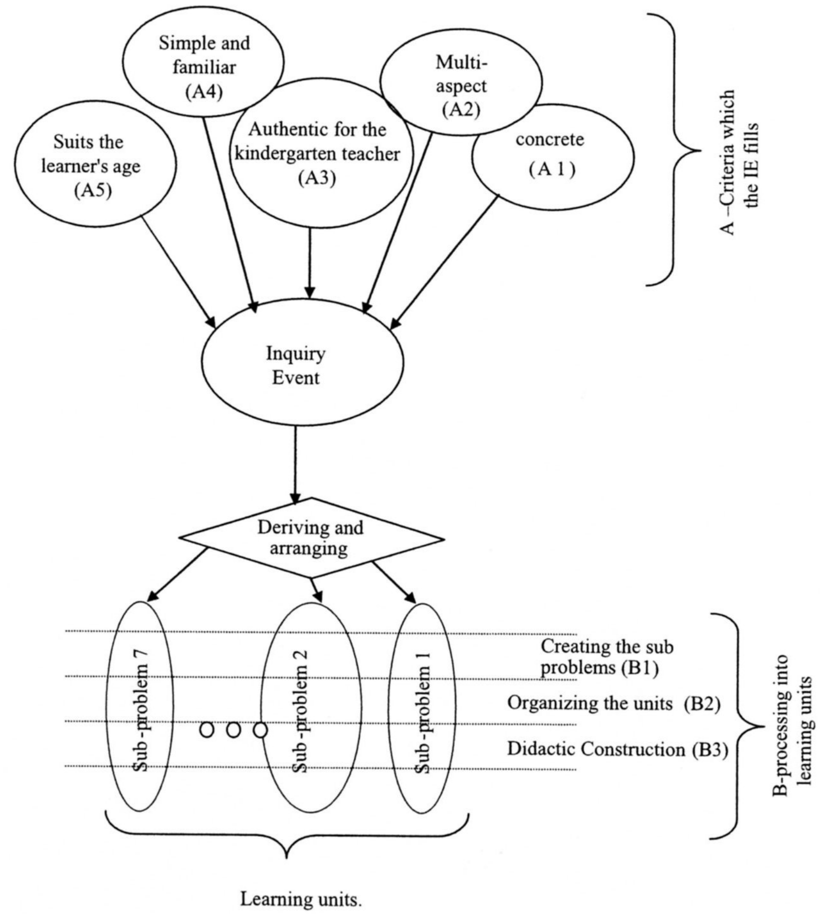

Figure 1. The two stages of IE development: The first stage — stage A, choosing inquiry events according to the five detailed conditions. The second stage, stage B, processing inquiry events to learning units.

Stage A: Criteria which the IE Fills. For an open ended problem to be considered an Inquiry Event, it should fulfill the following criteria:

1. Concrete: The IE should deal with a real and concrete, open-ended problem taken from a real-life situation. In addition, the event is dealt with in a veritable manner, and the learning group is asked to gradually reach a solution.
2. Multi-aspects — The problems encourage investigating different kinds of issues—ethical, economic, aesthetic, geographic, scientific, technologic, etc., — meaning that scientific questions should only be *part* of the whole problem.

3. Authenticity for the kindergarten teacher — The intention here is that kindergarten teachers deal with familiar events in their daily routines and problems that they deal with as part of their daily lives, in and out of the kindergarten.
4. Familiarity and simplicity for the children — Even if the events are to be part of the kindergarten teacher's daily routine, they still have to be familiar to the children. They also have to be simple and feasible to be conducted within the constraints of the kindergarten.
5. Suitability for the age of the learners — The event must have content and activities suitable for kindergarten children. The scientific issues should especially be ones which K-2 children can understand and which are part of their every-day lives.

Stage B: Processing into Learning Units includes a number of sub-stages:
1. Creating the sub-problems — In this stage the inquiry event is disassembled into secondary problems connected to different aspects of the main problem, the IE. The purpose is to turn each of the secondary problems into a separate learning unit.
2. Organizing the units — Creating a succession of the derivative problems, to enable a logical and suitable progression of the learning process.
3. Didactic construction — In this stage the teaching methodology is developed, and questions such as the following are addressed: How will each of the secondary problems be presented to the children? What demonstrations should be used? What kind of experiments will be done? What kind of artifacts can the children build? How will the activities be connected to create a succession?

It is important to emphasize out that all of these points are developed relating to the main problem — the inquiry event. The learning units are designed so that the IE is in the background. This means that the sub-problems are presented to the child in the context of the IE's main problem presented at the beginning of the teaching process. The children are reminded in each learning unit that their final goal is not just simply to deal with the secondary problem with which the teacher is currently teaching, but rather that the main goal is the IE. For this reason, most of the sessions will start with a reminder of the original problem and only afterward will the sub-problems be presented along with their connections to the main problem.

How and Why IE differ from Other Teaching Methods

I would also like to point out and emphasize the differences and similarities with IE and similar pedagogical methods such as problem-based learning and project-based learning. Both problem-based learning and project-based learning were discussed in the second chapter. As previously explained, the underlying idea of problem-based learning is that learning and teaching processes are driven from and start from a problem which is presented to the learners and they are required to deal with it. However, problem-based learning is a very general term which might include a variety of teaching activities. The problem the teacher selects may be narrow or broad; it can be specific or general; and it may be one which requires a small or a large portion of time to complete. Further, no constraints are imposed on what rules the problem should obey. The IE method begins the teaching/learning processes with a problem and hence it belongs to the PBL

approach. However, not every problem can be considered as an IE, but rather only these which obey the constraints that were presented earlier. It should not be too short or too long. The IE should last about 7–8 weeks and cover different aspects of the IE's main problem. One may say that the IE is a kind of a project and thus the same old lady under a different cloak. I agree that the IE method in some sense is similar to a project. However, there is a big difference. First, in projects, the learners themselves usually bring the problem that they want to pursue. It is not a systematic pre-designed curriculum. On the contrary, the child may bring in a project on a topic which the teacher knows nothing about. In the second chapter I criticized such an approach. It is my opinion that most pre-school teachers do not have the knowledge, skills or means to present or use such a method efficiently. The IE, as opposed to project-based-teaching, is a systematic curriculum based on problems with which the teacher is familiar. In addition, projects may include many different aspects. But there is no such demand that these aspects all be included, and may deal with only one aspect that the child chooses to concentrate on. Moreover, even if it does involve several aspects, it might include non-scientific topics. For instance, a child can choose to start a project on water. His or her project might include biology aspects, physical aspects, and chemical aspects, but there are no requirements for it to include non-scientific topics such as literature or history. The IE approach requires that a problem include several aspects, including non-scientific ones. For these reasons, I find the IE method to be different from other problem-based teaching methods.

An Example of IE: The Friend Abroad

A friend of the students in a K-2 class has left Israel with his entire family and now lives in England. He would probably enjoy receiving videotapes and books in Hebrew. The problem: sending a parcel which would include videotapes and books as well as some other goods. Several questions arise from this situation, relating to the problem at hand: Ethical questions (should we send him a package?); Geographical questions (where is England? How far it is from Israel? What language is spoken in England?); Economic questions (how much money would it cost to send a package containing several videotapes, books and some candy? How much money would each of the students need to contribute?); Technological questions (what materials should we use for the package? How would we send the package?) Scientific questions (What is weight? How can we measure the weight of the package? What kind of candy is appropriate to put in the package in regards to melting? What is melting and how does it happen?).

