How can Women Be Encouraged to Choose Excellence Tracks Leading to Employment in Tech Positions and the High-Tech Sector?

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This is a short summary, for the full paper (in Hebrew) see https://www.runi.ac.il/research-institutes/economics/aiep/policy-papers

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How Can Women Be Encouraged to Choose Excellence Tracks Leading to Employment in Tech Positions and the High-Tech Sector?

This policy paper was conducted in collaboration with the Trump Family Foundation, the TOP15 Initiative for the promotion of excellence in middle schools and Israel Innovation Authority, who has sought to explore possible ways and to propose interventions which may encourage more female students to pursue technological excellence tracks of study, thus reducing the gender gaps in these tracks.

To address this research challenge, we defined a technological excellence track – "tech track" – as a course of studies and accomplishments which comprises the following junctures: the juncture of opting to undertake an excellence program in **middle school**, the juncture of opting for "high-tech matriculation" in **high school**, the juncture of being selected for a technological unit during **military service**, the juncture of enrolling for a "high-tech degree" during **academic studies**, and the juncture of integrating into **employment** in a technological position and/or the high-tech sector.[1]

Examining the ratios of males to females along the tech track reveals that gender gaps begin to emerge as early as middle school: in **middle school** excellence programs, the share of female students is already 40%; in **high school**, the share of females among students undertaking high-tech matriculation is 35%; during **military service**, the share of female soldiers in technological positions is around 40%; in **academic technology majors**, the share of female students is 30% during the first year of studies, and their share among first-degree graduates is 25%; and in the **job market**, the share of female employees in technological positions, in the high-tech sector, and in R&D positions within the high-tech sector is 31%, 33%, and 20%, respectively.

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[1] Excellence programs in middle school: Programs which consist of a separate, dedicated homeroom class, including Scientific and Technological Reserve (AMAT) - a six-year excellence program of the Ministry of Education that aims to increase the number of students who complete five units in mathematics, science and physics, MOFET, Nachshon, Air Force Cadets, Gifted class.
High-tech matriculation: Expanded matriculation (5 study units) in English and Math, as well as Physics and/or Computer Science.
For the definitions of high-tech degree, high-tech sector and technological positions see footnote 2.

Three key phases account for most of the gender gap along the tech track: participation in an excellence program, studying for high-tech matriculation, and studying for a technology degree. The transition from technology degree studies to employment in the high-tech sector / tech position narrows down the gender gap, and the transition from technology degree studies to employment in an R&D position accounts for around 6% of the gender gap.

The existing gender gaps cannot be explained by differences in abilities between men and women, but rather by the different choices and preferences of boys and girls. Insights regarding the causes for the different choices made by boys and girls in the middle- and high-school phases include: (1) in middle school, girls make decisions more independently than boys (boys tend to seek more assistance from parents and math teachers when making decisions regarding their studies); (2) in middle school, girls assign less importance to the benefits they may derive from technological studies during their military service, and from employment in the high-tech sector upon entering the job market; (3) girls see themselves as less capable than boys with regard to Physics studies, however in Computer Science they see themselves as having equal or higher ability compared to boys.

An important finding of this study is that, in middle school as well as high school, **the main reason both boys and girls do not participate in excellence programs is the absence of such programs, or of information regarding their existence. The shortage of homeroom-class excellence programs in middle school, combined with a gender bias favoring boys among math teachers, contribute to gender imbalance in excellence programs and in high-tech matriculation tracks.** Since the share of female students who choose high-tech matriculation studies in high school is significantly higher among those who participated in excellence programs during middle school, and since such excellence programs do not operate throughout Israel, this finding may account for a significant part of the heterogeneity in the rate of eligibility for high-tech matriculation among schools.

In light of these findings, we recommend the following measures which may influence the decision of more female students to pursue excellence tracks:

1. **Providing every high-school student in Israel with access to high-tech matriculation studies, within their own school or in the framework of super-regional excellence centers and virtual classrooms.**
2. **Opening AMAT classes** in line with the recommendations of the Committee for Increasing Human Capital in High-Tech (“Perlmutter Committee”) and Government Resolution no. 172 – “Accelerating the Labor Market Through Advancing Human Capital and Adapting Skills to the Digital Age”.

