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Review Article

Israel's Achievements in Mathematics in the Last International Examinations: Part I: The TIMSS 2011

ABSTRACT: After more than two decades of deterioration in the Israeli TIMSS results in mathematics, Israel scored number 7 among all countries participating in the world. As the probability of such a sudden, huge improvement seems negligible, this article sheds a new light on the Israel "achievements". It shows that the students participating were not a sample according to statistical definitions and in additions – two sub-populations with the lowest Israeli achievements did not participate in this international examination.

Key words: TIMSS 2011, Israel, mathematics

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Introduction: The Unbelievable Israeli Miracle

When the results of the TIMSS 2011 Mathematics achievements were first published, Israeli media praised the astonishing finding: the Average Israeli scale score was 516, the 7th in the world, with only the Republic of Korea, Singapore, Chinese Taipei, Hong Kong SAR, Japan and the Russian Federation scoring higher (Mullis et al., 2012, Exhibit 1.2). This achievement aroused a few questions:

How is it possible to climb from no. 25 to no. 7 (with just 45 participants) in a 4 year period? In 2007 Israel ranked 25th among the 59 participants (Mullis et al., 2008), with an average of just 463, well below the 500 average (ibid, Exhibit 1.1. p. 35).

How was it possible to gain 53 points in such a short time, while all other countries with lesser achievements in 2011 – but still higher than the average – if at all – had just a small portion of this point increase? Of the 7 countries that scored much better than Israel in 2007, and had above average achievements 6 took also the TIMSS 2011 math examinations but had lower achievement than Israel in 2011. The US gained during these 4 years just one point (from 508 to 509); England decreased its achievements (from 513 to 507); Hungary scored 517 in 2007 but only 505 in 2011; Australia increased its achievements by 9 points (from 596 to 505); Slovenia decreased its achievements form 505 in 2007 to 501 in 2011 and Lithuania decreased its achievements by 4 points (from 506 to 502).

How come the seven countries scoring in math achievements better than Israel in TIMSS 2007, Italy (480), New Zealand (492), Kazakhstan (549), Sweden (503), Ukraine (469), Norway (473) and Armenia (500) scored less than Israel in TIMSS 2011 (498, 488, 487, 484, 479, 475, 467 accordingly); only 3 of them improved their achievements during these 4-year period and their improvement was minor in comparison to the 53-point Israeli improvement: Italy's achievements increased by 18 points, Ukraine's – by 10 and Norway had a modest 2-point improvement.

The "festival" around these allegedly achievement took exactly one day. The former Minister of education, Mr. Gideon Sa'ar described it as "[…] a dramatic change, Israel's students made a huge jump-off" (An achievement to Israel's students, 11.12.2012; Nesher, 11/12/2012). However, it did not take more than a day until Israel's media became quite suspicious (Arlozorov, 13/12/2012; Munshari Goren, 11/12/2012; Nesher, 16/12/2012) regarding these results. Here are some of the main problems in the extreme improvement Israel showed in just 4 years in the international math examinations.

Problems in The Israeli TIMSS 2011 Math Results

Here are the main points that can explain – at least partially – such a miraculous improvement occurring in just 4 years.

Only 77.4% of Israel grade 8 students participated in the TIMSS 2011 math exam (Mullis et al., 2012, Appendix C.3: coverage of TIMSS 2011 .Target Population, p. 437). The 22.6% absentees consisted of 16.4% School-level

Exclusions and 6.2% Within-sample Exclusions (ibid). Of all other participant countries only 5 had over 5% absentees; with a maximum of 7.2% (in the US). This fact was mentioned in many Israeli articles from publishing day of the results (e.g. Meniv, 2012; Solomon, 2012). Needless to explain that under such circumstances there is no meaning to the statistical term "sample" and thus – the "excellent achievements" are in fact pseudo-results.

