Policy issues in mathematics education in Israel:
Might a crisis in mathematics education in the country lead to positive reform?

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Abstract

# Introduction

Mathematics is one of the core subjects taught in the education system in Israel, and successfully passing Bagrut (matriculation) examinations in mathematics is a prerequisite to obtaining a high school diploma. The importance of mathematics is based on it being a requirement for all core activities in modern society, being, as it is, the basis for logical-quantitative thinking and the infrastructure for the study and development of science and technology [[citation required]].

This passage was not written by an educator, a math teacher, or an educational policy maker of the Israeli Ministry of Education. The passage is from the [[year]] State Comptroller's report about mathematics in Israel, in which addresses most aspects of mathematical education, emphasizing the decline in the number of high-school students studying mathematics at advanced levels (4- and 5-unit levels), especially the decline in the number of students studying at 5-unit levels. It also discusses the gaps between the different cultural and ethnic sectors, the stronger and weaker socioeconomic groups, and gender.

Mathematics education occupies the attention of policy-makers at all levels: academia, industry, security, and education. Following the strong criticism of the comptroller’s report and the other reports that accompanied it (the Ben Zvi Report and the Harari Report), it became clear that change and reform was required to provide an answer to the need for more high school students graduating with higher-level mathematics.

Criticism and reports such as this create an opportunity for extensive dialogue on teaching the subject. While it may be an opportunity to discuss explicit objectives, content, and teaching methods, such specific issues may overshadow the necessity of a more general dialogue with a focus on higher philosophical and conceptual levels.

An age-old question in education is who should learn what? The answer to this question is quite controversial, especially when it comes to the study of the sciences. However, when the agenda focuses on the augmented study of pure science, the debate on the issue digresses beyond pedagogic and content boundaries and penetrates political, economic, and ideological areas.

Rulings and decisions regarding this question lead to organizational decisions at school and classroom levels: Is it advantageous to have classes or groups of high achievers? What is the school’s position regarding subject majors or grouping students with similar interests?

Despite the abovementioned problems, students and parents continue to regard the study of math and science as something that will contribute to success in life by opening doors (in the military, higher education, and job market) and improving chances of future employment. The prestige of scientific learning continues to rise in Israel, making it easier to persuade students to study mathematics or physics on the 5-unit level than to persuade them to study literature or some subject in the humanities or social sciences on a similar level.

Over the past century, reform in the area of science education has been similar to reforms in other areas of education. Prof. Zvi Lamm (2000) reviewed about 50 major reforms made in the last century and found that none had managed to bring about any fundamental change in school culture, each having only a marginal impact at best.

In this article, I will present the “Program for the Promotion of Mathematics and Scientific Excellence” as a critical event that can deal with this crisis on different levels: policy, budget, and pedagogical.

Robinson and Aronica (2015) write that reforming any situation requires three concept levels: criticism of the status quo, a vision of what is desired, and a theory of change by which the transformation from one situation to the other can be accomplished.

A central question is the essence of the vision. Is the vision the “number” or the “percentage” of students learning mathematics? As the first step of reform, this may be the important objective, but as we progress in the program, this objective transforms into a comprehensive theory of change! Now, the original objective (greater numbers of students) gives way to a more social and personal dimension so that the vision becomes realizing every student’s potential, regardless of their place of residence or socioeconomic background, and closing the gaps between the different sectors. That is to say, studying mathematics on a high level becomes an important tool for strengthening the weaker and/or peripheral sectors of society.

# The National Program for the Promotion of Mathematics and Scientific Excellence

## Background

In recent years, Israeli society has been concerned with the (low) achievements of students in mathematics and the sciences as expressed in the results of PISA (Program for the International Student Assessment) tests, the number of students applying to scientific and engineering faculties, and the significant and consistent decrease in the number of students studying mathematics and the sciences at 5-unit matriculation levels.

Between 2006 and 2013 there was a 30% decrease in the number of students aiming to study at a 5-unit matriculation level in math. Furthermore, the data showed a decrease in the number of students who excelled in this group.

The State of Israel has demonstrated significant achievements in research and development and in the number of successful start-up companies thanks to the work of its outstanding and gifted graduates. Over 90% of undergraduates in engineering faculties in Israeli universities studied and completed mathematics at the 5-unit level in high school. A decrease in the number of students wanting to study mathematics at the 5-unit level thus affects the human resources that can join high-tech industries, which will ultimately have a negative effect on Israel’s economy.

A recent published study by the Taub Center (2015) found a positive correlation between studying mathematics at the 5-unit level and achievement in the job market and/or income level. Indeed, we are witness to the frustration of many students who did not have an opportunity to realize their potential and their desire to study in a progressive, intellectual environment.