3. **Emphasizing the promotion of excellence programs directly to female students, alongside better guidance and counselling by the professional staff in schools.**
4. Diversity report: advancing gender balance in excellence programs (AMAT, MOFET, Gifted tracks), publicizing diversity data on **Transparency in Education** website for high-tech matriculation studies, in **academia** for technology degrees, in the **job market** for tech positions.
5. Increasing awareness of parents in general, and parents of girls in particular, regarding the contribution of high-tech matriculation to high-quality employment, specifically employment in tech positions and in the high-tech sector.
6. Increasing the exposure to the contribution of "high-tech skills" to the high-quality employment of women.
7. Facilitating broad access to extra-curricular science and programming activities, and encouraging the participation of girls in these activities.
8. Differential budgeting of municipal authorities' investment in education, based on meeting targets of eligibility for high-tech matriculation in general, and that of female students in particular (requires benchmarks for assessing the effectivenss of programs, along the lines of PISA and MEITZAV exams).
9. Collective Impact activities aiming to increase the share of female students throughout the tech track (accompanied by effectivness measurement to assess the contribution of these programs to raising PISA and MEITZAV scores).

In addition, we recommend devising a plan and setting national targets for the encouragement of:

- Male and female students who are inclined to take 4-unit math matriculation (around 20% [14,000] of girls and around 16% [10,000] of boys), to further expand up to 5 study units.
- Male and female students who are inclined to take 3-unit math matriculation, to expand up to 4 study units.

We also recommend conducting a follow-up study in order to explore whether there are causes for the gender gap as early as kindergarten and primary school ages, and identify ways to encourage the interest of girls in STEM subjects, starting at kindergarten and primary school ages.

1. Summary and Conclusions

This policy paper was conducted in collaboration with the Trump Family Foundation, the TOP15 Initiative for the promotion of excellence in middle schools and Israel Innovation Authority, who has sought to explore possible ways and to propose interventions which may encourage more female students to pursue technological excellence tracks of study, thus reducing the gender gaps in these tracks.

To address this research challenge, we defined a technological excellence track as a "tech track" – a course of studies and accomplishments which comprises the following junctures: the juncture of opting to participate in an excellence program in **middle school**, the juncture of opting for "high-tech matriculation" in **high school**, the juncture of being selected for a technological unit during **military service**, the juncture of enrolling for a "high-tech degree" during **academic studies**, and the juncture of integrating into **employment** in a technological position and/or the high-tech sector.[2]

The track which leads to employment in tech positions and/or the high-tech sector is defined as an "excellence track" because: a. workers in tech positions and the high-tech sector are characterized by high skills which enable them to perform knowledge-intensive tasks with very high labor productivity – around ILS 600,000 per year – twice as high as that of workers in other economic sectors (Hashai, Sumkin and Nir, 2022); b. the contribution of the high-tech sector to the growth of the Israeli economy over the last five years has been around 40% of

[2] Excellence program in middle school**:** Scientific and Technological Reserve [AMAT], MOFET, Nachshon, Air Force Cadets, Gifted class.
High-tech matriculation: Expanded matriculation (5 study units) in English and Math, as well as Physics and/or Computer Science. This matriculation structure was found to predict studies for a technology degree and employment in the high-tech sector, as per a study published by the Aaron Institute for Economic Policy in collaboration with the Trump Foundation and TOP15, see Hashai, Sumkin and Nir (2022), "What Are the Necessary Skills for High-Tech Workers".
High-tech degree: computer science, mathematics & computer science, management information systems, electrical engineering, electronics engineering, computer engineering & computer science, computer & electrical engineering, communication systems engineering, and data systems engineering.
High-tech sector: HT industry - manufacture of pharmaceutical products, including homeopathic preparations (21), manufacture of computer, electronic and optical products (26), manufacture of air and spacecraft and related machinery (303); HT services - computer programming, consultancy and related activities (62), data processing, hosting and related activities and web portals (631), scientific research and development (72).
Technological positions: All workers in the high-tech sector, plus workers in other sectors in occupations - information and communications technology service managers (133), physical and earth science professionals (211), Life science professionals (213), engineering professionals (214), electrotechnology engineers (215), software and applications developers and analysts (251), database and network professionals (252), physical and engineering science - practical engineers and technicians (311), information and communications technology operations and user support practical engineers and technicians (351), telecommunications and broadcasting practical engineers and technicians (352).

the growth of the GDP, which is twice as much as the share of the high-tech sector in the GDP (around 18%); c. the high-tech sector encourages an increase in the share of workers in tech positions in other economic sectors, as well as in their productivity and wages, by boosting competitiveness, investing in innovation and undertaking optimization processes.

