

SCIENCES EDUCATION IN ISRAEL

Orly NISSEL*

Junior High School, ISRAEL

According to national and international exams achievements in sciences of Israeli students are less significant. Respectively, the question arises how it can be motivated interest of students, especially girls, to sciences. Sciences education is a prerequisite for choosing a career in this field, is very important economically. The paper discusses some strategies to stimulate science education for young people, especially girls.

Keywords: *education sciences, differences between girls and boys, educational strategies, "Hotam" program, cultivation of science-technology literacy.*

EDUCAȚIA PENTRU ȘTIINȚĂ ÎN ISRAEL

Conform rezultatelor examenelor naționale și internaționale, realizările elevilor israelieni în domeniul științelor exacte sunt mai puțin semnificative. Respectiv, apare întrebarea: cum poate fi motivat interesul elevilor, în special al fetelor, pentru științele exacte? Educația pentru științele exacte reprezintă o precondiție pentru alegerea carierei în domeniu, fiind foarte importantă din punct de vedere economic. În lucrare sunt abordate unele strategii în vederea stimulării educației pentru știință a tinerilor, în special a fetelor.

Cuvinte-cheie: *educație pentru științele exacte, diferențe între fete și băieți, strategii educaționale, „Hotam” program, cultivarea alfabetizării în știință-tehnologii.*

Introduction

Science literacy is an educational term, a general education for a certain orientation in the subject of science. UNESCO, the UN Organization of Education, Science and Culture, has published in 1983 the importance of acquisition of science literacy by all citizens as a principal purpose in science teaching in high schools. In the United States a reform in science teaching has been announced, in which standards relating to science literacy have been set, regarding contents, methods of teaching and teachers training (NRC, 1996). In another project - 2061 (AAAS, 1993), benchmarks have been set that determine what a pupil needs to know in science and maths in the 2nd, 5th, 8th and 12th grades in order to become a science literate citizen [12].

According to the results of national and international exams Israeli pupils' achievements in science are not so bright [3]. The question is why a subject such as science that deals with diverse aspects of knowledge, rich in research and experiments and very important from an economic standpoint, does not create interest and is not appealing to Israeli pupils especially with girls? Why do pupils report it as a non-interesting subject and emphasize this out by choosing other increased orientations in high schools. What strategies should be used in order to stimulate the science education of youth, especially girls?

Strategies for stimulating science' education

In the late 60's, research was the focal point of science teaching reform. Research allowed pupils to get experienced and acquainted with the scientific method through experimentation, making hypotheses, planning, observations and conclusion. The method is based on learning by doing – a direct involvement in the environment and experience in nature through experimentation. It is a method that cultivates curiosity and thinking. Today, the internet and technological communication makes it possible for high availability in learning of any field everywhere in the world. It is about real time data and information that comprise a rich environment which the pupil investigates while collecting data. Pupils are part of a scientific community virtually connected. For this purpose, new thinking skills are required that have to do with locating information, its processing and its wording from a critical standpoint.

Throughout the years there have been several reforms. One of them was called "Tomorrow 98" (Jubilee of the state, 1998), headed by the president of Weitzman Institute, Prof. Harari, who has been requested to examine the situation of science education in Israel and submit recommendations [1]. This subject is of importance to learning at every age level. Massive financial budgets were raised, hundreds of millions of dollars. A new subject was created: science and technology in junior high school.

* Scientific Coordinator – Valentina BODRUG-LUNGU, State University of Moldova.

In 1996, a new syllabus was published. The Ministry of Education had developed new teaching materials according to the recommendations. The position of teachers as leaders of the change was broadened and strengthened. According to the new program teachers are autonomous, they choose the teaching materials, design teaching sequences and lesson plans. The teacher teaches from manuals as he pleases; he develops educational initiatives as a pedagogical tool for pupils' motivation to study science and technology.

Apparently, the written teaching materials did not meet the pupils' needs. The concept in teachers' centers had changed. They accepted the educational program, and learned to implement it with discretion. Those involved in developing teaching materials supported teachers and were in constant dialogue with them in different training events. Teachers attended lectures of the best scientists and were updated in knowledge from cutting edge science. Teachers' centers were changed and converted in 2002 to a new model named– "Pisga" - Teaching Staff Development.

One of the educational programs written in 1990 is "Mabat" – scientific education for the general population. The program is designed to impart knowledge, understanding of basic terminology and scientific phenomena of nature. It is based on disciplinary structure of science and on social-moral considerations. This program has been the foundation of the new program and the TLE kits (Teaching, Learning, Evaluation) for the subject of science since 2009 and later.