Even before the publishing of these results Israeli media published dozens stories of both teachers and students questioning the conduct of the exam. Indeed, these stories were mostly published either without a reliable source or as talkbacks (e.g. Chai, 16/12/2012). Such stories came from all parts of Israel: one was about only a third of the Eilat students that were allowed to take the TIMSS exams in order to keep a "high level" another – about the choosing of a gifted class in Tel Aviv rather than a random class in that school, one other was about massive copying and teachers helping the students while in another school: about half of each class chosen did not take the exam, in comparison to 2-3 students per class in previous years". Indeed, such stories can be dismissed as false rumors, but given that I. they came out from too many sources; II. Many of them were published right after the examinations, a long time before the results came out; III. Taking into consideration a similar situation – when in 2003 the math achievements of Israeli 8th graders showed a large improvement since 1999, the praises and the pride of everybody in charge proved to be too soon.

The main reason of the 2003 "improvement" was the fact that only 77% of the relevant age group students took the examination (David, 2008). And indeed, the 2007 TIMSS results proved that the joy was premature. As had been the case in 2003, when no Ultra-Orthodox boys (e.g. test of time, 2012) and just a part of Arab students took the TIMSS math exam, the 2011 jump-off happened, according to Chai (16/12/2012) because "they did not include Jewish Ultra-Orthodox and Arabs". As a matter of fact, these examinations did include Arabs living in many parts of Israel, and thus "responsible", according to many journalists (e.g. Solomon, 2012) as well as scientists (Beller, 2012) to the enormous huge Arab-Jewish gap in the achievements: 71 points.

However, at least 16.5% of the Arab students did not participate in the TIMSS 2011 examinations: those of East Jerusalem (Solomon, 2012). The exact number of grade 8 students in East Jerusalem cannot be figured, as many – about 10% of them have already dropped out of school in grade 8 and about 20% - in grade 9 (Eitan et al., 2013), or even up to 40% (Tatarsky, 2013). In 2011 the number of Arabs living in Israel was about 1,938, 400 (CBS, 2013, table 2.2); about 300,000 of them lived in East Jerusalem. Thus, even without taking into consideration the high birth-rate of the Jerusalem Arabs in comparison to the decreasing birth-rate the general Arab population in Israel, the assumption that 16/5% of Arab students did not participate in the TIMSS 2011 examinations is quite modest.

The TIMSS 2011 examinations did not include special education students. The term "special education student" is quite unclear in Israel. According to CBS (Statistical Abstract of Israel, 2013), in the 2011/12 school year 106,668 elementary school students belonged to this 3-stage category: those learning in special schools, in special classes and in inclusion (ibid, table 8.15). This means that of the 924,010 elementary school students – 671,908 Jews and 252,102 Arabs, table 8.8), about 11.5% were "special education students". However, when we look at the tale of "Examinees who received accommodations for matriculation exams, by selected characteristics" (ibid, table 8.25) the picture is different. **34.8**%, namely **30.360** of the **87,292** students taking the matriculation exams in 2012 received level-1, 2 or 3 accommodations. Among Jewish students it was **39.9**%, namely **26.890** of the 67,342 grade 12 students. If "special education students" did not participate in the TIMSS examinations (Arlozorov, 2012; Kashti, 2012) there is no way to know whether the meaning was that in the Jewish sector almost 40% of the probably less able, especially in taking exams students, were excluded. In any case – it is clear that taking out such amount of the population gives a twisted if not an untrue picture.

In summa:

Even without taking into consideration the unproved testimonies about the highly selective population of students that took the examinations the published facts demonstrate that the students participating could not have been considered a sample and thus the "results" have been meaningless.

Additional Facts that Contradict the Allegedly Math High Performance of Israel in the TIMSS 2011

The TIMSS 2011 results contradict those found in the yearly internal math examinations – the Meitzav [Education Ministry's Performance Index] taken at the same year by the same age group and showing decline in the achievements in comparison to the previous examinations (Skop, 2013; Velmer, 2012). Frank (2012) had explained this point by comparing the Meitzav and the TIMSS results during the same time period: 2007-1011. The Meitzav examinations include 4 times more same age students than the TIMSS, thus, they are probably more reliable and more exact. In 2008 the Israeli math average in the Meitzav was 500; in 2009 – 509; in 2010 – 511, in 2011 – 522 and in 2012 – 501. All in all – an improvement of one point during the interval between the previous and the current TIMSS results. That means, that the expected result of the TIMSS 2011 was about the same as in 2007, namely, 24th in the world score rather than 7th. There is no reason to assume that the marvelous improvement shown in the international examinations had no trace in the national ones.