Despite the higher wages of workers employed in tech positions and in the high-tech sector, not all population groups manage to integrate in this high-quality employment to the same extent, and women in particular are significantly underrepresented: among employees in tech positions as well as those employed in the high-tech sector, the ratio of men to women approximates 2:1, whereas the ratio of men to women among all salaried workers across the economy is around 1:1. These gender gaps suggest that there is a substantial untapped potential of women in knowledge- and technology-intensive firms.

Our aim in breaking down the tech track to decision and selection junctures is to quantify the significance of each stage / juncture to the emergence of gaps, to discern the main reasons driving women to quit the tech track at each stage, and to formulate policy recommendations and actionable measures meant to retain women and even increase their participation through the track.

A current overview (as of the year 2020) of the gender gaps at each stage shows that the gaps begin to emerge as early as middle school: in **middle school** excellence programs, the share of female students is already just 40%; in **high school**, girls opt for a different matriculation aggregate than boys, despite the dramatic increase in the share of students taking 5-unit math matriculation, and although boys and girls share a similar rate of high mathematical and technical competencies during middle school (the top quintile of the MEITZAV scores is equally shared by girls and boys). The share of girls who take high-tech matriculation, out of all female high-school students, is around two thirds of the share among boys, while the share of girls taking expanded matriculation in Biology and/or Chemistry is nearly three times higher than the share of boys taking this matriculation track.[3] Accordingly, the ratio of girls to boys among students taking high-tech matriculation is 1:2 (35% girls, 65% boys). In the **army** as well, the share of female soldiers in technological positions is low, standing at around 40%. The share of **first-year female students** majoring in technological subjects decreases to around 30%, and drops further to 25% among **first-degree graduates** with a technology degree. The share of **female workers** in tech positions is 31%, in the high-

[3] Biology/Chemistry matriculation: Five study units in English and Math, along with five units in Biology and/or Chemistry (without expanding Physics or Computer Science). In 2020, 11.5% of male students took high-tech matriculation compared to 7.3% of female students, while 1.7% of male students had earned expanded matriculation in Biology and/or Chemistry compared to 4.7% of female students.

tech sector it stands at 33%, and is lower still among workers in R&D positions within the high-tech sector, of whom only 20% are women.

Quantifying the gender gaps at each stage for the year 2020 was carried out for individuals from different age groups. In order to track the development of these gender gaps through the various stages of the tech track for the "same" people, we chose individuals from the age group born between 1984 and 1989. The life course of an individual born in 1984 may look like that: at age 12, in 1996 – graduating from primary school and starting middle school; at age 18, in 2002 – graduating from high school and starting military service; at age 22, in 2006 – completing military service and starting first year or academic studies; at age 25, in 2009 – graduating with a first degree and entering employment in the job market. Hence, tracking the age group born between 1984 and 1989 enables us to track individuals who finished primary school and started middle school between 1996 and 2001, finished high school and started their military service between 2002 and 2007, completed their military service and started their first year in higher education institutions between 2006 and 2011, and completed their first degree and entered the job market between 2009 and 2014.

The table and figures below present, in relation to those born between 1984 and 1989, the share of males along the tech track, from middle school up to the integration into the job market in 2019, and the contribution of each phase to the expansion or narrowing of gender gaps. The contribution of each phase to the gender gap is calculated according to the following formula:

$$contribution_x = \frac{(maleshare_x - maleshare_{x-1})}{(maleshare_N - maleshare_0)}$$

where *$maleshare_N$* represents the share of males at the job market phase, *$maleshare_0$* represents the share of males in the sample, and *$maleshare_x$* represents the share of males along the tech track. Accordingly, the share of males in our sample *($maleshare_0$)* is 47%; the share of males in excellence programs is 60%; the share of males taking high-tech matriculation is 64%; the share of male first-degree graduates is 39%, the share of male first-degree graduates with a technology degree is 78%; and finally, the share of males in the high-tech sector, among employees aged 30 to 35 (in 2019), is 64%. Hence, **the gender gap to be explained in the tech track stands at 17%** - the difference between the share of males working in the high-tech sector (final stage of the tech track) which is 64%, and the share of males in our sample (first stage of the tech track) which is 47%. The difference between the share of males in excellence programs (60%) and the share of males in our sample (47%) stands at 13%, thus the excellence-programs phase accounts for 77% (13%/17%) of the gender gap throughout the tech track. The phase of high-tech matriculation studies in high school accounts for 24% of the gender gap throughout the tech track (the difference between the share of males taking high-tech matriculation and the share of males in excellence programs [4%] divided by the overall gender gap throughout the tech track [17%]), and so forth.

