



Hemda, a Unique Model of Science Education - the Benefits of Assembling Science Education

Tehilla Ben-Gai¹

Abstract

Hemda – Center for Science Education, serves as the scientific arm to all high schools in Tel-Aviv-Yaffo. Hemda has its own, specially designed campus for science teaching. Pupils from all over the city leave their schools, once or twice a week, and come to Hemda to learn Physics, Chemistry and/or Computational Science. Hemda assumes the responsibility of teaching science to 9th to 12th grade students according to the Israeli curriculum, preparing them for Matriculation Examinations and much beyond. Hemda is a metropolitan center that works on collaboration with the schools. The unique model of Hemda enables each pupil in Tel Aviv-Yaffo to achieve high quality science education regardless their backgrounds.

Hemda is resting on highly qualified teachers; most of them with Ph.D. in physics or chemistry, who teach in 18 cutting-edge, well equipped laboratories.

The educational concept of science studies at Hemda is built on integrating theoretical studies with experimental work: hands on experiments and demonstrations, many of them computer controlled implementing the results in models and simulations. Traditional separation between classes and laboratories is broken: experiments can be carried out any time.

The unique model of Hemda results in many advantages for the benefit of the students: worldwide-unique program for excellent students named "computational Science"; excellence classes for in-depth physics; special program for 9th grade students aiming at science-learning motivation and skills through specially designed experiments; enrichment courses and special projects, a variety of workshops for the students choice, books for the benefit of the country-wide students and developing new experiments utilizing the added value of teachers and Lab technicians team work.

During 2016/17, over 2000 students from 18 high schools attend Hemda every week. This figure marks a record in the center's 25 years history.

1. Introduction

We live in an age when the most important economic resource is knowledge. If we believe that scientific and Technological knowledge is most important, then education is the best investment.

Science Education in this new technological era requires high skills, expertise and state of the art laboratories. Physics and chemistry are considered to be two of the most important basic disciplines needed for research or technology design in almost every field. They provide basic tools to understand scientific processes define problems and find solutions in other fields, such as biology, medicine, computers, nanotechnology and many more.

For many years, we witnessed in Israel a decrease in the number of junior high students who choose to take science as their major subject in high school. This led to decrease in the number of science and technology university students and, as a result, lack of scientists and engineers for many years.

2. Establishing Hemda

In the late 1980s, the Israeli Ministry of education missioned professor Haim Harari, the president of the Weizmann institute of Science at the time, to head a committee missioned to reform science education in Israel. The committee found that as in many other countries, science education is facing many problems:

¹ Hemda Science Education Center, Tel-Aviv-Yaffo, Israel,

New teachers were difficult to hire because of low payment; Excellent scientists were recruited by research institutes or high-tech industry and start-ups and were not attracted to education; Lab equipment was expensive and difficult to maintain, so schools couldn't afford it for a once-in-a-year demonstration or hands on experiment. Combined with old-style books and non-attractive curriculum, those factors turned off any sparkle or desire to choose science as a major subject by pupils at the end of their 9th grade (the year pupils in Israel choose their main studies for the years to come).

The Tel Aviv-Yaffo city took upon itself to deal with these issues by centralizing all high schools' science education under one roof: "Hemda". Hemda, synonym for "Science education" in Hebrew, was established in 1992 as a joint venture of professor Harari, Tel Aviv-Yaffo municipality and the Rothschild foundation. Hemda is an independent association, with a professional board, headed at the first 17 years by professor Haim Harari and then by professor Daniel Zajfman, the current president of the Weizmann Institute of Science.

Hemda is located in the middle of the city so it is easy to get to (transportation is supported by the municipality); The building, which was specially designed as a campus for science teaching, has 18 highly equipped spaces that serve both as laboratories and as teaching classrooms.

During the 2016/17 school year, over 2000 students from 18 high schools attend Hemda every week between 4 academic hours (9th and 10th grades) to 8 hours (11th and 12th grades). This figure marks a record in the center's 25 years history.

Teaching science under one roof in Hemda opens the opportunity for integrating students from different social backgrounds. It offers access for every pupil in the city to state-of-the-art equipment. It attracts highly trained and talented teachers and supports them.

As its role as the scientific arm of all high schools in Tel Aviv-Yaffo, Hemda has the responsibility to teach physics and chemistry according to the Israeli curriculum and prepare them for the Matriculation Examinations. It is important to understand that the pupils who arrive to Hemda remain students of their home neighborhood high school and are not uprooted from their communities. Furthermore, this means there are no physics or chemistry teachers within high schools for this age level.

3. This is a Unique Model.

It enables each student in Tel Aviv-Yaffo to achieve high quality science education regardless of their socio-economic background and their high school resources. Schools in socio-economic deprived areas have the chance to offer science studies, even when there are only a few students who wish to study these subjects and otherwise would not been allocated with a class and a teacher. Every student from those schools has the opportunity to get the best teachers in the best environment.

4. Assembling Resources

Hemda is resting on 32 highly qualified teachers; most of them with Ph.D. in physics or chemistry. The center's teachers are experienced in theoretical and experimental research in different fields.