In 2009, Gideon Saar was appointed as the new Minister of Education in Israel. Upon entering his office, he decided to make a big reform in the educational system while stressing the teaching of science and set goals for the subject. In August 2009, Dr. OferRimon was appointed as Vice President of Science and Technology Administration in the Ministry of Education. He wrote his doctoral thesis on the results of international exams in math and science and their repercussions on the country.

A report from the parliament sitting of Science and Technology Committee of the Knesset [1], were attended Prof. Harari and those in charge of science education: Dr. Rimon claimed that technology education had gone through a major crisis, in part completely terminated as contrary to what is common in the world where technology education is in a big momentum. The goal is to rectify this. Cited from prof. Harari, '... we live in an era of knowledge that includes economics and technology. Scientific education is always important especially to the scientific and technological elite. But for the general population this is a fringe subject. A man can be successful in life without having a single clue about science and technology. This has been changed, from an intellectual and economic standpoint. Singapore with its 4.5 million people, a former British colony, started with nothing – a collection of poor peasants, and reached its achievements due to the improvement in education and especially of scientific education”.

Many subjects rely on science: health, agriculture, energy, environmental protection, water and security. 1. It is important to take care of the future scientific elite, who generally speaking are - pupils of the Vth study units in the subjects of physics, chemistry, biology and technology who will be the future engineers, development personnel, scientists and basically the economic foundation of Israeli industry and also Defense elite, etc. 2. Mandatory science and technology education for every citizen. 3. Technology in education, meaning the use of modern technology in the education of all subjects. There cannot be science without technology. Educational technology without science is like studying the technology of yesterday.

Practically speaking, scientific-technological education should start from the first grade, if not as early as the kindergarten. Stressing 7-9th grades in junior high school. The science teacher is different from any other teacher. He is required to study some physics, chemistry, biology, computers and technology. He is supposed to be a universal expert in changing fields master all materials and subjects and be updated on all developments, there is no chance he would know that. Science teacher needs to receive support, instruction on the internet and trainings by the system. This is a completely different role than what science teacher used to be. Programs must be improved; to have more hours per week, more laboratory lessons. International exams supply a mirror for us to look at ourselves. It is important that we demonstrate success in them. If the Minister of Education, Gideon Saar, will do wonders it will bear fruition in 2020. The result is a continued neglect. 20 years ago, before the IT revolution, the educational system did not hear of it. [1].

Dr. OferRimon states that Science and technology is a unified subject from kindergarten up to and including 9th grade [1]. The educational programs in elementary schools and junior high schools are very broad. The recommendation is that they should receive 4-6 weekly hours. In the increased subjects of theoretical education in 2008 - 58,705 took the exams. The educational program of 1996 is excellent, broad and integrative. The subjects of chemistry, physics, biology, earth sciences and technology were included. The problem is that there is no clear definition for the pupil. Requirements need to be balanced according to the need of knowledge

establishment in each of its area. Pupils' results in national and international exams are low. In the Timss exam of 2007 Israel ranked 25th out of 49 countries. The rate of outstanding results of over 625 was just 5% of the pupils. The basis supplied by the educational system to adequately function in the 21st century is of concern. The problem lies in the learning sequences from elementary to the high school. Human body is studied just in an elementary school. In the 10th grade many pupils do not study any scientific subject. A pupil who chooses expanded biology would be lacking in knowledge of physics and chemistry. At the end of 10th grade the international Pissa exam tests scientific literacy of 15 years old pupils. This explains why they do not succeed in the exams. The problem is that there are children at the age of 15 who do not have a scientific foundation in important fields.

The rate of pupils who choose increased scientific subjects is pretty low - about 20 thousand pupils. There is a need to define exactly what each child has to know in each grade. There is a need to decide what 9th graders have to know in order that more children should continue with increased science orientation.

"We want to reach a situation that every child in 10th grade studies a scientific subject. Pupils who are talented in science have to be challenged from an early age with an affirmative action for girls and pupils from a weak socioeconomic background. We are talking about the subject of the future generation" (Dr. Rimon – 2012, Education.gov.il, CMC scientific education in high schools 22.3.2012).

The Ministry of Education speaks to high school pupils through the communication media, and presents educational courses in physics, chemistry and biology, challenging and enjoyable studies. Pupils are experienced in practical studies in a laboratory and perform research studies that enable them to understand well the scientific world surrounding us. The studies are interesting and pave a path for integration in industry.