Table 1: Tech tracks – quantifying gender gaps and the contribution of each phase

Tech Track Timeline	Track Completion: Employment in High-Tech Sector		Track Completion: Technology Degree and Employment in High-Tech Sector		Track Completion: Employment in High-Tech Sector OR High-Tech Matriculation Graduates Employed in Other Sectors	
	% of Males	Contribution	% of Males	Contribution	% of Males	Contribution
Sample	47%		47%		47%	
Excellence Programs	60%	77%	60%	40%	60%	79%
Taking High-Tech Matriculation	64%	24%	64%	12%	64%	25%
Academic Degree	39%	-145%	39%	-75%	39%	-148%
Academic Technology Degree	78%	226%	78%	117%	78%	231%
Track Completion (2019, aged 30-35)	64%	-82%	80%	6%	64%	-86%

Source: Aaron Institute tabulations based on CBS data, 1984-1989 cohorts.

Figure 1: Tech tracks – quantifying gender gaps and the contribution of each phase up to employment in the high-tech sector (and approximately tech position)

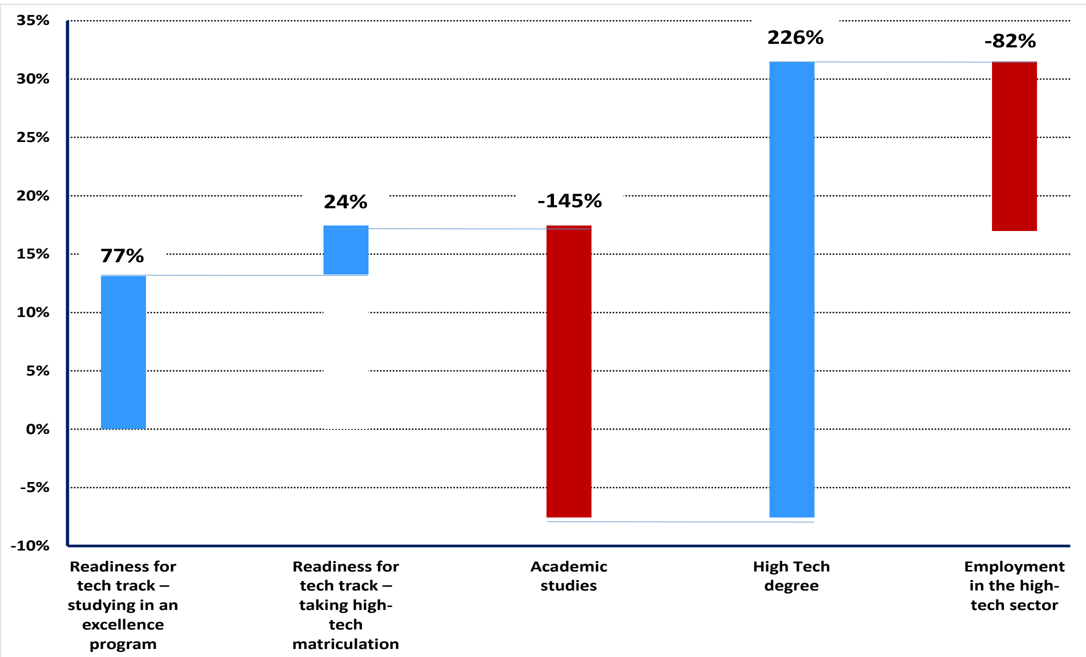
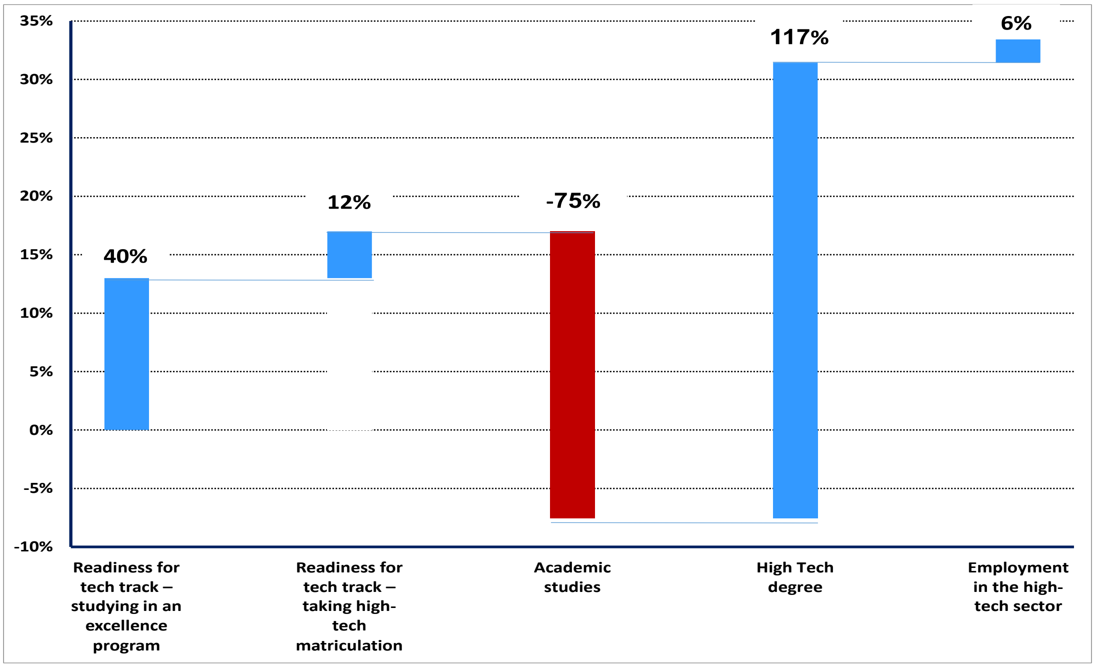