In the above IE example it is reasonable to assume that a K-2 teacher would be familiar with the situation. Teachers have certainly sent parcels at some point in their lives. They are familiar with the connection between the cost of sending a parcel and its weight. They know how to weigh. They are also aware of the things that should be put in a parcel and things that should not. So, with very little help, the teacher may understand the relevant underlying physics principles required for dealing with this IE. The ethical aspect is probably one in which the teacher is an expert and knows what

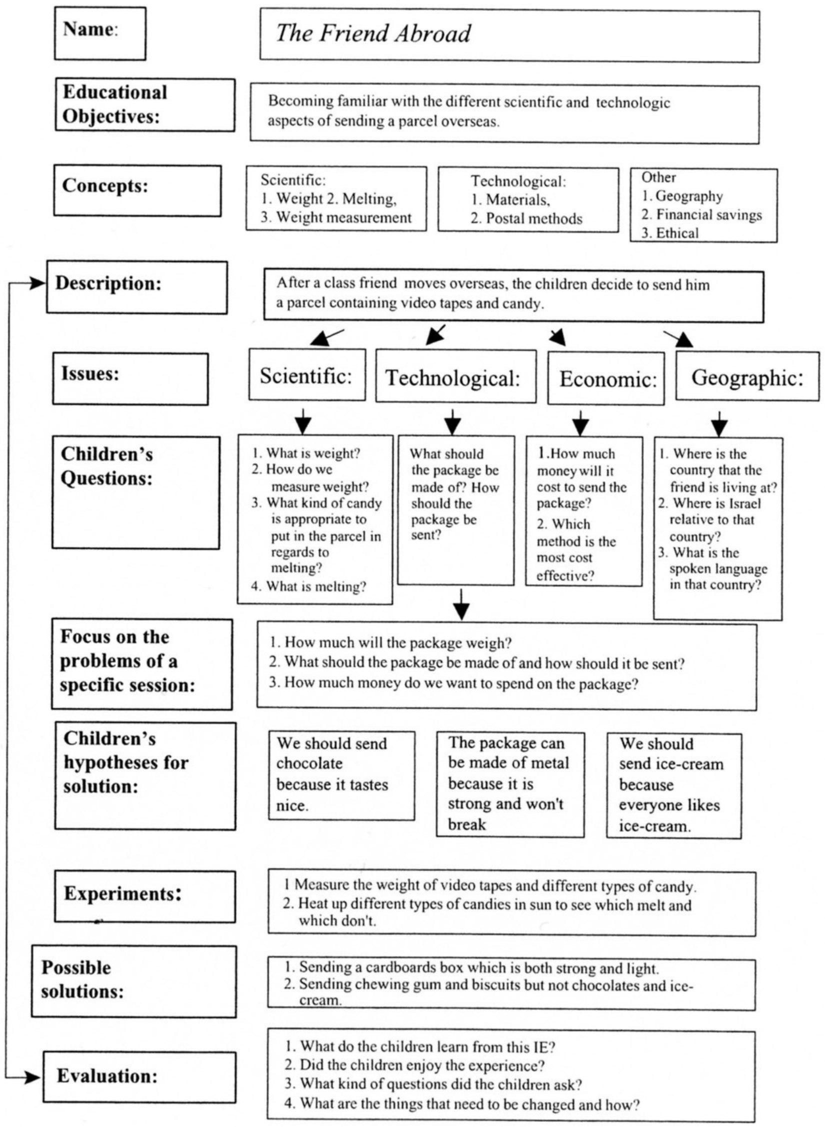

Figure 2. The use of the IE design instrument (IEDI) for the Friend Abroad IE.

and how to teach to his or her children. The mathematical aspect is also relatively simple for the teacher.

As can be seen from the example, unlike the project-based approach, which might demand that teachers deal with problems with which they have minimal knowledge, and therefore might require them to devote much time to the learning of that subject,

the IEs must be familiar to the teachers. Whenever I present the idea of IE, there are always educators who approach me after the class and tell me that they were surprised at how much science could be taught through such simple daily situations which they could implement in their classes. Indeed, the IE method can be seen analogically as a flashlight which sheds its light on the scientific issues of problems which teachers have already experienced. To help teachers design their own IE the Design Inquiry Event Instrument (DIEI) was developed as shown in Figure 2. DIEI guides the teacher through the necessary stages of designing IE: naming the IE, detailing its objectives, indicating the main concepts, describing the IE story, raising different IE questions, focusing on difficulties, hypothesizing children's possible answers, suggesting relevant scientific experiments, and offering possible solutions for the problems. Figure 2 is a DIEI for the example that was provided in this section.

PART B[1]: INQUIRY-EVENTS AS A TOOL FOR CHANGING SCIENCE TEACHING EFFICACY BELIEF OF KINDERGARTEN AND ELEMENTARY SCHOOL TEACHERS

Elementary School Teachers' Beliefs and Attitudes toward Science Teaching

Although there are few previous studies specifically addressing the question of anti-science attitudes among elementary school teachers, literature suggests that such attitudes do exist (Gustafson and Rowell, 1995; McDuffie, 2001; Parker and Spink, 1997; Skamp and Mueller, 2001; Stepans and McCormack, 1985; Tosun, 2000; Yates and Chandler, 2001). Like most people (Nemecek and Yam, 1997; Park, 2000), it may also be that many teachers regard science merely as a school subject detached from everyday life. Indeed, elementary school teachers are not known to be science oriented (Cobern and Loving, 2002).

Motives and interests are influenced by our attitudes (Miller *et al.*, 1961). Teachers who feel this detachment from science would, at best, regard teaching it as simply fulfilling an obligation (Cobern and Loving, 2002). Given the tremendous impact they have on children, and on the success or failure of any curriculum, teachers' knowledge of science and their attitudes toward it, should be of significant concern. A more fundamental factor, often discarded in existing literature, which may explain elementary school teachers' behavior toward science teaching, is their belief system.

"Belief" is "information that a person accepts to be true" (Koballa and Crawley, 1985, p. 223), differing from "attitude" which is "a feeling, either for something or against it" (Miller *et al.*, 1961). Attitudes stem from beliefs, and both are related to behavior (Riggs and Enochs, 1990). The following example, taken from Koballa and Crawley (1985) will clarify this point. An elementary school teacher judges his/her

[1] This part is based on a paper that was published in *The Journal of Science Education and Technology* 12(4): 495–502.

teaching ability to be lacking in science (belief), consequently developing a dislike for science teaching (attitude). The result is a teacher who avoids teaching science if possible (behavior). Teachers' beliefs can be divided into outcome expectancy beliefs, and self-efficacy beliefs. "Teachers who believe learning can be influenced by effective teaching (outcome expectancy beliefs) and who also have confidence in their own teaching abilities (self efficacy beliefs) are more persistent, provide a greater academic focus in the classroom, and exhibit different types of feedback, than teachers who have lower expectations concerning their ability to influence student learning" (Gibson and Dembo, 1984, p. 570).

OBJECTIVES

The goals of this research were:

1. To examine changes in the educators' science teaching efficacy beliefs and science teaching outcome expectancies, as a result of a four-day workshop based on Inquiry-Events;
2. To examine teachers' attitudes, resulting from a four-day workshop, toward the Inquiry Event method as a tool of teaching science in kindergarten and elementary school.

METHOD

In the spring of 1997 and in the spring of 2001, two four-day-workshops on science for kindergarten and elementary school teachers were conducted[2]. The first group (spring, 1997), consisted of 30 participants, while the second group (spring, 2001), consisted of 28 participants. Among the participants were experienced K-2 teachers, curriculum developers, and teaching-trainers from 20 different developing countries in Asia, Africa, Eastern Europe and the Caribbean Islands. The IE related workshops each lasted four days, for about 9 hours each day. The workshops included an opening lecture explaining the meaning of IE's, observing IE activities in a kindergarten, and participants designing IE's in small groups (3–5 participants) using the Design Inquiry Event Instrument (DIEI), whose framework is shown in Fig. 2. The IE's designed in each group were then presented to the entire class, and were followed by a discussion.

The scientific questions of the IE's that were presented to workshop participants related to scientific concepts such as weight, temperature and light, and included demonstrations and active experimentation.

