

Background and History of Non-Formal Science Education in Israel

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Clore Garden of Science

Israel has long been aware that its survival depends to a large extent on its ability to anticipate and meet the scientific and technological challenges of the future and that the development of an infrastructure of scientific talent therefore is of national importance. In the early 1960's scientists and educators from the Weizmann Institute of Science, Israel's largest interdisciplinary research body, made this a primary goal, turning their attention to developing new teaching programs and designing better science curricula. In 1964 the first after-school science clubs and summer camps were held at the Weizmann Institute and in the coming years other Israeli institutions of higher education following the lead of the Weizmann Institute began similar extra-curricular science programs for science-oriented youth. Representatives of these institutions, with the support of the Ministry of Education, established the Committee for the Advancement of Science Education in 1968.

The philosophy behind the Clore Garden of Science and its activities today originated many years before the Garden of Science was built. The following is part of an article entitled "Extra-Curricular Science Education" that I wrote for the GIREP Conference on Physics Teaching in 1979. This article was the result of a long process of considering the connection between formal and informal education and then of developing extra-curricular science programs for young people in Israel. The approach taken by the Weizmann Institute of Science is that research scientists are uniquely qualified to serve as instructors and mentors in these programs. It still reflects the philosophy that guides programming decisions.

"It is becoming increasingly clear that even the best of formal education systems can benefit greatly from an extra-curricular education program. There are several reasons for this:

- *Regular school curricula are designed for a large number of pupils. Changing these programs is usually a long and complicated process.*
- *Although the aim of curricula planners is to encourage independent thinking, the formal educational frameworks are not well suited for this purpose. Every subject taught within the classroom and laboratory (if there is one) has already been gone over thoroughly in the textbook; answers have already been provided for most of the questions. Thus, the pupil is not given the opportunity to gain first-hand insight into the scientific process, nor any of the satisfaction to be derived from self-discovery. It may well be that this lack of awareness influences many pupils when they come to consider their future professions.*
- *Schools do not offer students the opportunity to experience the interdisciplinary phenomena of science, and to deal with these phenomena at a level determined by their own motivations and abilities.*
- *Schools normally do not deal successfully with exceptional pupils.*
- *Some pupils who do not do well in school (for reasons such as inability to perform under pressure of examinations, etc.) may flourish within a different framework.*

There are those who claim that some of these problems might be solved by incorporating scientists into the secondary school framework. Experience has shown, however, that although scientists enjoy working with young people, they do not like to do so within the established school system and prefer an independent, informal, extra-curricular framework. Incidentally, extra-curricular science programs require only minimal investment, since existing scientific talent and equipment can be exploited.

An extra-curricular program offers many advantages:

- *It is flexible, and can easily be changed to suit both pupil and teacher.*
- *Direct contact with the scientist gives the pupil new ideas, values and working methods. It teaches him self-criticism, and strengthens his ability to solve unexpected problems arising in the course of work.*
- *The curiosity and motivation of the pupil are manifested right away in his choice of subject and in his approach to it. Active participation in a limited setting permits free expression without strain, and encourages teamwork.*
- *It develops the ability of the youth to convey his thoughts coherently and to accept criticism of his findings, i.e. to develop a sense of intellectual honesty.*
- *Extra-curricular activities provide a framework within which youngsters can experiment. Making errors actually becomes a constructive experience, from which they can learn. They are encouraged to seek further information in libraries or from experts in the field.*

Even when schools are good, extra-curricular activities can play an important role. Of course, in deprived areas short of good teachers and equipment and without the necessary facilities or stimulation in school and at home, the help provided outside the school is of inestimable value.

It has often been shown that scientists become more sensitive to the problems of society in general through their involvement with education. Through the participation of its staff, the scientific institution can make a vital contribution to the society in which it exists.”

The 1980 article then goes on to describe some of the programs the Weizmann Institute’s Youth Activities Section offered young people.

“The Youth Activities Section has pioneered in the establishment of extra-curricular science projects for Israeli youngsters, a program which today includes more than 20 science clubs headquartered on campus, and nearly a dozen clubs that convene at regular intervals elsewhere in the country; five summer science camps located on the Institute’s grounds as well as in development towns far from the major centers of population; an annual Science Fair; a Mathematics Olympiad; a one-to-one tutoring program for underprivileged children; and an innovative Science Experiment Bank designed to implement a new educational concept by servicing science clubs and school laboratories throughout Israel.

Working with maximum flexibility, since it is free of the strictures of a school system, the Youth Activities Section is uniquely able both to carry our educational experiments and to activate projects especially geared to provide talented youngsters with individual attention. It gives them an opportunity to experience interdisciplinary research, and a chance to learn

something at close range of the workings of the day-to-day world of science – all this within the framework of a center of scientific research having a large body of students and staff on whose services the Section can draw.

Keeping up with the latest developments in science is beyond the means of any normal school, and more specifically those of schools in development areas. How then to expose the maximum number of Israeli school children to the rapid changes that take place in modern research? This is one of the most challenging problems in science education. The Youth Activities Section feels that a partial solution to this problem lies in the establishment of a science center, to which children from all over Israel could come to intensive science programs. Next year, the Section will launch a pilot scheme for laboratory work, lectures and demonstrations, and will offer facilities beyond the scope of any normal school, such as expensive materials and sophisticated equipment. Instructors at the center will be drawn from three sources:

- *The teaching potential of the Institute's research staff will be tapped.*
- *Hand-picked specialist high school teachers will be employed on a part-time basis.*
- *Class teachers of the pupils attending the center will themselves participate in the teaching program, and will be required to attend preparatory in-service courses beforehand.*

In the first stage of the project, pupils will attend for one-day periods only: it is planned to establish a center with overnight facilities, which would make it possible even for pupils from more remote areas to visit the Institute for several days of curriculum enrichment. A significant number of Israel's high school pupils could then be accommodated in the course of a year.