Figure 2: Tech tracks – quantifying gender gaps and the contribution of each phase up to employment in an R&D position in the high-tech sector (technology degree graduates in the high-tech sector)



Three key phases account for most of the gender gap along the tech track: participation in an excellence program, studying for high-tech matriculation, and studying for a technology degree. The most significant stage in terms of explaining this gap is studying for a technology degree, followed by participation in an excellence program. The transition from technology degree studies to employment in the high-tech sector / tech position narrows down the gender gap, and the transition from technology degree studies to employment in an R&D position accounts for around 6% of the gender gap.

As stated above, **these gender gaps cannot be explained by differences in capabilities between men and women**. Research findings, as well as the performance of boys and girls in the MEITZAV exams taken in 5th and 8th grades, indicate that boys and girls share a similar rate of high mathematical and technical competencies (around 20% of boys and around 20% of girls are in the top quintile of the MEITZAV scores); ergo, **the gender gaps in the middle- and high-school phases stem from different choices and preferences of boys and girls**.

To investigate the reasons for the differing choices of boys and girls in the middle- and high-school phases, our study included several surveys, the results of which reinforced the claim that it is not a matter of differences in capabilities.

The surveys point to some important insights: (1) in middle school, girls make decisions more independently than boys (boys tend to seek more assistance from parents and math teachers when making decisions regarding their studies), therefore girls should be approached directly and presented with the benefits of studying technological subjects; (2) in middle school, girls assign less importance to the benefits they may derive from technological studies in their military service and in the job market, therefore middle- and high-school students should have more exposure to the association between studying technological subjects during middle school and high school and opportunities for high-quality employment in the job market, including the finding which shows that the wages of those who had taken high-tech matriculation tend to be higher compared to those who had taken any other matriculation aggregate – the wage premium for high-tech matriculation among non-Haredi Jewish men (women) is 93% (110%), while the wage premium for matriculation in the Biology-Chemistry track is only 55% (86%). Similar outcomes can be seen when comparing the wage premiums of students who had taken 4-unit Math matriculation. In this case as well, the wage premium for expanded matriculation in Computer Science is significantly higher than that of expanded matriculation in Biology-Chemistry. And among these students as well, the share of girls who choose Biology-Chemistry over Computer Science is higher than the share of boys; (3) girls see themselves as less capable than boys with regard to physics studies, however in computer science they see themselves as having equal or higher ability compared to boys. Since computer science matriculation is an equal or even stronger predictor of high-tech employment compared to physics matriculation, girls should be encouraged to take computer science matriculation (in part, by increasing the availability of classes and teachers preparing for this matriculation). For high-school students, the surveys present a similar picture, with the main difference being that **in high school girls see themselves as having even better grasp of scientific subjects than boys**.