The Science Teaching Efficacy Beliefs Instrument (STEBI) was chosen to be used in the pre-test and post-test, since it was found to be a valid and reliable tool for investigating elementary school teachers' beliefs toward science teaching and learning

[2] The workshop was the first part of a 20 day course on "Science Education in Early Childhood" organized by the Golda Meir Mount Carmel International Center, in the framework of MASHAV, The Center for International Cooperation, Ministry of Foreign Affairs, Israel.

(Riggs and Enochs, 1990). The statements in the STEBI questionnaire are assembled into two distinct item categories:

1. Personal belief toward science teaching efficacy- for instance: "I am continually finding better ways to teach science"; "I do not know what to do to encourage students to take an interest in science."
2. Outcome expectancy belief of science teaching- for instance: "When a student does better in science than usual, it is often because the teacher exerted some extra effort"; "Even teachers with good science teaching abilities cannot help some kids learn science."

To analyze the influence of the IE method on designing science activities, questions were added to the STEBI questionnaire. In the pretest, the participants were asked to describe the most stimulating science activity they had conducted in their class prior to the workshop, and in the post-test they were asked to design a similar activity, that may contribute to the development of children's cognitive skills. They were also asked to give their opinion in the post-test, regarding the IE method and its potential as a tool for science teaching.

RESULTS

Beliefs toward Science Teaching

Pre-test and post-test means and standard deviations for each of the two dimensions of science teaching efficacy belief, are shown in Table 1, which indicates that the means increased in both categories. The results of the t-paired sample test shown in Table 2, indicated that the changes in both dimensions of the participants' teaching efficacy beliefs were statistically significant.

TABLE 1. Means and Standard Deviations (SD), for the two Dimensions of Science Teaching Efficacy Belief

	Pre-test		**Post-test**	
	Mean	**SD**	**Mean**	**SD**
Personal science teaching efficacy belief	3.45	0.38	3.94	0.37
Science teaching outcome expectancy	3.95	0.13	4.45	0.19

TABLE 2. Results of t-paired Sample Tests for the two Dimensions of Science Teaching Efficacy Belief

	t	***df***	***p***
Personal science teaching efficacy belief	2.23	57	<0.05*
Science teaching outcome expectancy	2.15	57	<0.05*

Teachers' Beliefs Regarding the IE Method

In order to examine teachers' beliefs regarding the IE method as a tool for science teaching in K-2, the participants were asked to express their opinions in the post-test questionnaire. All of the participants felt that the IE method is an efficient tool for teaching science, especially in early childhood. The reasons they gave were divided into the following categories: (1) IE presents science to a child as an integral part of life; (2) IE helps to teach science effectively; (3) IE contributes to the development of the child's cognitive skills; and (4) IE helps children develop social skills. Table 3 demonstrates some of the participants' statements, according to the four categories.

Changes in Perspectives regarding the Most Stimulating Scientific Activity

Changes in teachers' responses in describing the most effective science activities in kindergarten and elementary school in pretest and post-test were compared. It was

TABLE 3. Categories of Participants' Beliefs about the IE Teaching Method

Benefits of IE Method Mentioned by Participants	**Samples of Teacher's Answers**
IE presents science as an integral part of life to a child	"It helps children to see many realms of life as a whole." "It helps integrate science with other subjects, and does not leave science as an isolated issue in children's minds." "It relates science to real life situations."
IE helps teach science effectively	"It develops teacher's creativity, by releasing them from conventional teaching styles . . ." "It facilitates hands-on experiments." "It enables the teachers to plan their objectives (be it general or specific)."
IE contributes to the child's cognitive development	"It helps children to organize their thinking processes and arrive at logical solutions." "It helps accepting and remembering ideas." "It helps a child to solve practical problems." "It helps children to develop cognitive skills, because they find solutions from different alternatives on their own." "It stimulates the children's thinking, rather than only giving information."
IE helps children develop social skills	"It helps develop communication skills." "It gives the children an opportunity to work in groups and develop team work skills."

found that in the pretest, 10 of the 58 participants (17%) gave no answer at all. Thirty-one participants (53%) mentioned science activities entailing only observation and description skills. Thirteen participants (22%) depicted activities involving the use of categorization skills, and only four participants (7%) described activities requiring problem solving skills. In the post-test, eight participants (14%) described activities involving only observation and description skills, 28 participants described IE's (48%) and 22 participants (37%) depicted activities requiring problem solving skills which are not IE. The results indicate a notable increase in the design of science activities requiring problem-solving skills.

IE's Designed by Participants

One of the tasks given to the workshop participants was to design their own IE's. Some examples were: 1) Going to the Beach, 2) Owning an Aquarium, 3) Raising a pet animal, and 4) Visitors in the Kindergarten. The IE helped the participants to come up with scientific and technological questions requiring the use of problem solving skills. The participants indicated that, although raising a pet animal in kindergarten is a familiar experience to most of them, they were not aware of its potential to develop the child's problem solving skills. Prior to the workshop, they regarded this activity only in the context of developing the child's observation and verbal skills.

SUMMARY

It was found that IE is a highly efficient teaching method in our search for a more effective approach to improve science teaching efficacy beliefs of kindergarten and elementary school teachers. This investigation also indicates that significant changes in teachers' belief systems toward science teaching can be produced in a short period of time. These results corroborate with those of Spooner and Simpson (1979), who found that a significant change in teachers' attitudes may be achieved within a few daily sessions.

This study also indicates that during the workshop, teachers acquired positive attitudes regarding IEs. An analysis of teachers' beliefs toward IE's signified the potential of this tool to promote teaching science in kindergarten and elementary school and to contribute to the development of children's cognitive skills. The participants predominantly mentioned that the greatest potential of IE's is its ability to introduce science to a child as an integral part of life, and not as an isolated problem. This is consistent with Dewey's approach (Dewey, 1916) to the teaching process, which requires taking the psychological needs of a child into consideration, rather than introducing science as a logical coherent subject. Dewey's approach was further discussed in chapter B. According to this approach, teaching processes should be based on the child's mundane experiences, practical day-to-day problems and familiar intelligible issues, which are of vital interest to the child. In my opinion, IE may be an appropriate tool to organize the teaching processes in the necessary "psychological order."

In addition, it was found that the teachers' point of view regarding science activities had been changed as a result of the IE method. Prior to the exercise, the most stimulating science activities described by participants required mainly the use of observation and verbal skills. At the end of the workshop, most participants agreed that the most stimulating science activities involved problem solving skills. Interestingly, some participants denoted that using the IE method influenced their own thinking processes: in the words of one of the participants: "it has made me a better thinker." However, most participants noted that the IE "calls for a lot of hard work," and its design requires more practice as well as additional training courses.

This study is preliminary in its nature. Other studies need to be designed, to replicate this treatment with a larger number of subjects from different educational backgrounds and realms, as well as to attempt to answer other questions that did not arise in this research. The next part of this chapter discusses implementing IE's in kindergartens.

PART C[3]: BRINGING INQUIRY EVENTS TO THE KINDERGARTEN: INQUIRING INQUIRY EVENTS IN THE FIELD

In part A of this chapter the general idea of IE and the rationale for using it were presented. Part B described the impact of IE on educators' science teaching efficacy beliefs as a result of a four-day workshop based on Inquiry-Events. This part continues examining the IE approach. The study presented here evaluated the IE teaching method in two kindergartens which made use of the *inquiry events* method. Specifically, the following questions were addressed:

- What was the kindergarten teacher's point of view toward science teaching in kindergartens before learning about IE?
- What was the kindergarten teacher's point of view toward implementing the *inquiry event* method?
- Is, and how is the program suitable for the kindergarten teacher's needs?
- What teaching methods were employed by the teachers?
- Were the IEs suitable for children?

