Translation by Makash of the background paper of the Center for Research and Information of the Israel Parliament - the original paper is available (in Hebrew) at http://www.knesset.gov.il/mmm/data/pdf/m02978.pdf

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The Knesset (Parliament)

Center for Research and Information

Jerusalem, November 7, 2011

Information about Education for Sciences and Technology

The following background paper was prepared for the discussion that will take place on November 8th at a joint meeting of the Committee for Science and Technology and the Committee for Education, Culture and Sport. The subject of the discussion is "The Education to Science and to Technology" and hereby we bring our main findings as general background for this discussion.

The Education to Science and Technology: Background

The study of sciences in the schools has two main purposes. The first, most basic and general, is that Science Education is a mean to impart knowledge and tools that are essential for a citizen in the 21st Century. This approach considers the study of science in school as a basic need, without any necessary link to the future academic or professional occupation of the student. The alternative approach considers the scientific education in school as preparation for the future in the army, the university and the industry. The army uses today, much more than in the past, of knowledge intensive technologies; it needs soldier with basic knowledge of the scientific disciplines. When the level of those mobilized have a low level of knowledge then the army need to invest much more resources for a lengthier period of time for training them. Similarly, the future students of science at the universities need the knowledge that will serve as the ground for the advanced knowledge they will acquire in the university. In what concerns higher education, the lack of such knowledge, may have the consequence of restricting the scope of interests of the students and therefore to diminish the number of students that will study such disciplines that are the knowledge base for research in the exact sciences. [1]

Changes have taken place in the last 20 years - technological studies have become more scientifically oriented; courses of study that became available are more updated with have an orientation to advanced technologies; there is an increase in the number of those among the students that pass the Baccaulerate examinations. Despite all these developments the technological education still need to cope with several challenges and issues of principle:

Most those who support the enlargement and strengthening of technological education, specially those who coming from economics and business, stress the need to provide professional training to the students while they still are in the framework of the educational system (before they conclude their high school studies) so to attend to a critical need of the economy. They argue that the main danger posed by the lack of such training is the paralysis of branches of the economy and the industry that claim for technically skilled human resources and the consequent transfer of business and enterprises to developing countries that have a more adequate manpower or alternatively the stimulus for employing working immigrants here in the country. There are also those who claim that the relative advantage of Israel in science and technology is endangered because the high school technology study track is not attractive enough for outstanding students due to a low image, insufficient budgeting and more.[2]

In contrast to this approach there are those who argue that professional education is only an interest of capitalists, and not that of the society or the students. They claim that the argument concerning "the needs of the economy" is based on an approach to the students as resource, in the economic sense of the word. If there is a national need for professional training of workers for the industry this can be accomplished after the conclusion of high school studies (and only for those interested in such training) and as far as needed even to act for the participation of the state in the disbursements of the industry for such training[3].

There are those who argue that technological education presently vacillates between two poles. The professional interest and the theoretical-scientific interest are different and in fact one comes at the expense of the other and in fact theoretical knowledge comes at the cost of practical experience.

Main finding concerning the education for sciences and for technology

The Center for Research and Information of the Knesset (Parliament) dealt with the issue of education for sciences and for technology in a document from January 2010 [4]. The information provided in here is based on that document and in updates that follows the information received from the Ministry of Education in preparation to the present discussion[5].

- The number of teaching hours recommended in the framework for **Studies of Sciences and Technology in the Elementary Schools** following the program of studies is: 3-4 weekly hours (expressed as WH in what follows) in grades 1-2; 4-5 WH in grades 3-4; 5-6 WH in grades 5-6. According to the guidelines of the Core Curriculum Program the students in elementary schools from all sectors should study no less than e WH in each grade from 1 to 6. **In practice the scope of the studies vary between the diverse currents in the Jewish educational sector (Religious vs Secular) and in some cases the number of teaching hours does not correspond to the demands of the Core Curriculum Program; among other reasons for this disparity there is the shortage of teaching hours.**
- The Harary Committee recommended that the scope of **Studies of Science and Technology in the Junior High School** be of 6 WH and so has been defined in the curriculum. The Director General Circular* the minimum quota of Science and Technology studies in junior high schools should be 4 WH in grade 7 and 5 WH in each grader from grades 8 to 9.*

  According to the information we received from the Ministry of Education in the school year תש״ע 2010 the Ministry began to map the extent of the studies in practice in the field. The conclusions of such mapping were that only a third of the schools filled the minimal quota of hours for Science and Technology. The Ministry inform that following measures for control and enforcement it adopted the share of schools complying with the regulations rose to 75% in the year 2011 (תשע״א).

  The Ministry additionally began to implement the Program for **Strengthening the Information and Skills in Junior High School**. The program include adding a teaching hour for each grade in the age cohorts for grades 7, 8 and 9 [6].