It is therefore clear that this reality has an impact both on the personal (fulfillment of academic and employment potential) and national (the future of security, economics, and academics in Israel) levels. Changing this reality will positively affect the social aspect.

##  Data

In this section, I present data demonstrating the extent of the problem: a significant decrease in the number of students studying mathematics at a level of 5-units. The data is shown as overall numbers (Graph 1), by ethnic sector (Jewish, Arab, Druze, Bedouin, Graph 2), by gender (Graph 3), and by socio-economic level of the school as based on the “care index” assigned to the school (and not according to the rating given by the Central Bureau of Statistics (CBS) to the community, Graph 4). (The school’s care index is more indicative of the socio-economic state of the school since it is based on student data, whereas the CBS data gives a representative picture of the entire community).

Graph 1: Overall number of students studying 5-unit mathematics units by grade and year (11th and 12th grades).



Graph 2: Number and percentage of students studying 5-unit mathematics by sector and year

Graph 3: Number of students studying 5-unit mathematics by gender and year

Graph 4: Number of students studying 5-unit mathematics based on care index of school and year

Graph 4: Numbers of students studying 5-unit mathematics based on care

# The reasons behind the problem

Like every issue in the socio-educational field, the significant and consistent decline in the number of students studying mathematics at the 5-unit matriculation level is a result of more than one factor. The factors, presented below, were gathered through discussions within the Ministry of Education and from information garnered in the framework of the “5×2 initiative” (2015) – a joint project of the Ministry of Education and the Business Coalition.

I shall divide the factors and barriers into a number of categories:

## Students

Today students have feelings of low efficacy, prefer higher marks at lower levels of difficulty and with less effort, have experienced learning gaps since junior high, and exhibit a lack of perseverance. In addition, Israeli students are at the age when they are facing upcoming military service, and many believe that it is too early to invest time and energy for the purpose of higher-level learning that will be completed only in about six years.

## Teachers

A large portion of teachers lack mathematical knowledge and have feelings low efficacy. There is a shortage of teachers able to teach on the level of 5-units. Programs training elementary and junior high teachers offer only a low level of mathematical education. There is a low number of graduates who pursue teaching due to issues of pay, professional status, and promotion opportunities. Many qualified teachers drop out of the system as a result of their difficulty in adapting to the educational system, their inability to invest their time and effort in struggling students, and the lack of a teacher support infrastructure.

## Schools

Many schools do not offer a 5-unit study program (only 566 out of 1100 schools taught mathematics at the 5-unit matriculation level in 2012). However, a major factor is the schools’ orientation towards percent eligibility. (That is to say, schools are more focused on the *number* of students taking matriculation – at any level – than the *quality*, that is to say the level, of matriculation). There is a lack of awareness about the importance of learning at the 5-unit level and about the very real difference between 4- and 5-unit study levels. Also, there is a lack of infrastructure for data-based management, a “tough” acceptance policy, and the absence of a consistent policy.

## Parents

Many parents show a lack of awareness of the importance of 5-unit matriculation studies. There are gaps (on the social level) of the extent of extra help provided. Parents tend to encourage children to aim for higher marks.

## Ministry of Education headquarters

An established, up-to-date database of teachers and students is not available. There is no appropriate curriculum (the only program available is an examination program) and there is a lack of updated learning materials. Furthermore, school evaluations are based only on the percentages of eligibility for matriculation without any quality parameters. There is also a lack of consistency in the degree of difficulty of matriculation exams, a lack of sufficient resources to support the educational tracks, and a lack of differential policies adapted to different sectors and populations.

## Associated organizations (academia, Business Coalition, non-profit sector, Israel Defense Forces)

**Academia**: The existing bonus policy encourages students to choose 4-unit over 5-unit matriculation levels. University policy does not encourage students in science programs to also participate in teacher training courses. There are a limited number of enrichment programs in the area of the sciences that nurture students in 5-unit programs while still in high school.

**Business Organizations**: There is a lack of coordination between the various intern/volunteer programs, a reduced scope, and the lack of pedagogical and professional knowledge.

**Non-profit sector:** There is a lack of proper coordination with Ministry of Education policies.

# Action plan for Promoting Mathematics and Scientific Excellence

The action plan takes into account the constraints discussed in the previous section and is accompanied by a budget that addresses the goals and objectives of the program. Most importantly, this action plan sets out clear, precise annual objectives.

As mentioned above, the plan’s goals do not restrict itself to simply increasing the number of students in 5-unit matriculation programs; there are wider objectives. The strategy when setting up the program was to begin with the 5-unit study programs in high school on the grounds that it would affect the 4-unit, and even the 3-unit, study programs, and, in the more advanced stages, would positively affect mathematics instruction in junior high and elementary schools. The program also assumes that increasing the number of students in 5-unit mathematics programs would also increase the number of students studying chemistry and physics at high levels (Today, the number of students at a 5-unit level in each subject has remained constant – approximately 8,000 students each.)