METHOD

Participants

The study included two kindergarten teachers and the children in their kindergartens. Both kindergartens were around the city of Haifa: a kibbutz kindergarten where, at the time of the study, 30 children attended from ages 4 and 8 months to 6 and 5 months, and an urban kindergarten with 26 children from the ages of 5 and 5 months to 6

[3] This part is based on work which Liat Bloch carried out as part of her master thesis and I thank her for allowing me to use the name of her thesis as the name of the chapter.

and 8 months. The kindergarten teachers were certified kindergarten teachers. The teacher from the urban kindergarten had 10 years experience, whereas the kibbutz teacher had 12 years experience.

Description of the Kindergartens

The urban kindergarten is situated in the heart of a noticeably poor urban neighborhood. The houses are four stories high, there is no greenery surrounding them and there are no gardens. The population appears to consist primarily of lower class immigrants coming from all types of different places. The kindergarten itself is an old structure which, at the time of the study was scheduled to be demolished and rebuilt in a more successful manner. The structure of the shops in the vicinity of the kindergarten displays the general impression that the area serves the surrounding community. The shops seemed active but very shabby. The picture inside the kindergarten and in its playground contrasts the surroundings that were just described. The kindergarten is small and packed but is full of materials and has an active feeling in it. The walls are decorated and the children look busy to the random visitor. There is a feeling of everlasting nurturing and investment in everything. The kindergarten playground enjoys a natural grove, full of scraps and different fixtures. It also spreads out on a vast amount of land. The pre-school teacher described the playground as one that suffers from vandalism from bored youths of the neighborhood. The kindergarten group of children is described by their teacher as one that comes from a weak background and she feels that the kindergarten fills many voids within them.

The kibbutz kindergarten is fundamentally different in nature. The feeling that welcomes the visitor is one of space. The children's freedom of movement is evident in the huge grass playground. They stop to pick strawberries from the strawberry bush on their way. The structure of the kindergarten is that of a conventional kibbutz kindergarten: The yard is rich with scraps. The area used for activities inside the kindergarten is very large and is divided into different corners. The meeting is not part of the playground, so the children can continue what they were doing while the staff organizes it. This contrasts with the urban kindergarten where there was little space left while class preparations were taking place. Another noticeable difference is the meeting with a broad staff. The kindergarten teacher and nanny are constant figures. However, in all of my visits, there were two additional grownups helping with the work. The kindergarten consisted of children from the kibbutz and in addition, children from the surrounding area like Haifa and surrounding settlements, where parents were interested in having their children brought up in this type of framework. The group of children is considered a strong one by the eyes of the kindergarten teacher: it consists of children that come from a nurturing environment.

This study is not meant as a comparison between the two completely different children populations. Comparing the IE method in two kindergartens with such distinct socioeconomic differences between the groups of children, will help assess the applicability and suitability of this and method in a wider variety of kindergartens.

Procedures

The study included the following stages: (1) Locating willing kindergarten teachers suitable for participation in the study; (2) Obtaining entrance permits to the kindergartens; (3) Preliminary work with the kindergarten teachers: specifically the program, finding a suitable IE for them, and constructing a work schedule where one or two weekly sessions could be integrated with their current schedule; (4) Conducting the program in the kindergartens: both having the teachers learn the program and conduct the sessions; (5) Gathering the data: teaching the teachers, videotaping the lessons, documenting the conversations with the kindergarten teachers during visits to the kindergartens, and conducting interviews with the teachers; (6) Rewriting or revising material; and (7) Analyzing the data.

The first five stages are field work and were conducted between April and August of 2003. The observations took place during May and June of the same year, on the days in which the sessions took place according to the program. The interviews took place at different dates during the study.

Tools of the Study

The IEs

1. The IE in the kibbutz kindergarten — "A Guest Visits the Kindergarten." The future event that will occur is the visit of a guest to the kindergarten. The problem the children are confronted with is to prepare for the visit. The problem is real in a sense that the children make real preparations and at the end of the process the guest will arrive. The other conditions are also fulfilled as this is a multi-aspect problem, familiar, simple and well known to the kindergarten teacher. Secondary problems extracted from the main problem include: drink preparation and creating napkin dispensers. These problems are structured to teach scientific and non-scientific topics, for example: Drink preparation is used to teach the topic of liquid concentration. The resulting learning units are organized so that the first is dedicated to presentation of the problem and planning the preparation. The following units deal with the preparations themselves. These units are conducted through group sessions which are then followed by personal experience. The program details realizations that will be implemented in discussions and different activities during the hands-on experience portion, including napkin dispenser construction (3rd unit), which constitutes an opportunity to build a technological artifact. The last unit is the actual hosting and constitutes the conclusive unit of the entire IE.

2. The IE in the urban kindergarten — "Sending a Parcel." This IE is similar to the "friend abroad" IE. Much like in the "Friend Abroad" IE, the Sending a Parcel IE presents a real problem: The children pack the parcel and send it (unit 6) to the children of the "Nitzan" kindergarten, with whom they had contact during the school year. This is an example as to how the original IE, the Friend Abroad, can be changed to fit the real experiences that the teacher and the children had. The IE's problem is presented in the opening unit: We wish to send a package to the kindergarten we visited. Here, the problem is also simple, familiar to the children and the kindergarten teacher, and

solving it is real. The next units deal with choosing the appropriate contents. One of the scientific topics which was pursued in some of the units is the topic of weight. The following routine took place in most of the lessons: First, there was an assembly of all the children. During this stage the kindergarten teacher reviews what has been learned and starts a discussion on the new subjects through use of realizations provided by the program. For example, during a hands-on session of the program, the children experienced using the balance scale they were learning about. During the second lesson they filled plastics cups with a sand-like material or gravel and compared the two using the scale. On other days, different aspects of the program were emphasized, which gave the children a chance to experience them first hand, for example: decorating. Building a technological artifact was presented here as well (during unit 6), where the children built personal scales. The activity stage in the kibbutz kindergarten usually involved children working simultaneously around a number of tables; in the urban kindergarten, activities were conducted the around one table while the children took turns according to the teacher's instructions.

Observations

Observations by one of the researchers (L. B.) took place in both kindergartens for the entire working days that the IEs were executed. Thus, the researcher could obtain more information, especially about the atmosphere in the kindergarten before and after the IE's activities. There were 15 such days. Eight observations were conducted in the kibbutz kindergarten and seven in the urban — one observation for each session. The lessons were also videotaped.

Concluding Session

The last session in each of the kindergartens is a concluding session which is not necessarily required by the program. This session functions as a sort of posttest, which aims at testing the knowledge gain of the learners at the end of the study period. Questions about the studied topics were prepared for this session.

1. *Questions for the Sending a Parcel IE:*
   a) Should I, in your opinion, include tomatoes when sending a parcel? Should I include biscuits? How can I know that the object I chose is suitable for sending in a parcel?
   b) Why is it preferable to pack the parcel in a cardboard box and not a metal one?
   c) Why are there differences between the weight of a stone and cotton wool?
   d) Why is gravel heavier than foamed plastic?
   e) How do we use the scale to measure how much a parcel weighs?
   f) Why is it important to know the weight of the parcel?
2. *Questions for the Guest Visits the Kindergarten IE:*
   a) How many jugs of raspberry juice to be put on the table did you prepare? Why in fact did you use four jugs?

b) What affects the sweetness of the raspberry juice? What makes it sweeter and what makes it less sweet? Why?
c) If I have a glass of raspberry juice which is too sweet for me. What should I do to decrease its sweetness?
d) What is the napkin dispenser made of? Is there a reason for choosing wood for the dispenser? What affects the stability of the wooden dispenser?
e) How would you recommend measuring height when making a personal card?
f) If I wanted to buy a tablecloth, how would I explain to the salesman which tablecloth I want? What is the difference between measuring the height of a child and measuring the table? Why is it different?
g) What happens to a balloon when it is inflated? What happens to the balloon when it is inflated and grows until bursting? Why is a soccer ball harder when it is inflated than when not inflated?
h) What happens to the chocolate when making fondue? Why?