- The document from the Center for Research and Information concerning Science and Technology Education from January 2010 indicate that according to the curriculum, **all the students in High School in grade 10 , as part of their compulsory education, 9 weekly hours in the Sciences (Physics, Chemistry and Biology). In practice a substantial share of schools do not provide Science Studies in grade 10 with the exception for students who choose the Science courses of studies (trends). Contrary to the recommendations of the report "Tomorrow '98" (Harary Report) that students who do not choose Science courses of studies (trends) in High School should learn Science and**

Technology in Society, in practice today there are no compulsory studies of Science and Technology in Society.

The reply of the Ministry of Education to our inquiry, in preparation to this discussion, includes the information that in April 2011 they have issued a directive to all principals of high schools that each student in grade 10 should learn 3 WH in one of the three basic sciences (Physics; Chemistry; Biology) or in the discipline Science and Technology in Society[7].

Information received from the Central Bureau of Statistics indicate that between the years 1999 and 2009 there was a decrease in the number of teaching hours in the disciplines: Physics, Chemistry, Computer Sciences and Technological Disciplines. In contrast there was an increase in the number of teaching hours in Mathematics and Biology (Mathematics is the only compulsory discipline for the Baccaulerate in this list), as can be observed in the Table 1 that follows.

Table 1. Number of Hours in the disciplines of Science and Technology in High School, 1999-2009, Data from the Central Bureau of Statistics [8]

	Mathematics	Physics	Chemistry	Biology	Computer Science	Technological Disciplines
1999	60,261	15,504	13,952	21,810	27,361	23,168
2009	85,147	14,704	11,443	22,382	20,598	21,856

- **Among all those who applied for Baccaulerate examinations in the year 2009 the share of Biology was 19%; Chemistry, 10.5%; Physics, 14%. Most those who applied to examinations in sciences went for the highest level (an annual mean of 84% of students of Biology; a mean of 69% of students of Physics; and a mean of 80% of students of Chemistry)[9].** The share of those who pass the examinations among those who apply is very high (about 98%) and has been stable between the years 2001-2009[10]. See table 2 below.

Table 2. Number of those applying to Baccaulerate examinations in Physics, Chemistry and Biology and their share among all those who apply to Baccaulerate examinations, 2006-2009 [11]

	Physics		Chemistry		Biology	
2006	10,6737	13%	8,689	10%	12,344	15%
2007	11,067	13%	9,100	11%	12,756	15%
2008	11,273	13%	9,362	11%	13,021	15.5%
2009	11,832	14%	8,828	10,5%	16,027	19%

Table 2 above shows that in the years 2006-2009 there were no significant changes in the number of those who apply to Baccaulerate examinations in the area of Sciences (Chemistry, Physics and Biology) and their share in the overall number of those who apply to Baccaulerate examinations. However in the year 2009 there was relatively a substantial increase in those who apply to the Baccaulerate in Biology.

The data published by the Ministry of Education does not include the share of those who study more than one scientific trend so one cannot add up from them a comprehensive picture of the total share of those who apply to the Baccaulerate in Sciences. Still we can deduce from the above data that the

overall share of those who apply to the Baccaulerate in Sciences is not more than 43% of those who apply to the Baccaulerate examinations.

- The grades in the Meitzav examinations and the international examinations provide an expression of the gaps in the educational system between students from different sectors of the population and between students from different socio-economic background. We should point out that the comparison of the grades from the latest Meitzav exams point out to a narrowing of such gaps in the last years.

  In the Meitzav examinations for 2011 there was a gap between Hebrew and Arabic speakers: in grade 5 the gap was 38 points (in Meitzav grades) [12] in Mathematics and 18 points in Science and Technology; and in grade 8 the gap was: 34 points in Mathematics and 22 in Science and Technology. However a comparison between Hebrew and Arabic speakers of the same socio-economic background annuls much of these differences[13].

- The findings of the Pisa survey for 2009 show that the mean grad in Israel is lower than the mean grade for the OECD countries in three examination areas: Sciences (455 against 501); Mathematics (447 against 496); and in Reading (474 against 493). In Israel there is relatively low share of those who excel in Mathematics in comparison to the mean in the OECD countries (4% against 9%)), and a large share of those with difficulties (33% against 18%)[14].
- Here follows information about the cadres for teaching Sciences in the Junior High schools in the last decade.

Table 3. Number of teachers of Sciences in the upper division, 1999 and 2009 – Data from the Central Bureau of Statistics [15]

	Mathematics	Physics	Chemistry	Biology	Computer Science	Technological Disciplines
1999	3,601	984	891	1,500	1,751	1,055
2009	5,689	943	751	1,703	1,408	1,218

- From Table 3 it can be observed from the data received from the Central Bureau of Statistics that the number of teachers in the disciplines: Physics, Chemistry, Computer Science went down from 1999 to 2009. However in the disciplines: Biology, Mathematics and the Technological disciplines there was an increase of the number of teachers between 1999 and 2009.