An important finding which emerges from our surveys is that, in both middle- and high-school phases, **the main reason that boys and girls do not participate in excellence programs is the absence of such programs, or of information about them.** 53% of girls (47% of boys) of the middle-school students surveyed, and 69% of girls (58% of boys) of the high-school students surveyed, stated that the reason they did not study (or had not previously studied) in a homeroom-class excellence program was the absence of such a program in their school. **The shortage of homeroom-class excellence programs in middle school, combined with a gender bias among math teachers, contribute to gender imbalance in excellence programs and in high-tech matriculation tracks.**

Since the share of female middle-school students who intend to pursue high-tech matriculation studies in high school, and the share of female high-school students taking high-tech matriculation, are significantly higher among those who participated in excellence programs during middle school, this finding may account for a significant part of the heterogeneity in the rate of eligibility for high-tech matriculation among schools. In addition to these findings, we found that school size has a positive effect on the rate of eligibility for high-tech matriculation, and this outcome holds for both boys and girls; however, in schools where the rate of eligibility for high-tech matriculation is higher, the share of girls who earn such matriculation is actually lower: 40% girls compared to 60% boys. As previously mentioned, a similar ratio of 40% girls is also prevalent in programs for gifted students. In this context, it should be also noted that the locality of the school – its size, wealth, area, and proximity to employment hubs – have an effect on its education budget and on the eligibility rate for high-tech matriculation.

In light of the aforementioned findings, we recommend the following measures which may influence the decision of more female students to pursue excellence tracks:

1. **Providing <u>every</u> high-school student in Israel with access to high-tech matriculation studies**, within their own school or in the framework of super-regional excellence centers and virtual classrooms.
2. **Opening AMAT classes** in line with the recommendations of The Committee for Increasing Human Capital in High-Tech ("Perlmutter Committee") and Government Resolution no. 172 – "Acclerating the Labor Market Through Advancing Human Capital and Adapting Skills to the Digital Age".[4] **Emphasizing the promotion of excellence programs directly to female students, alongside better guidance and counselling by the professional staff in schools.**
3. Diversity report: advancing gender balance in excellence programs (AMAT, MOFET, Gifted), publicizing diversity data on **Transparency in Education** website for high-tech matriculation studies, in **academia** for technology degrees, in **the job market** for tech positions.
4. Increasing awareness of parents in general, and parents of girls in particular, regarding the contribution of high-tech matriculation to high-quality employment, specifically employment in tech positions and in the high-tech sector.
5. Increasing the exposure to the contribution of "high-tech skills" to the high-quality employment of women.

[4] See (in Hebrew) https://www.gov.il/he/departments/policies/dec172-2023.

6. Facilitating broad access to extra-curricular science and programming activities, and encouraging the participation of girls in these activities.
7. Differential budgeting of municipal authorities' investment in education, based on meeting targets of eligibility for high-tech matriculation in general, and that of female students in particular (requires benchmarks for assessing the effectivenss of programs, along the lines of PISA and MEITZAV exams).
8. Exploring the possibility of increasing the number of female students invited for the selection process for techonological units in the IDF, in order to increase their share in the academic studies stage.
9. Collective Impact activities aiming to increase the share of female students throughout the tech track (accompanied by effectivness measurement to assess the contribution of these programs to raising PISA and MEITZAV scores).[5]

In addition, we recommend devising a plan and setting national targets for the encouragement of:

- Male and female students who are inclined to take 4-unit math matriculation (around 20% [14,000] of girls and around 16% [10,000] of boys), to further expand up to 5 study units.
- Male and female students who are inclined to take 3-unit math matriculation, to expand up to 4 study units.

We also recommend conducting a follow-up study in order to explore whether there are causes for the gender gap as early as kindergarten and primary school ages, and to identify ways to encourage the interest of girls in STEM subjects, starting at kindergarten and primary school ages.[6]

[5] Cross-sector collaboration to address social problems, see https://sheatufim.org.il/en/.
[6] In 2020, the US enacted the Building Blocks of STEM Act, which requires the NSF to allocate research funds towards identifying measures which may encourage the interest of girls in STEM subjects, starting at kindergarten and primary school ages, in order to increase the participation of women in these occupations, see https://www.congress.gov/bill/116th-congress/senate-bill/737.