Interviews

Semi-structured interviews were conducted with the kindergarten teachers on the following subjects: (1) The general view of how the kindergarten teacher sees science teaching in kindergartens. (2) The teacher's view concerning the IE method. (3) General impression of the learners during the program.

Field List

Since L. B. stayed in the kindergarten beyond the time during which the program was conveyed, she could have random conversations with the teachers, with the nannies or assistants, as well as the supervisor (on the day she visited) and with the children before and after the sessions. These conversations were documented and used later as additional data.

ANALYSIS

The data can be divided into two main parts: (1) Teachers' views concerning science teaching in kindergartens and the IE method; and (2) teaching processes that took place during the IE lessons. The views were mainly summarized from the interviews and the random conversations conducted with the teachers on the different occasions. The teaching strategies were identified through inductive analysis (Patton, 1990) performed on the observations, which were transcribed verbatim. This includes extracting from the data patterns, themes, and categories of analysis. It is done by the following procedure: The transcriptions are first reread by each of the researchers individually to formulate a tentative understanding (Roth, 1995). The data was then organized, again by each researcher separately, to search for patterns that describe and demonstrate teaching processes and strategies. In subsequent readings, we attempted to confirm the tentative understanding of the phenomena on the tapes. Initial categories of teaching processes were established. Then, as part of the verification methodology (Strauss, 1987), the two researchers repeatedly re-read the

data together. Initial categories created separately were revised as a result of several rounds of discussion. Three final categories were finally established:

1. Strategies advancing scientific knowledge — this category was sub-divided into four sub-categories: (1) Familiarization of new terms by announcing part of the term — this sub-category included statements where the teacher announced part of the new scientific concept and then waited for the children to complete it. (2) Explaining the new term by referring to its verbal meaning — this sub-category included all the statements where the teachers used different forms of the word to clarify its meaning; for example: Concentration, concentrated, concentrate. (3) reinforcing understanding by purposely referring to a wrong possibility — this sub-category included all statements where the teacher purposely presented incorrect uses of scientific terms or explanations, and (4) using analogies to reassure understanding — this sub-category included all of the statements where the teacher made use of analogies to clarify scientific phenomena.
2. Strategies advancing scientific reasoning — This category was divided into the following sub-categories: (1) directing to specific features in observations — this sub-category included statements where the teacher directed the children to search or take note of specific features or properties within the object that they were dealing with; for example: its size, shape or structure; (2) advancing causal thinking and thinking in a multi-constrained environment — this sub-category included statements where the teacher or the pupils drew connections between variables, or took different constraints into consideration; (3) encouraging the drawing of generalizations — here we included the statements where the teacher encouraged the drawing of generalizations, or where the children made such generalizations themselves.
3. Strategies used to recruit children's attention and advance coherent understanding of the IE — This category was divided into the following two sub-categories: (1) brief reminder — this sub-category included all the statements where the teacher reminded the children of the main problem in order to pursue the IE activities; (2) encouraging meta-cognition — this sub-category included all the statements where the teacher encouraged the students to think on their thinking by asking question along the line of: How did we come to that conclusion? What did we do? How did we come to know?

RESULTS

Views of the Teachers

Teachers' Views concerning the way science is being taught in pre-schools. The interviews and conversations held with the teachers presented a picture showing no organized or compulsory curriculum for science teaching in kindergartens. The urban kindergarten's teacher expressly complained several times in different conversations about the absence of any such program. She did, however, favorably point out a series of five visits to a science center (this will be discussed in the final chapter of the book, dealing with out-of-school learning).

From what both teachers said, it appeared that the following is their interpretation to what they are expected to do in regards to science: To deal with science when the appropriate opportunities present themselves, by their own choosing, as a part of the annual program dealing with different topics, and to teach science using their own judgment. This concurs with the view expressed by the kibbutz kindergarten teacher who stated that: "Science teaching (is done) . . . through space . . . through the legs, through field trips," and in another occasion, "science integrates in everything even without naming it." As an example, she pointed out that the pursuit of science takes place through the learning of holidays, for example: The Jewish holiday of Lag Baomer. Lag Baomer is a traditional holiday in which groups of youths collect vast amounts of wood, which they later use to create a bonfire on the night of the holiday. The teacher pointed out that the flame and fire used in this holiday can be used as an opportunity to pursue science, so that there may be an integration of science in many daily opportunities. However, it was clear from the interview that for her, using terms such as "burning" and "fire," and talking about the burned woods, is a kind of such an implementation of science teaching. I do not see this as a kind of scientific activity that fully exploits the scientific aspects of the situation due to the lack of experimentation, concluding, creation of any hypothesis etc. In other words, there is partial dealing with scientific concepts; however, there is a lack of scientific thinking.

Both kindergarten teachers mentioned that a few years earlier they received a science kit for their kindergarten which contained some equipment such as lenses, mirrors, distance measuring tools, etc. They also both participated in an in-service course which aimed at preparing them for using the kit. However, they both complained about the equipment not being durable enough to withstand the conditions of the kindergarten which did in fact not survive. The urban kindergarten teacher claimed that the very perception of a science corner in the kindergarten isolates the incidents and distances them from the daily activities, which she saw as an additional shortcoming in integrating the kit into the kindergarten. This means that the teacher sees a gap between the way which she has been directed to teach science by the ministry of education, and the kit which was received from the same office. When asked as to the written material used to guide her and supply her with activities, she answered that written material does indeed exist and includes various tasks, but is not very lucid and is rarely used in kindergarten activities. This complaint was shared by the other teacher. In summary, the teachers of both kindergartens criticized the kit immensely. In addition, much criticism was voiced toward the nature of the instruction that teachers receive in scientific topics. In the urban kindergarten, there was mention of the varying policies of the ministry of education toward the existence or non-existence of instruction during a certain year. In the kibbutz kindergarten, the teacher had troubles fingering out this instruction in any way.

Teachers' Views Concerning the IE Method. In both kindergartens we saw a positive attitude toward the IE. This attitude was expressed in two ways: practical and verbal. The practical expression of a positive attitude toward the program was evident in the change of willingness of the urban kindergarten to receive this activity and to free the necessary time for it. With the beginning of cooperation between L. B. and the preschool teacher, the teachers seemed to be a bit suspicious and mostly hesitant toward the compatibility of the learning material to the group of pupils in her kindergarten. She found difficulty in freeing time for the activities and it seemed that she preferred different alternatives. As the IE program progressed, her willingness to free the required time grew. In the conversations L. B. had with the kindergarten teacher while coordinating the continuation schedule by phone or during the visit at the kindergarten, the teacher expressed a positive attitude toward IE which, in my opinion is reason for the supposed change. The kibbutz kindergarten teacher showed willingness to participate in the program from the start. It was apparent that her satisfaction in the progress of the conveyance of the program led to the continuation of this willingness.

The urban kindergarten teacher commended significant aspects: the program's spiral nature allows broadening, deepening and repeating of matter studied earlier: the way that the matter is structured — first creating a basis of motivation which can then be built on: a goal exists, however the path leading to it is no less important and many new things are learned along it. Another advantage that was especially noticeable with the urban kindergarten population is that the things there are simple and familiar in principle. The kindergarten teacher worded it as: "We didn't bring intimidating instruments." For the kibbutz kindergarten teacher the fact that the program provided tangible products like napkin dispensers, which the children could take home, or a file where their "personal cards" could be filed, were fundamental advantages. She repeatedly mentioned the possibility of the children taking the napkin dispensers they had made, as a [Shavuot] holiday gift. She seemed to be pleased with this option. After the first session she filed the "personal card," while mentioning the advantage of having a file like that, which can demonstrate the accomplishments in the kindergarten.