Table 1. Quantitative goals

|  |  |  |  |
| --- | --- | --- | --- |
| Population | Objective | In 2012 | Goal for 2019 |
| Students | Students with motivation, ability to withstand pressures and hardships, and having intellectual curiosity and commitment | 8,869 | 17,738 |
| Teachers | Increase in the number of mathematics teachers qualified to teach 5 units, an increase in training and professional development, strengthening the mathematical and pedagogical knowledge with some of the teachers | Approx. 1000 | 1,800 |
| Schools | Addition of 5-unit programs of study for mathematics and science in all schools in the country. | 566 | 800 |

As stated previously, this action plan provides measurable and reasonable annual goals. For example, regarding students, the objectives are set out in Graph 5.

Graph 5: Program objectives, number of pupils who sit for 5-unit matriculation exams by years.

## Awareness and motivation

In order to increase awareness and motivation, lectures, meetings, and tours are being offered to students, parents, teachers, and the community. In addition, there are a public campaign to raise awareness; endorsements by leaders in the Ministry of Education, local government and the business sector; and the publishing of an annual status report about mathematics education.

## Recruitment and professional development of teachers

Communities of teachers are being established with the help of leading educators. There is to be improved certification for active teachers, students are to be prepared for a degree in mathematics education, and engineers and graduates in the sciences are being encouraged to undergo teacher training (“from high-tech to teaching” program). B.Ed. graduates can undergo retraining to teach higher-level math and science, and an “adopt a teacher” program has been initiated whereby a veteran teacher mentors a teacher just starting out with the 5-unit program. Roles are better defined, and mathematics coordinators in the schools, teachers, teacher educators, and home-room teachers are being offered professional development programs. Teaching assistants and support staff are being recruited and trained.

## Student support

Student support includes the following: extra hours of mathematics instruction in junior high, extra hours to promote excellence in junior high, extra hours of individual instructions based on the number of students in 10th grade, and social involvement in mathematics. In addition, 5-unit mathematics students mentor junior high students. Special programs are being developed based on the requirements of the individual population and sector.

## Supportive technological environments

This includes expansion of high school and virtual mentoring; experimenting with the use of massive open online courses (MOOC); establishing a technology infrastructure for databases (teachers and students) on the school, district, and national levels; and increasing the amount of technological learning aids available (videos, practice sessions, demonstrations).

## Support policy

A Steering Committee was established which includes representatives of the Ministry of Education, academia, the business sector, the non-profit sector, the military, and other stakeholders.

***Academia***: This involves a change in the calculation method for bonuses for acceptance to universities (students who follow a 5-unit matriculation program will receive an extra 30-35 points, whereas those following 4-unit programs will continue to receive 12.5 points); adding a quality index when assessing schools and not just evaluating according to the percentage of students taking matriculation (the educational perspective that began in 2016); implementing the “new curriculum” in mathematics (including the development of learning materials); ensuring that school administrators provide a minimum number of teaching hours in mathematics; updating the policy of local authorities and schools to increase the number of 5-unit matriculation students; establishing an educational continuum from junior high to high school; maintaining and ensuring consistency in the level of difficulty of the matriculation exams; considering a system of rewards and incentives for 5-unit teachers; and establishing a training system that focuses on five-unit study in all districts.

# Intermediate achievements

Although it is difficult to provide a definitive view of the program's success at this early stage, I think that its results so far are impressive and encouraging based on three factors: the change in public discourse, the change in attitudes and conceptions in the schools, and initial increases in the numbers of students and teachers.

There is no doubt that the program has been well perceived by most of the media. Many articles have been written, most of which support the program and its goals. Some object to how mathematics is viewed quite differently from other subjects.

Nonetheless, the discourse continues and has begun to affect schools, parents, and students. In my opinion, this public debate is a positive occurrence and contributes to the program and changes made along the way.

A study conducted by the Israeli National Authority for Measurement and Evaluation in Education (known by its Hebrew acronym, RAMA) to evaluate the effect of the program in its first year points out that “according to the interviewees, in most of the schools examined, changes have occurred in two areas: An increase in the number of graduating students who have followed a 5-unit program in grade 12, and an increase in the potential pool of students who will follow a 5-unit program in coming years. In both cases, as noted, this was an expected change, even if the interviewees in question accorded the program high positive feedback as a result of their familiarity with the students concerned.”

The largest and most significant change occurred in the second year of the program, when new Minister of Education Naftali Bennett changed the “Math First” program into a national plan for the advancement of mathematics and scientific excellence. This was a program on a much wider scope that was accorded a large budget and the backup and support of all the heads of departments and directors at the Ministry of Education, including department director-general, Michal Cohen.