Speaking as a teacher and as science coordinator in the school I can say that a feeling of frustration has been created. The system has reduced class hours and increased demands. I agree with Prof. Harari and Dr. Rimon. Burnout and the aging of teachers is evident in teaching of science without any young teachers entering the system. This stems from the complexity of the subject and the multitude of knowledge in the fields of biology, chemistry, physics, computers, etc. Youngsters choose subjects that are easier to teach (OferRimon, Aging Teachers – 6.12.2011). A lack in laboratory assistants and strong teachers in the subjects of science is felt in the educational system. Today the situation in the field is opposite! There are many hours budgeted and added but there is a lack of good teachers that have the skills and excellent materials. The system has created a kind of internal ruin.

The Ministry has created new programs for teachers' recruitment. The project is led by Haifa University. The Ministry of Education has approached outstanding graduates in science fields, from all universities in Israel that expressed interest to practice science teaching. They study intensively in the summer and in school vacations. They receive financial incentives from the government. The teachers are accompanied by mentors and leading teachers of science. The project is called "Hotam" ("imprint" in Hebrew) – to imprint. What is the "Hotam" program? It is a Teach for All Program. Bachelor degree graduates with honors who integrate as leaders in the teaching disposition, a social mission that has the purpose of affecting education in Israel. "Hotam" operates with international success in 12 countries, on 4 continents for 20 years, led by the USA and UK. Israel seeks quality teaching.

"Hotam" does conversions and career changes and integrates motivated young people with broad education in school teaching. The project has existed in Israel for 2 years already. These teachers who join the system bring qualified fresh forces with them. Amongst thousands graduates of the founding program in the US and UK (that was the basis for the "Hotam" program) – 65% remain in the field of education in different teaching positions and management in different setups [2]. The disadvantage is that "Hotam" teachers do not master all the material studied in science. The subject includes many fields and it is impossible to study all teaching subjects in two intensive months. A constant support is required. At times there is a difficulty in controlling a class which causes the waste of study time. Learning is not always significant and of quality. I suppose that with accumulation of seniority and in the process of teaching the situation of class control will improve.

On the ground, Israeli students are extremely wise and curious. There is no reason that they would not relate to the subject of science and improve their achievements in national and international exams. Success in this subject depends on a continued investment by the system and the government in students and teachers. A continued investment with no dependency on politics is of utmost importance. The subject has been neglected for years and this serious damage needs to be rehabilitated in a long process which requires patience. Once the conditions improve and study becomes interesting and significant, the students will relate to it and choose it. There is a need to invest in teachers all the way through. Trainings are important and teach to diversify teaching methods, skills and lessons sequences. The number of weekly hours strengthens the subject and

enhances knowledge. Schedules and production have to be met. All these need to be analyzed profoundly. The teacher must work hard at learning the material, prepare interesting lesson plans and attract students to love the subject. The educational system need to focus more attention to science literacy.

In Israel, in 2005, 7-9th grades pupils received a printed collection of assignments for cultivation of science-technology literacy. The assignments include: 1. Scientific knowledge – terms, principles and procedures. 2. Knowledge of science – characteristics of science and scientific research, the effect of science and technology on society. 3. Skills – derivation of information out of text, table, graph or illustration, use of scientific evidences, wording of scientific explanation for phenomena [9].

In order to study according to the new program, T.L.E– Evaluation for information Learning Teaching-& kits were created [8]. The kit items have to be drilled and study sequence has to be created, the Ministry of education exam needs to be at the end of each subject and a final exam for each chapter. There needs to be an "Indicator" - an answer sheet and uniform scoring for each exam, examination of the output of each school and each teacher, supervision of performance and study in the field, fulfilling the teaching hours and schedules across the calendar.

The formative assessment is an assignment of assessment intended to promote the learning of pupils. These assignments supply a feedback to teachers and pupils, so that teaching and learning activities can be altered according to results. Formative assessment is different than summative assessment that has the purpose of control measurement. Purposes of formative assessment: 1. To give the pupil a tool to direct his work and assess it independently. 2. To strengthen personal responsibility that each pupil has in the performance of his assignment. 3. To give the pupil a possibility to diagnose parts of his work needing improvement. 4. To encourage the pupil to develop personal initiative in volunteering work. Formative assessment as a tool of improving teaching and learning (Midjanski, 2009 [5]).

In the TLE kits in addition to contents and written lessons plans there are also questions on different knowledge levels according to Bloom's taxonomy. But this model has been shortened, meaning, skills and abilities have been assembled according to Timss (2007) – 1. Knowledge and comprehension; 2. Application; 3. Thinking [apud 8].