An obvious drawback of the program is holding discussions in large groups. The supervisor mentioned this drawback after watching a session in the kibbutz kindergarten. The urban kindergarten teacher also suggested that dividing the group into 2 groups of 13 children would also be an improvement. The kibbutz kindergarten teacher said that work in small groups, as suggested by the supervisor, demands the wearying and tiring matter of repeating the same activities many times. In this matter, she said in her interview: "I think that even in a small group, the remarkable students will stand out and the quiet ones will be quiet." She did not agree that the large group should be divided. This is possible, according to her, particularly because the group discussions are followed by small group hands-on activities where all of the children can express themselves. She also mentioned, with satisfaction, the contribution of the realizations that the activities invite: "children at kindergarten age need something real."

TEACHING STRATEGIES USED BY THE TEACHERS

The following three categories were identified in regards to the teachers' teaching strategies: strategies advancing scientific knowledge, strategies advancing scientific reasoning, and strategies used to recruit children's attention and advance coherent understanding of IE. Each of these categories was divided into several sub-categories which are detailed here.

Strategies Advancing Scientific Knowledge

Scientific concepts are a fundamental part of the suggested program. They are learned in association with the IE. Specifically, they are learned within its scientific aspect. The level of difficulty is supposed to be suitable for kindergarten children. Different central scientific concepts were discussed in the two IEs: in the "sending a parcel," the scientific concepts included *weight* and *material properties — water resistance, hardness, resistance to tear, stability etc.*, and from the "guest visits the kindergarten," *solids – liquids, concentration,* and *stability* were included. These were not the only concepts. For instance, the concept of melting came up on both inquiry events.

The strategies used to teach the scientific knowledge were divided into the following sub-categories: (1) familiarization of new terms by announcing part of the term, (2) explaining the new term by referring to its verbal meaning, (3) reinforcing understanding by purposely referring to a wrong possibility, and (4) using analogies to reinforce understanding.

Familiarization of New Terms by Announcing Part of the Term. A typical strategy used by both teachers was to say part of a term and let the children complete it. Learning to pronounce and use the term is a large part of understanding it.

. . .

5. Teacher	How do we make raspberry juice?
6. Children (together):	With this pink thing.
7. Teacher	So what is it called?
8. Almog	(Trying to remember).
9. Teacher	Concen . . . . . .
10. Almog	Concentration.
11. Children (shouting together):	It's heavy, it's similar to black.
12. Teacher	What's this? (presents the bottle of concentrate)
13. Children	Concentrate

Explaining the New Term by Referring to its Verbal Meaning. The following paragraph is a continuation of the previous one:

14. Teacher	If I drink this (the concentrated liquid) what will I feel?
15. Teacher	Why will I feel such sweetness?
16. Child	Because you didn't add any water.
17. Teacher	Because they took the raspberry juice and concentrated it . . . It's very concentrated and that's why it's so sweet. Do you think it'll be tasty for me?

The teacher (lines 5 to 7) determines that the children are not quite familiar with the term *concentration* and mediates toward familiarity with it by adding part of the term (line 9). After one child completes the term, the teacher goes on to check whether the other children can now use the term, and by pointing to the bottle, i.e. use of a materialization (line 12), she makes sure that the children are familiar with the term and know how to use it (line 13). With the children now familiar with the term, she moves on to mediate their real understanding of the term. She doesn't define it, but rather goes back to the taste of the concentrated liquid (line 14). The children can now imagine its taste and connect that to the concept of concentration, as indeed one of the children explained that no water was added to the concentrated liquid, and hence it is sweet (line 16). The teacher continues and explains why the liquid is sweet by using the new term in different grammatical forms: as a verb and as an adjective (line 17).

Reinforcing Understanding by Referring to a Wrong Possibility Purposely. Purposely referring to an incorrect possibility was a common strategy used by both teachers. Session 6 of the "sending the parcel" IE takes place after the children come back from visiting the post office. Discussion of the balance scales is held without the scales themselves (after using the scales in the previous sessions). Measurement of the weights with the scales is not easy for the children. They need to understand:

a) The purpose of the weights.
b) The significance of the need to balance the two sides for measurement to take place.

Here is a segment from the discussion:

1. Teacher	How many holders does the scale have?
2. Children	Two

At this point, the questions were familiar, presenting the topic the teacher wanted to pursue. It is worthwhile to realize that she could do so by mentioning that the scale has two holders and then continue to what she wanted to discuss. However, she preferred to use questions, presumably because in such a manner, the children who feel they know, might be more motivated and willing for the next challenge.

. . .

7. Teacher	True, we check using balance scales with two holders, one with
8.	what we want to weigh, right? We put weights on the second
9.	holder and . . . when will the scale tell us the weight? (No response from the children and a silence is heard for a few seconds).
10. Teacher	If I put the parcel on one holder and I put a weight which
11.	doesn't manage to bring down the parcel on the other holder, is
12.	that the weight of the parcel? (The intention is to the weight of
13.	the weights)
14. Child	Yes (quiet around him)
15. Teacher	That's it? That's the weight of our parcel?
16. Hen	It means that the parcel is heavier.

Line 7 presents a difficult challenge for the kids. The teacher, who realizes that the children are not responding, goes on to clarify her question. She provides a wrong assumption — lines 10–12, which results in one wrong answer — line 14. This wrong answer does not get an active response. Rather the teacher waits for a few seconds (there was a silence for few seconds). Then the teacher repeats her question implying that they needed to think further: that the previous direction was not the one she expected. She elicits a correct conclusion from one of the children (line 16). The teacher continues:

17. Teacher It means that the parcel is heavier. When did we reach that
18. conclusion? When did we get the result of the weight of the
19. parcel? How did we reach that result? When one holder is up
20. and the other is down?
21. Children (enthusiastically) When they are both the same.
22. Teacher When we reach a balance. When we kept adding until they
23. were balanced.
24. Teacher Yes, that's how we weigh with a scale

In line 17 the teacher repeats the correct answer. She now moves on to her original question in lines 17–19 in different forms. This is done to make the point clear. In lines 19–20 she again uses the wrong possibilty method. Her response invites the children to reject her proposal and look for another one. In line 21 few children reach the right conclusion and the teacher reinforces their answer.

It must be noted that this discussion took place without any real exhibits. To clarify the weighing process without the presence of the scales, the teacher mediated through *question asking, suggesting incorrect answers, reinforcing correct answers* and repeating them.

Using Analogies to Reinforce Understanding. In the summarizing session (observation 6) of the sending a parcel IE the teacher checked whether the children understood that heavier objects contain less air than lighter ones:

1. Teacher What materials did we check with the scale, which are similar to crisps, that we took apart and saw that it had air?
2. Christina Foamed plastic
3. Teacher . . . and what materials are more similar to gumdrops?
4. Child Gravel and also nails.

In this example the teacher seems to make use of analogies. She asks the children to suggest materials that are similar to crisps (a snack whose structure resembles foamed plastic) and others that are similar to gumdrops (which have more similarity to a stone).

Strategies Advancing Scientific Reasoning

Scientific reasoning is defined here as the skills which enable one to observe, hypothesize, use appropriate apparatus, measure, interpret data, and draw generalizations. Teaching strategies connected with these skills were identified: directing to specific features in observations, advancing causal thinking and thinking in a multi-constraint environment, and encouraging generalizing.

Directing to Specific Features in Observations. Observations have an important role in science and require one developing appropriate skills. For example, children should be able to focus and concentrate on relevant parts of the objects, things, or processes which are relevant to the study at hand. In the following episodes, we describe how the teacher directs the children to conduct observations. In the sending a parcel IE program, after the children learn about the weight differences between the

different materials that were tested, a question about the reasons for these differences is asked. To do this, the teacher brings a small stone and some foamed plastic. The teacher asks that they pass these around themselves and says:

5. Teacher Look, it's bigger than the stone. How can that be? (referring to the weight of the piece of foamed plastic)

The children are not explicitly asked as to the reasons but are *directed toward raising hypotheses*, based on the observation, which would explain the foamed plastic being bigger yet lighter.