The main change observed after the summer 2016 matriculation exams was a sharp rise in the number of students applying for 5-unit matriculation programs. The planned goal for 2016 (see Graph 5) was 12,593 students at the 5-unit level. The summer 2016 matriculation data show that 12,846 students took the 5-unit matriculation exam, and this is still not the final number for the 2015-2106 academic year since some students have yet to take their matriculation exams (Winter 2017 exams had not yet been offered).

There was also an increase in the number of students following the 5‑unit program in sectors other than the Jewish one. For example, the number of students in the Arab sector taking 5-unit programs has increased by 47% compared to 2012 (the year with the lowest turnout), in the Bedouin sector it has increased by 145%, and in the Druze sector by 70%. In other words, the program’s goal of realizing student potential in the various sectors is indeed being fulfilled.

# Discussion and conclusions

In my opinion, this program is an example of how a crisis situation at the national level – one with potentially serious consequences on different layers of society – can be used as a starting point to deal with the problem overall and change the crisis into an opportunity to promote and correct social issues.

According to the RAMA evaluation report, already in its first year, the program succeeded in halting the decline in the level of mathematics education and reversing the trend. I believe this was due to several reasons:

1. correct analysis of the problem (many members in the field and in academia helped in analyzing the situation and determining the obstacles involved);
2. full support of Ministry of Education senior management;
3. tangible partnerships with outside agencies (e.g. the 5×2 initiative) that took part in the analysis and discourse, and took actual steps to help implement the program;
4. policy changes at administration level;
5. a very significant budget increase;
6. the program's holistic nature that included resources, teachers, a new policy, a change in the perception of teaching, and the creation of coalitions both within and outside the Ministry of Education.

I assume that the data will be in accordance with the defined objectives. I also assume that there will be some changes in the program and the various actions after gaining more experience.

Some people fear that the program will lose its momentum due to political factors in the case of changes in personnel in the Ministry of Education. I, personally declare that I have no such concerns because the program has proven its importance regardless of one political viewpoint or another.

# References

5x2. (2015) “About the Initiative.”

Retrieved from:

<http://www.5p2.org.il/about-the-5x2-initiative/>

Israel Ministry of Education. *Annual Reports*. Testing Division.

Israel Ministry of Education. (2014) *Teaching Mathematics,* (Hebrew)

Retrieved from:

<http://www.mevaker.gov.il/he/Reports/Report_248/afbac200-9404-4280-8003-39e7d8d78953/224-ver-4.pdf>

Lamm, Z. (2000). *Pressure and resistance in education: Articles and conversations*. Ed. Y. Harpaz Jerusalem: Sifriat Poalim Press. (In Hebrew)

Robinson, K. & Aronica, L. (2015) Creative Schools: The Grassroots Revolution That’s Transforming Education. New York: Viking Press.

Taub Center. (2015) “Regarding the connection between number of units studied in mathematics and salary level”

Retrieved from:

[http://taubcenter.org.il/he/ תורת-המספרים-על-הקשר-בין-מספר-יחידות-הב](http://taubcenter.org.il/he/%20%D7%AA%D7%95%D7%A8%D7%AA-%D7%94%D7%9E%D7%A1%D7%A4%D7%A8%D7%99%D7%9D-%D7%A2%D7%9C-%D7%94%D7%A7%D7%A9%D7%A8-%D7%91%D7%99%D7%9F-%D7%9E%D7%A1%D7%A4%D7%A8-%D7%99%D7%97%D7%99%D7%93%D7%95%D7%AA-%D7%94%D7%91)



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Fares has a BA in mathematics and statistics from the University of Haifa, and an MA in education systems management from the University of Haifa. In addition, he is a graduate of the Mandel Leadership Institute.

Today, he is director of the National Programs Division in the Ministry of Education. In his capacity as director of the National Programs Division, he is in charge of the National Program for the Advancement of Mathematics and Scientific Excellence, its main goal being to double the number of students studying at 5-unit matriculation levels. In addition, he is the director of a national program to advance English and a program to promote excellence in the periphery.

 From 2009 to 2014, Fares served as the National Commissioner of Druze and Circassian education, and prior to that, he was Northern District Superintendent of Druze and Circassian education.

From 2003 to 2007, after completing a two-year program of study at the Mandel Leadership Institute, Fares worked at Ministry of Education headquarters in Jerusalem, implementing the Shoshani Report on differential budgeting, and supervising teachers’ salaries in the Economics and Budgeting Administration of the Ministry of Education.

Fares founded and directed both the Yarka High school of Sciences and the community school in Hurfeish. Previously, he taught mathematics and computer science at several schools in the Galil in Israel.