Team-work at Hemda enables every teacher to be part of a community; to share ideas; to get support; to take part in weekly seminars about science and science education. There is a prospect for every teacher for personal and professional development: they initiate projects, they can develop new courses, they can be in charge of the Labs, they can ask for new equipment; to develop new materials for theory and experiments; be part of the managing stuff; write books; invite lecturers and go on with any idea that contributes to their development as teachers and for the benefit of the students.

New teachers are trained during their first years. They are guided by a group of experienced teachers from the moment they set foot at Hemda.

The teachers are supported by a trained staff of technicians that take part of our team work: part of their job is initiating new demonstrations and hands-on experiments.

5. Educational Concept

Physics, chemistry and computational science are always being taught in Hemda with demonstrations, experimental laboratory work, computer simulations or inquiry activities. Theoretical frontal classes are kept at minimum. Therefore, traditional separation between classes and laboratories is broken: experiments can be carried out at any time. All our spaces are multifunctional so active learning is the heart of our activities.

Cooperation between teachers and Lab technicians enables documentation of the experimental unique knowledge that accumulated during our 25 years of operation: we put every experiment and

demonstration on our website. Our teachers also develop special courses and write books for the benefit of all science high-school students and teachers in Israel.

6. Pedagogic Vision

We aim at enhancing our students' scientific literacy and deepening their knowledge. We are doing it by fostering our students learning skills, teaching them to use technology, we promote their curiosity; encourage them to develop intellectual doubts and scientific skeptic thought, enhancing their scientific thinking and inventive creativity. By doing this, we also guarantee their success in the matriculation examinations. All students are also offered individual tutoring by their teachers.

We lead our students to learn, but raise doubts; to submit reports based on scientific carefully validated data; raise arguments based on evidence, pay attention to what teachers say, but ask questions. We wish to enhance not only intellectual abilities but also their creativity confidence, especially among girls. Team work is essential these days in academic life and in high-tech industry; that is why our students sit in groups by default.

7. Special Pedagogic ventures

7.1 "Computational Science": Computers as a scientific Tool

A unique three years program developed in Hemda for outstanding students.

In addition to basic physics and chemistry, Hemda has initiated and implemented a new contemporary course: "computational science" (CS). The program was developed at Hemda with the goal of providing outstanding and creative student's tools for solving multi-disciplinary problems through building computational models and simulations. CS harnesses the computer to solve problems that cannot be "cracked" in any other way. CS students construct simulations, study them and, if possible, comparing them with empirical data.

Students learn to write code and develop algorithms using neural networks, evolutionary algorithms, regression methods, cellular automata and numerically solve differential equations.

The program is based on project based learning (PBL) and non-traditional evaluation.

This course is now a major science matriculation subject, recognized by the Israeli Education Ministry and the Israeli universities.

7.2 Excellence Classes for In-Depth Physics

Hemda has issued a new program for excellence class: the idea is to gather excellent students into one class and to teach them physics with a unique pedagogic approach, special didactic ways and personal tuition.

This class enables the students to learn physics with sophisticated math tools, to study in-depth theoretical and experimental interdisciplinary issues, to enrich their knowledge with topics that are not in the regular syllabus, to take part in special experiments and to be exposed to cutting edge science. Projects are guided by Hemda's teachers cooperating with universities and research medical centers. Team work is encouraged but every student is individually supported.

At the 11th grade the students study physics particles and spend a 4-days seminar at the Large Hadron Collider (LHC) at CERN, Switzerland .

At the 12th grade, the students take part in a 3-days science seminar at the Weizmann Institute designed especially for them.

7.3 "Arrow" project: Science for 9th grade students

Special program for 9th grade students aiming at attract and potential students in order to ignite their motivation and to give them skills through specially designed experiments.

7.3 Enrichment Courses

Since our teachers have expertise in different disciplines they can offer our students courses that are beyond the syllabus. The courses are intended to intrigue curiosity and creativity. Courses include topics such as astronomy and cosmology, relativity, space exploration, medical physics and more.

7.5 "Science as Culture" to the Community

The Science as Culture Project at HEMDA offers the public the opportunity to increase its involvement in contemporary scientific issues, which will intensify scientific discourse around the family table throughout Tel Aviv, and create an atmosphere in the homes that would encourage science studies.

Parents, siblings and other relatives who have made the Science Culture evenings an integral part of their cultural activities have guided more students to become interested in science and perhaps even to select science as their major study track. Our project name, Science-Culture at HEMDA, shows our outlook: science is culture, in the same way as are films, concerts and theatre.

7.6 "Makers Space"

Many of our students aim at studying science and engineering. Research and design require creativity and innovation that are not always a part of the traditional syllabus. In order to encourage our students to find their 'inner inventor' Hemda had built a maker space, equipped with 3D-printers, laser cutter, CNC router, Arduino devices and more. The space is open after school for students to build their own project. The "makers space" encourages a guided exploration of the students positional and build creative confidence.

8. Conclusions

Hemda is a unique program and a unique place. Students with a desire for science find here a home. Being a student at Hemda is a sign of excellence in the city of Tel Aviv-Yaffo. More than half of our graduates choose a career in science, technology or computers. Many of them ascribe their choice and success to their experience in Hemda.