6. Hen I know, the size doesn't matter. How light it is is what counts.
7. Matan If you step on a stone it doesn't break. It's easier to take apart.
8. Hen Because foamed plastic is weak and stones aren't weak.
9. Teacher So what is it?
10. Hen It's strong.

It is important to mention that the teacher does not respond to answers that she was not expecting. She asks to continue passing the stone and foamed plastic around and asks again:

11. Teacher Why do you think the stone is heavier?

And some additional hypotheses follow here:

12. Ariel It's weaker.
13. Matan It's a kind of metal.
14. Child They're both light . . . they're just hard to break.

It appears that at this stage the children did not go in the direction that the teachers desired at all. They are focused on the idea that the foamed plastic is weak, probably because they feel that they can easily break it, as opposed to the stone which requires a much greater force to break. Therefore, she needs to clarify her question by another reference to the main topic:

15. Teacher But I purposely wanted to give you a small piece. You can still notice that the small stone is heavier, even with these tiny pieces.

And in response the pupils make additional hypotheses:

16. Child Size is not important.
17. Hen Weight is what gives us the strength.
18. Christina When its material is strong.
19. Child A stone is a stone.

As can be seen from the previous paragraph, the teacher still did not get the responses she was expecting. Now she focuses her questions and directs them to "feel" what makes the foamed plastic lighter than the stone. This is still hard for the children.

20. Teacher What does foamed plastic have that makes it lighter? Do you feel what it has that makes it lighter?

She then continues in the same direction while raising hypotheses:

21. Hen You can crumble it
22. Teacher Look, do you see the holes? What's inside?
23. Hen What's inside?
24. Teacher If we have a material that has holes inside, what does that mean?
25. Child Sponge.

26. Teacher What do holes have inside of them?
27. Child Nothing
28. Hen Air
29. Teacher Eh . . . Foamed plastic has lots of air in it, so now do you understand why it is lighter than the stone?
30. Child Because it has air in it

After revising her question (line 20) she still did not get the answers she was expecting (line 21). Only now does she directly ask the children to look at the holes (line 22). Again, it is important to note that she does not actively respond to answers that are wrong from her perspective, and after one child answered that there is nothing in the holes the room is filled with silence. This strategy was typically used by both teachers on different occasions. The children, who probably understand that silence means that they should think more, indeed suggest the answer that the teacher was looking for (line 28) and which she reinforced (line 29).

Here is another example on the same topic, but on a different occasion:

During the revision that took place in the fourth session, one of the children suggested sending crisps. The teacher shows enthusiasm toward this idea and asks the assistant to bring a packet of crisps, with which they then conduct the observation:

7. Teacher Shula is passing the crisps. You must all take one crisp, but before you eat it, you must check to see if there are air bubbles.
8. Children There are. There are.
9. Teacher So what is there?
10. Children Holes.

In this example the teacher *shows flexibility, accepting one of the children's ideas and pursuing it further*. In this case the teacher directs the children to look for the bubbles in their observation.

Advancing Causal Thinking and Thinking in a Multi-Constraint Environment. Research, in essence, is based on finding relationships between variables. As can be seen in the previous examples, an effort was made to find a connection between the weight of an object and its structure — does it have holes? We found that the IE program provided the teacher with many situations where she could advance the children's skills to find relationships between variables. Here are some illustrative examples:

Teacher Should we send chocolate?
Matan No
Child Because it will melt . . .

And afterwards:

Teacher When does the chocolate melt? When what happens?
Matan Melts faster when it is heated
Child From the heat

In this example, the children were asked to connect between heat and melting and to realize that because of this, a chocolate should not be included in the objects that will be sent in the parcel. In addition, the program invited opportunities where the children needed to take into account different considerations, and realize that although a solution may fit to fill one constraint it may fail to fit another. They were also exposed to the need for compromise. For example:

1. Teacher What would it be better to send a parcel in, what did we decide?
2. Hen Cardboard
3. Teacher Why did we decide on cardboard?
4. David Because it has space for crisps
5. Teacher Right, what about the weight?
6. David You can also put it in metal
7. Teacher Let's say that it would go in (the crisps), should we take a metal case?
8. Child No, because it's heavier
9. Teacher What would happen if it was heavier?
10. Child We'd pay more money

Simple as it may seem, it is not so simple for the children. The children need to understand that both metal and cardboard boxes are good materials for a parcel container. In both there is space for the crisps. They must understand that, while it is possible to use a metal container to move the goods, and it may even be preferable by some aspects, like withstanding higher loads or resistance to tearing, they must still take weight and cost into consideration. If the parcel is heavier they will need to pay more, as they were told in the post office, when the children visited it.

Moreover, as we shall see, the IE invited the teacher, on occasion to search for reasons as to the connections between and among variables. It is important to have skills in finding connections between variables through observation and measurements. This skill may even be considered a great achievement in developing the child's scientific thinking at this early stage of life. With this in mind, in many cases the program invited the teacher to encourage the children to give explanations on the nature of these connections. Finding a connection between variables does not necessarily indicate understanding the nature of the connection. For example, why is a material that has many holes lighter? In another example, after reaching an agreement that chocolate is included in the group of items unsuitable for sending in a parcel, the teacher sees fit to elaborate on the cause of melting. She conducts an experiment where the heating mechanism is a candle and the margarine in the pot hardly changes in the few minutes that the heating takes place. The teacher draws the children's attention to the "problem":

Teacher Now look at what happens here. It happens very slowly. Why? Does anyone have any idea?

In response, the pupils raise ideas about the causes. In this case the cause was the fact that there was only one candle. Pursuit of the cause was the teacher's idea and was an elaboration on the suggested IE frame.

Encouraging Drawing of Generalizations. One important thing in science is drawing generalizations. After all, we do not want the child to refer the findings of an experiment only to that specific experiment, but rather to be able to understand that the findings obtained in one experiment may be generalized. The IE program enabled many such situations. For instance, after categorizing flowers as unsuitable for sending in a parcel because they wither, a generalization is made about all plants. The following are another two detailed examples of this issue:

Example 1

After concluding that a lighter object has holes which contain air, the teacher directs for generalization —

1. Teacher	What can we conclude from our observation?
2. Avichai	Whatever has no air is harder
3. Teacher	And what about its weight?
4. Avichai	It is heavier
5. Teacher	Avichai has reached a very important conclusion, that whatever has air inside is heavier?
6. Avichai	No, lighter

Here one can see the use of a sort of scientific language by the teacher (line 1) — conclusion based on evidence, i.e. the observations. It is interesting to note that one of the children was immediately able to formulate a generalization (line 2), although not the one the teacher desired. However, after directing the children (line 3), the same child revised his answer (line 4). Now, the conclusion does not refer to a specific object, but is rather a kind of principle — the children have reached a generalization. To confirm that the children did indeed understand the principle, she uses a known technique discussed previously — providing a wrong possibility (line 5).

Example 2

This example is from the activity where the children built a wooden napkin dispenser. Its base could be wide or narrow. At the request of the teacher that the napkin dispenser be stable, one of the children suggested the wider base option. The teacher refers to the child's suggestion:

Teacher	Raz used a wide base. Who has any conclusions from what Raz is doing?

This was hard for the children and they didn't respond. The teacher used a familiar strategy for the kids: she began a sentence and asked them to continue:

Teacher	The conclusion starts from the following sentence, listen to my Sentence: the wider the basis is . . . the wider it is . . .
Raz	The more stable it is.
Teacher	The napkin dispenser is more stable.

It is important to mention that this generalization was not completely absorbed by the children. In another opportunity the teacher repeats the same idea and continues a sentence:

Teacher	The wider the napkin would be, it would be . . .
Child	Taller.