Bloom's Taxonomy has the purpose of reaching two main targets; 1. Study planning. 2. Testing of results. It consists of 6 gradients: knowledge, comprehension, application, analysis, synthesis and evaluation. The source of the word is from Greek: *taxis* – arrangement and *nomus* – law. It is the formation system that is organized by a gradient order that has a meaning. The achievement of a target at a higher level depends upon the achievement of prior targets. Bloom's Taxonomy (1956) – a term that is borrowed from the field of biology to the field of education. The taxonomy is based on the proposition that there is a higher mental skill in existence. The different levels are described by a pyramid. As understanding is reached in higher levels of the Taxonomy, it is assumable that a better and deeper control has been reached on the lower level of the taxonomy [11].

In addition to the new study materials different strategies have been integrated to diversify teaching.

1. *P.E.O.E. strategy* (P – predict, E – explain, O – observe, E – explain)

An Australian strategy with investigatory approach comprises 4 stages: predict, explain, observe and explain. The idea is that during an experiment it is possible to break down and isolate each step separately which allows for the understanding of the experiment without skipping stages. 1. *P – predict* – understand the situation or the challenge, no surprises. 2. *E – explain* – in this process the person studying shares the group with his prediction. 3. *O – observe* – decide what you can collect, evidences or measurements, that can be used and examine the student's prediction. 4. *E – explain* – explaining the observations. Theories or models are used to help explaining the evidences and measurements. Knowledge can be given or the student will require a research so as to support or refute findings.

This layout assists students to understand the connections in final explanations, causes a change in existing and prior perception. The surprise is by a cognitive conflict while assimilating investigatory skills. It helps the teacher in understanding a wrong rooted thinking or lack in understanding, mixing of missing terms, deep thinking. Help in understanding the group's character. The teacher thus knows what to stress in future lessons. He will thus diversify his teaching methods, allow for another type of thinking, reveal knowledge levels [10] taken from Portal.herzliya.k.12.il 'on Sunday 2011 at 10.

2. *Silent demo strategy*

An experiment is performed silently with nobody talking, neither the teacher nor the pupils. It allows for concentration and observation at any stage. Silence allows the pupil to deal alone with understanding and personally concentrate on each stage of the experiment (from a lecture in Shlomi, NiraKoshinski, 2010 [7]).

3. *Explaining Science Model*

A learning model, called Explaining Science, which integrates contents and skills (Dr. Tami Yehieli). The models are explained to the students through presentations which include sketches, pictures and graphs. The subjects are abstract and from the field of physics. By this model the student is associated with the subject in an easy and clear fashion. The examples are taken from an environment that is familiar to the child's world.

In this context other educational strategy as *Research project in 9th grade* needs to be mentioned. In the current year of 2012 the subject of research is mandatory for the first time in the 9th grade in Israel. The pupils, in groups of four, have been requested to choose a subject and research it according to scientific rules. Reports have been written and posters made up, and a theoretical paper was submitted. The posters were presented in the school on the highlight day event. Two posters were chosen from all that participated in a competition in the Israeli Museum on 23.3.2012.

Many teachers have been exposed for their first time to writing a research paper and the process of explaining to the pupils was complicated. At the end pupils and teachers reported a pleasurable study. Friendly relationships have been established between pupils and teachers. In the process of my reading different articles from Israel and the world I have found similar points in the field of science teaching. There is a gap between the achievements of boys and girls in the favor of boys [4].

Girls are reluctant to choosing scientific subjects due to sociological-psychological reasons. They are afraid of failing and this turns to other fields. In the field of physics the situation is even more problematic - very few girls are admitted to this field. So the problem of gender is prominent.

All over the world there is a big gap between the achievements in international science exams between girls and boys. All over the world there is a decrease in choosing science subjects amongst girls as compared to boys. The reasons are similar. In different areas in the world the issue of gender is given importance and attempts are made to augment the teaching science and empower girls in this field. In the world as well as in Israel the number of girls studying science in high schools and Universities is very low.

Conclusions:

- Israel should put greater efforts in the young generation, especially in the girls, to prepare a future generation of scientists. They should achieve international achievements like Prof. Ada Yonat&Prof. Dan Shechtman who won the Nobel prize.
- Since 2009, as a result of political change and shift in the educational conception, the situation has varied in the way of teaching sciences in Israel. Gideon Saar, the minister operated in the reinforcement of the core subjects, he allocated thousands of educational hours in mathematics, sciences and mother tongues. This stimulus has been done to improve the students' achievements, especially the girls' achievements in sciences, in Junior High School.
- All over the world, including Israel, there is a big gap in the achievements in international sciences exams between girls & boys. The education system will be focused more on science' education of youth, especially girls. The educational strategies, based on best international and national experiences will be developed.

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