The pilot scheme will provide the opportunity to test aspects such as whom to teach, what to teach, and how to teach it. With the cooperation of the Weizmann Institute research staff and local high school principals, we hope to draw up a comprehensive plan for the Center by the end of the year.

It is our belief that this project will add a new dimension to our program, thus extending and enriching the scope of extra-curricular science education available to our children."

Since 1980 there have naturally been many changes. It is important to compare what was then with what is happening today and to consider the development of our original philosophy. All of the institutions of higher education operate extra-curricular science programs and are part of the Committee for the Advancement of Science Education, which obtains funding for the numerous activities from the Ministry of Education. The Weizmann Institute still has the most extensive programs and its Youth Activities Section is now called Young@Science to express its goal of offering science programs to all people – young and "young at heart".

Perach, the one-to-one tutoring project has broken away and become a major, highly successful and very important national program, funded by the Ministry of Education, matching 46,000 underprivileged children in one-to-one tutoring as well as special learning groups with 28,000 university students.

In Young@Science there are over 60 weekly, after-school science clubs with about 700 pupils. Three summer residential programs allow the participants to work in actual research

laboratories and meet like-minded young people from around the country and the world. The pilot scheme launched in 1981 now offers a variety of programs and, thanks to the beautiful, 80-bed Laub Science Youth Village, accommodates students from all over the country for multi-day activities. “Adventures in Science” offers advanced science single or multi-day class programs for over 5000 10th – 12th graders each year. “Science Mornings” is geared to junior high school and has about 10,000 participants a year learning topics such as waves, energy, motion and the senses. The “Arrow” is a three-year project to nurture young scientists starting in 10th grade. Students get an overview of modern science, learn about science research and work on individual science projects under the supervision of a scientist.

These and other programs involve over 20,000 science-oriented youth and about 200 Weizmann scientists, staff and graduate students as instructors.

The intensive programs described above have reached full capacity. In order to increase science literacy to a far wider audience, but through a less intense method, it was decided to build a science center. The Clore Garden of Science, an interactive science museum totally outdoors and therefore very different from other science centers, has been built as a way of attaining this goal. As in the other programs, the Garden of Science takes advantage of Weizmann Institute resources, both staff and equipment in developing exhibits and educational programs. When seen in this light, the Garden of Science is a direct continuation of almost 40 years of extra-curricular science activities at the Weizmann Institute.

When I first conceived the idea of the Garden of Science I saw an innovative way to introduce Israel’s multidimensional public to science. By opening to the public, the Weizmann Institute would be involved in science education for a larger population than previously possible. Also, I took into account that Israel, although a small country already had two science museums and seemingly, the country had neither the resources nor need for another, similar museum. However, given the Weizmann Institute’s desire for true outreach, the suggestion was made to create something totally different, i.e., an outdoor, open-to-the-elements science complex.

Placing the exhibits in an outdoor setting in a beautifully landscaped park on the attractive, award-winning Weizmann Institute campus, distinguishes the Garden of Science from other science museums. Additionally, it allows the Weizmann Institute the ability to invest financial resources in the exhibits themselves rather than in a building. At the same time the visitors see that science can be taught in many locations, not only in the laboratory or classroom nor in a traditional museum edifice. The Garden of Science creates a positive atmosphere in which to appreciate scientific principles, and arouses curiosity as well as a sense of aesthetics.

The Clore Garden of Science was opened in 1999 and has about 70,000 visitors a year. More than half of the visitors are school pupils who come with their classes and the annual Science Festival attracts over 10,000 visitors during two days. There are more than 70 exhibits that are constantly being revised and are added to each year.

The collaboration with Weizmann Institute scientists is very important to the success of the Garden. Scientists performing cutting-edge research often propose and plan Garden exhibits. The Garden of Science is divided into courts, each dedicated to a different field. The outdoor setting of all our courts facilitates the use of natural resources in demonstrations and exhibits allowing the visitors to see, feel and use resources such as sun, wind and water.

The exhibits in the Court of Energy and Environment illustrate the principles of solar energy – an important scientific field at the Weizmann Institute which has one of the most sophisticated solar research facilities in the world. At the Solar Furnace, for instance, a thick piece of wood bursts into flames seconds after a parabolical shaped mirror is turned towards the sun, capturing the heat embedded within its rays.

In the Court of Planetary Sciences water sprinklers create one of the Garden's most exciting exhibits: a rainbow in a cloud. This installation demonstrates that white light is composed of a spectrum of "rainbow" colors, and allows visitors to enjoy the wonder of a full-circle rainbow.

The EcoSphere, our latest addition, is a unique new educational facility. It differs from other areas in the Garden in that it does not demonstrate principles of physics. On the other hand it is a continuation of our philosophy of presenting scientific topics being worked on in the Weizmann Institute. The main concept behind the EcoSphere is to enable the visitor to explore phenomena involved in our environment and about interrelationships within the ecosystem. The EcoSphere contains a variety of life forms that are amenable to the demonstration of biological processes, often in environments that simulate those common to Israel. In addition, there are exhibits that demonstrate basic themes and processes in ecology, many being researched at the Weizmann Institute. The structure of the EcoSphere was built on the geodesic principles first developed by Buckminster Fuller. Through its variety of activities, the Ecosphere can host different types of visitors, from organized groups of children and adults to teachers, research students and individual visitors to the Clore Garden of Science and will become a significant study center for people who have an interest in the field of ecology.