Or in the concluding meeting when the second researcher (H.E) asked the children about the differences between the two possibilities of building the napkin dispenser with a wide or a narrow basis, no one mentioned its stability, even though they did provide good answers:

Researcher	How is it better to build the napkin dispenser, like this (points to the narrow base) or like this (points to the wide basis)?
Child	A wider is better.
Researcher	Why?
Child	Because one can put more napkins.
Raz	In here (points to the suspender with the narrow basis) I can't even put my hand inside.

Strategies Used to Recruit Children's Attention and Advancing Coherent Understanding of the IE. One major advantage of the IE is the presence of the IE's main problem which enables the teacher:

a) To quickly recruit the children's attention, and motivate them for the upcoming activity.
b) To create connections among different parts of the IE and thus lead to a coherent understanding of the IE.

Brief Reminder. For example, through a short question, why did we think about the parcel? At the beginning of the second session of the "sending a parcel" IE, the teacher moved quickly to the idea of weight. It seemed very much connected to the parcel IE's problem, and no long introduction was needed to get into the new topic.

In the other IE, the teacher could easily move to the topics of measuring the table for the tablecloth, making the raspberry juice, or melting chocolate or margarine to prepare snacks because of the direct relationship to the main problem of the visitor to the kindergarten. This made the transitions feel very natural.

Encouraging Meta-Cognition. The presence of the IE's main problem helps the teacher to ask questions which force the children to remember the question they were dealing with and the process they used to reach conclusions. For instance, how many jars did we decide to make for when the visitor comes? Why did we decide this? How did we prepare the chocolate fondue? How did we come to know that the chocolate melts when it is heated? Why didn't we choose the metal parcel? How did we come to know that a lighter object has more air? How did we know how much raspberry concentrate to put in the jar? How did we know that the heavier the parcel will be, the more expensive it will be to send it? How did we measure the parcel's weight?

DISCUSSION

The current research examined the effects of the Inquiry Event teaching method. The IE was developed to give the kindergarten teacher a comfortable environment for science teaching. As with many other scientific curricula, the IE is also based on pedagogic approaches such as: inquiry learning, problem based learning and authentic learning. So, one can ask, what is the difference? For me, while there are some similarities between the IE and the other curricula, there is also a significant difference. The IE is built in a way that considers the pre-school teacher's needs first. The teacher's needs are expressed in the following manner: (1) the inquiry events are situations that are familiar in the teacher's everyday life in and out of the kindergarten. (2) The scientific aspect of the inquiry event is only part of the whole event. In addition, it should be noted that the scientific aspect is systematically built-in to the curriculum. The assumption is that if the kindergarten teacher deals with everyday situations, where most of the aspects deal with problems which are familiar, and the scientific aspect has organized guidance, it will be easy and natural for the teacher to acquire the missing scientific knowledge and mediate it efficiently to the kindergarten children. The present study tested this assumption. The findings do indeed verify this assumption. To understand how the IE indeed influenced the science teaching in the two kindergartens in which it was tried, let us first refer to the situation of science teaching in those kindergartens before the IE curriculum was executed.

Our findings reveal a gap between two contradicting lines of evidences. According to one line of evidence, there were little dealings with science prior to the IE program. The two teachers complained about the absence of any structured curriculum, and about the science kit they got a few years earlier as being unsuitable for children. Moreover, from the interviews with the urban teacher, the more meaningful scientific activity were the visits to a science center, outside the walls of the kindergarten, which were not lead by the kindergarten teacher, but rather by the science center's staff. According to the other line of evidence is the picture according to which science teaching is integrated into "everything." So, on one hand it seems that the teachers are not satisfied with the absence of a systematic scientific curriculum and find it difficult to mention specific episodes of science teaching, and on the other hand, it seems that science teaching is done everywhere, anytime, "through our feet, through field trips and all the subjects that we're working on." How then, does the gap between this discontentment and the report, according to which, science is seemly integrated in "everything we do," develop? To bridge this gap we must first understand the central approach, according to which most kindergarten teachers in the country (including those in the current study) have been trained. This approach is the integrated approach, according to which the daily activities should be approached from a variety of different aspects, because even the most banal topic has great educational and research potential. Even though the teachers understand the central idea behind this approach, from the interviews with them regarding the state of science teaching in the kindergarten prior to the study, we feel that implementing this approach is meaningless. Teachers do not understand and do not have the necessary tools for implementing this integrated teaching approach. After all, for kindergarten teachers who do not posses good scientific background it would be hard to "find the science" in the daily situations which they are confronted with. I warn that such amorphous approaches according to which one can teach science "everywhere," "anytime," and with no systematic curriculum, might lead, especially in the case of preschool teachers, to the situation, as was the case in the two kindergartens in our research, of an illusion of science teaching with no real teaching. Surely enough, lack of significant dealings with science often arises when trying to "combine" science with everything (Schoeneberger and Russel, 1986).

The IE was found to be an efficient learning method. The findings show that the IE helped teachers to advance both scientific knowledge and scientific reasoning. As

explained in the first chapter of the book, the term 'science' is used to describe both a body of knowledge, i.e., the variety of scientific concepts as well as the activities that give rise to that knowledge, i.e., observing, asking questions, hypothesizing, using appropriate apparatus, measuring, recording data, interpreting data, and formulating theories or models. Advancing scientific knowledge in kindergarten children means that first they should be familiar with the terms verbally. We found that both teachers, in many cases, familiarized the terms by starting to say part of the term and letting the children complete it. Also they explained the meaning of the term verbally and used different grammatical forms so that the children could internalize the concept. The fact that the concepts were familiar to the teacher made it fairly easy for them to teach the scientific concepts in the same way that they teach language.Thus, they could use analogies to confirm the children's understanding. In advancing scientific reasoning processes, the teacher also encouraged children to draw generalizations. This is indeed a very important result. Being able to draw generalization is considered as a higher order thinking skill (Zohar, 1999). If one purpose of science education stated in the first chapter, is its ability to develop children's cognitive capabilities, this finding shows that the IE does indeed address this issue. Moreover, we found that the IE enabled the two preschool teachers to expose children to real life situations where they needed to consider several conditions at the same time. Sending the parcel in a nylon bag will be cheap because it is light and also because it protects the parcel content from getting wet, but at the same time it is not strong enough and therefore a cardboard box will be better, even though it does not possess two of the nylon bag's characteristics. This demands *multi-consideration thinking*, which also is a type of high-order thinking, that should be nurtured in children.

One interesting result is the existence of the main IE problem. It was found that this helped the teacher present connections between the different parts of the IE. It was as a kind of a powerful background that allowed the teacher to deal with a variety of activities. In this way it was easy for the teacher to recruit the children's attention to new concepts and tasks, as soon as they were convinced of the connection between the new activity and the main IE's problem. In addition, the IE's main problem also served as a kind of glue that enabled the connection of the different activities to a coherent story. My interpretation is that these "stories" made the science activities more relevant, both to the teachers and to the children. This relevancy made science easier for the teachers to teach and for the children to learn. Also, we believe that another advantage was the fact that the IE presented a real problem in a sense that all the activities aimed at achieving a concrete goal. In chapter 3 it was argued that children tend to employ engineering models of inquiry in which they explore the reasons for achieving a desired effect, rather than scientific models. In the same manner it might be that the practical nature of the IE, i.e., that the children act in order to execute some real objective like having the visitor or sending the parcel, is an advantage because it fits the natural way children learn.

In summary, although this study took place in only two kindergartens and consisted of only two inquiry events, it seems to lead in the direction of building a curriculum which considers and emphasizes the teachers' needs and not only those of the children. This may lead to more efficient K-2 science teaching. It is particularly important at the K-2 level which the literature sees as one of the weakest links of science education. There is room, of course, to broaden the IE to wider populations and additional *inquiry events*.