According to "The test of time" (2012), the TIMSS 2011 was very different from the TIMSS 2007 math test, and thus "The international Association for Evaluation of Educational achievement (IEA) did accept the Israeli results under the condition that no comparisons would be made with previous tests" (ibid) due to the enormous changes in the translation of the test into Hebrew. Mr. Foy, who is the IEA person in charge of the analysis of the data , said, on a telephone call from Boston on 20/12/2012 that: "the Israeli side was determined to change the examination, even though we made it clear

to them that it would be impossible to compare the results [after the changes]" (ibid).

According to Mullis et al. (2012, table 8.5), Israeli students scored the highest in the world in their math self-confidence. While in China, the world record-holder in achievements, only 7% of the students had full confidence in their math knowledge, in Israel it was 31%. However, these 7% Chinese students has a basis for their confidence they scored 709 in the math exam, while the over-confident Israelis scored just 573.

Israeli students had also the world record in the smallest rate of students with no math confidence: 22% (ibid). No less than 14 countries with the rate of students having no math confidence varying between 27%-49% had higher actual math achievements (ibid). Thus, it should be concluded that self-confidence does not necessarily result in higher scores…

69% of Israeli teachers Israeli teachers reported being "satisfied" (Mullis et al., 2012, Exhibit 7.16: Teacher Career Satisfaction), scoring in the world second place along with Armenia and Tailand, with only Chile having a higher rate of "satisfied" teachers (72%). The Israeli data is very different in many aspects. Take, for example, the salary one: the Israeli teacher is very poorly paid. According to Chai (25/6/2013): "[…] Israeli schools lag behind OECD counterparts in investment per student. Teachers work less hours, earn lower salaries, classrooms most crowded". For example: "The secondary education average in Israel was $25,159, compared to the OECD average of $40,382" (ibid). The conclusion must be that either the participating teachers lied, and thus it is hard to believe to any other data given by them, or [almost] only "satisfied" teachers participated in the TIMSS and thus we have another proof that the "sample" was rather a chosen group of classes with exceptional, well-paid teachers.

The Israeli teacher must deal with discipline problems resulting in a world record in dropout of teachers. Only 6% of 8th grade math teachers declared that there were "hardly any problems" regarding (Mullis et al., 2012, Exhibit 6.10: School Discipline and Safety). The same rate was found in Morocco, New Zealand and Malaysia, while only in 5 countries the rate was lower in Hungary (5%), Tunisia (4%), Syrian Arab Republic (3%), Finland (2%) and Sweden (1%). It is difficult to understand how it is possible to feel a high level of satisfaction when teaching classes with discipline and safety issues.

How did it happen? What could have caused such an increase in the Israeli TIMSS 2011 score?

Over-preparation of the students (e.g. Arlozorov, 2012; Finkeltein, 2012; Munshari Goren, 2012).

After the publishing of the TIMSS 2011 results one of the immediate assumptions that could have explained the extreme increase in the Israeli score was "over-preparation of student". How is it possible to prepare too much? If it is – how come it had not worked in other international examinations?

It is indeed possible that before taking the TIMSS 2011 examinations Israeli students had more preparations than in previous years. However, if this is the case – the conclusion must be that Israeli students must learn more than they had before, and Israeli teachers must teach more, for example – more hours. According to Chai (25/6/2013):

> […] Within middle schools, the average Israeli teacher's hours in the classroom stood at 874, compared to 1,219 in OECD countries. In high schools, the hours were even lower, with 700 in Israel, compared with the average 1,154 hours in OECD member nations.