Table 4. The mean age of the age of teachers in the upper division by sector of the population, 1999-2009, Data from the Central Bureau of Statistics[16]

		Mathematics	Physics	Chemistry	Biology	Computer Science	Technological Disciplines
Hebrew Sector	**1999**	4.4	46.4	44.4	42.9	41.0	44.3
	2009	45.1	50.2	47.7	46.0	44.9	49.9
Arabic Sector	**1999**	36.6	36.8	36.3	37.5	33.0	34.9
	2009	38.9	42.0	40.1	40.2	36.8	39.3

- Table 4 above shows that the mean age of teachers of Sciences in the upper division went up in all sectors. In the Jewish sector: in the year 2009 the mean age of Physics teachers was 50.2, of Chemistry 47.7 and of teachers of Biology was 46. Their mean age in 199 was: 46.4 in Physics, 44.4 in Chemistry and 42.9 in Biology. Also in the Arab sector there was an increase in the mean age of teachers of Sciences the overall average for the teachers of Sciences in the Arabic sector is substantially younger than that in the Jewish sector.

  The Ministry of Education, in its reply, indicates that it is well aware of the scarcity of teachers and the aging of the teaching cadres in Sciences. The Ministry is trying to cope with these issues in the last year and have adopted among others the following steps:

  The establishment of a program for re-training of Higher Education academics for teaching Sciences in High School. 430 such teachers have been trained so far: 370 in 2010 (180 in Mathematics; 40 in Sciences for Junior High Schools; 90 for Biology; 15 for Chemistry and 45 for Physics). 60 teachers in the year 2011 (50 teachers in the Engineering disciplines – Electronics; Electricity, Machinery and Computer Science) and 10 teachers in Sciences.

  Additionally students who choose Science Teaching are entitled to preferential conditional loans in each year of their 3 years of studies; such loans become a grant in case they work in the required field[17].

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[1] Center for Research and Information of the Knesseth (Parliament), The Education for Sciences and Technology, Roy Goldsmith, January 2010

[2] Center for Research and Information of the Knesseth (Parliament), Professional and Technological Education in Israel and the World, Yuval Vergan and Gilead Nathan, July 2008.

[3] Ibid

[4] Center for Research and Information of the Knesseth (Parliament), The Education for Sciences and Technology, Roy Goldsmith, January 2010.

[5] Dr. Ofer Rimon, Director of the Administration for Science and Technology, Ministry of Education, Letter, November 6 2011.

[6] Dr. Ofer Rimon, Director of the Administration for Science and Technology, Ministry of Education, Letter, November 6 2011.

[7] Dr. Ofer Rimon, Director of the Administration for Science and Technology, Ministry of Education, Letter, November 6 2011.

[8] The data was received from David Maagan, head of the area of Higher Education and Teaching Human Resources, the Central Bureau of Statistics, letter from November 6, 2011.

[9] Web site of the Ministry of Education, Data on Examinations 2009; Chapter D;. Also Center for Research and Information of the Knesseth (Parliament), The Education for Sciences and Technology, Roy Goldsmith, January 2010.

[10] Web site of the Ministry of Education, Data on Examinations 2009; Chapter D;. Also Center for Research and Information of the Knesseth (Parliament), The Education for Sciences and Technology, Roy Goldsmith, January 2010.

[11] Web site of the Ministry of Education, Data on Examinations 2009; Chapter D;. Also Center for Research and Information of the Knesseth (Parliament), The Education for Sciences and Technology, Roy Goldsmith, January 2010.

[12] For example, while the mean grade in Meitzav for Mathematics in grade 8 among Hebrew speakers was 532, among Arabic speakers it was 498, a gap of 34 in the multi annual scale.

[13] RAMA (The National Authority for Measurement and Evaluation), Meitzav 2011, Part A Achievement Tests, October 2011.

[14] RAMA (The National Authority for Measurement and Evaluation), Meitzav 2011, Part A Achievement Tests, October 2011.

[15] The data was received from David Maagan, head of the area of Higher Education and Teaching Human Resources, the Central Bureau of Statistics, letter from November 6, 2011.

[16] The data was received from David Maagan, head of the area of Higher Education and Teaching Human Resources, the Central Bureau of Statistics, letter from November 6, 2011.

[17] Dr. Ofer Rimon, Director of the Administration for Science and Technology, Ministry of Education, Letter, November 6 2011.

* Note of the translator: Hozer Mancal are the statutory guidelines to the educational system periodically issued by the director general of the Ministry of Education.