A sharp increase in the teachers' level

The assumption that Israeli math teachers improved dramatically from 2007 to 2011 contradicts all other available data. Let us look at some of these discrepancies.

According to the data available from the Central Bureau of Statistics (CBS, 2013), the vast majority of 11- and 12 grade teachers, preparing the students for the matriculation examination, do not have even a BSc in math. How is it possible that 53% of the TIMSS 2011 sample – teaching junior high school students (Mullis et al., 2012, Exhibit 7.4: Teachers Majored in Education and mathematics) – had such teachers, when they hardly exist in high school?

Prof. Azriel Levi, the former Head of the Mathematics Committee in the Israeli Ministry of Education, summarized this situation responding to the news about the sharp dropout in the rate of students taking the 5-point math matriculation exam in 2011/2:

> "The real problem is that we do not have teacher even for the small minority of students taking the highest, 5-point math matriculation exam. We shall make an effort to have more students learning high level math when we have a surplus of university graduate teachers who are unemployed. In

the current situation less than 25% of the young teachers have a degree in mathematics".

Indeed, the CBS data show that in 2009 only 22% of the math teachers who were under 45 had a first degree in mathematics while 42% learnt no mathematics, didactics of mathematics or any close scientific subject during their undergraduate studies. Only 45% of the math teachers had taken the high level 5-point math matriculation exam, while 6% had no academic degree whatsoever. In addition, within one decade (1998-2008) a decrease of 30% in the number of new math teaches (Nesher, 22.6.2012).

By the way: there is no positive correlation between the double requirement: "degree in math and degree in didactics of math" and the students' achievements in the various countries. Only in 6 of TIMSS 2011 participating countries the rate of teachers fulfilling this demand was higher than in Israel: Armenia: 55%; China: 55%; Georgia: 54%; Romania: 73%; Russia: 63% and Turkey: 55%, but only in two of them – China and Russia – the students' achievements were higher than in Israel (616 and 543 respectively). In the four others the achievements were lower than the 471 international averages: Armenia: 459; Georgia: 437; Romania: 451 and Turkey: 449.

The question: "does the math teacher needs math education, and if he or she does – what is the minimal level required?" still has no absolute answer, in spite of dozens years of research and discussions dealing with it In the 2011 Israeli conference two main opposite opinions were suggested (Rosenberg, 2011). Movshowitz-Hadar suggested that a math teacher must have at least a BSc in math and a Master degree in math education (ibid, p. 14); Lowenberg Ball (2011) claimed that the influence of the math level of the teacher on students' achievements is minimal. Without getting into this debate, it should be clear that pretending that 53% of Israeli math teachers have higher education both in math and didactics of math is false, and thus puts all other findings published about the TIMSS 2011 under doubt.

According to Nesher (22/6/2012), the rate of 12th graders taking the highest, 5-point math matriculation examination, decreased between 2006 and 2010 from almost 13,000 to just above 10,500 in spite of the fact that the total number of examinees increased. This has been the result of the fact that while in 2006 14.1% of the examinees tool these examinations, 5 years later only 10.7% did. Thus, it does not make any sense that while the general Israeli tendency has been to dropout high level math, the international achievements increased so sharply. The math learning situation has been quite bad when the TIMSS 2011 was taken (The situation of math learning, 8.11.2011), which also strengthen the assumption that such an increase in the achievements was not possible.

There is a contradiction between the continuing crisis in science learning in Israel (e.g. ***Nesher, 6.10.2011, 1.5.2012***) and the allegedly high level math learning, as found in the TIMSS 2011 math examinations, as the main reason for this crisis has been the low level of math learning of the students, which prevents them from taking high level science classes.

Epilogue

The second part of this article will concentrate on the results of the PISA 2012 where Israel scored 34th among the 43 OECD participants, with an average of 454, 46 below the OECD average (Kashti, 2014; Gravé-Lazi, 2014; PISA 2012 Results). This has been the final proof that the TIMSS 2011 Israeli excellent results were indeed false, most probably relying on a non-sample.

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