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WHAT CAN WE LEARN FROM THE PISA RESEARCH ABOUT THE FACTORS AND PARAMETERS AFFECTING THE SUCCESS OF STUDENT ACHIEVEMENTS IN MATHEMATICS? A COMPARATIVE STUDY BETWEEN ISRAEL AND FINLAND[1]

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Abstract. There is a crisis of many years in Israel in the subject of mathematics learning. In the last PISA tests, conducted by the OECD during the last ten years, Israel is placed 39-41 among all the countries participated the research. It was also found that all the years Israel "won" to be one of the first three countries with the highest grade distribution among all the countries and economic entities participating in general and among OECD countries in particular. In addition, it was found that rate of Israeli students who fail the mathematics test is one of the highest in the organization countries. The goal of this research is comparing students' achievements in the Israeli education system and in the Finnish education system, which is considered a system with excellent achievements in mathematics and low-grade distribution rate in general and in mathematics grades in particular. This comparison is aimed to identify the Israeli education system's problems and learn the lessons to improve it.

This article discusses the question what is the main success factor in mathematics in Israel compared to Finland according to the 2015 PISA test results and what can be learned from this difference? In this paper I have based on my research findings in which I analyzed the correlation between the PISA questionnaires and student achievement in mathematics.

Key words: OECD, mathematics, PISA test, learning achievements, education systems

1. Introduction

The PISA research started in 2003 and was designed to enable each country to examine outputs in its education system and to evaluate students' achievements from a shared and agreed international perspective. The research is conducted once every three years, with students aged 15 years (in most countries they study in 9th-10th grades). The research examines three areas of literacy: science, reading, and mathematics, and each research cycle emphasis one of them. The questions in this research examine knowledge in practical approach, knowledge that is essential to the "adult world", life skills and ability to solve complex problems that require integration of various domains emphasizing skills in order to examine if the student is ready enough to cope with what expects him in his adult life, does he know to translate what he has acquired in the education system (or outside it) to action in various fields, what tools and skills does he have, and whether it is enough to allow him cope what expects him in his life. Therefore, the student readiness towards his maturity in a modern country and developed economy is emphasized. Another characteristic is the economic point of view - the student's ability to integrate in economy and contribute to society. The test grades range between 200 and 800 and today, the average grade in the OECD countries for all skills is about 500 points, while low performance is defined as a

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grade below 400 points (approximately). According to the OECD, a low-performing student is a student who lacks the required skills to take full part in modern society. In addition to the test, the participating students fill "student questionnaire" which include questions about the student himself, his family, his scholastic environment and his studies in the selected discipline (the emphasized discipline) (RAMA, 2016).

Mathematical literacy is defined as the individual's ability to **formulate, apply and interpret** mathematics in various contexts. It includes mathematical thinking and use of mathematical terms, procedures, facts and mathematical tools to describe, explain and predict different phenomena. It helps people to identify the role of mathematics in the world and formulate funded opinions and decisions as expected of contributing, involved and thinking citizens (RAMA, 2013; translated from OECD[2] website 2013).

While solving the problem that is presented to the student in this research, the student is required to use mathematics and mathematical tools in a series of stages (Rama, 2013):

- Formulating – formulating situations in mathematical way
- Employing – applying mathematical terms, facts, procedures and inferences.
- Interpreting – interpreting and evaluating mathematical results.

The test questions are divided by the proficiency levels presented in the sequential grades scale in mathematics to six levels by cut points (widely described in table 1), each proficiency level represents a qualitative change in mathematics knowledge level accompanied by a description explaining student characterization in this grades range in terms of their mathematical literacy level and what they usually know and successfully solve.

Table 1. Students' proficiency level in mathematical literacy (OECD, 2017, p. 79; RAMA, 2016, p. 110)

Proficiency level	Lower limit value	What students are able to do in each level
6	669	Level 6 students are able to conceptualize, generalize, and use information based on their research and on modeling problems that describe complex situations. They can link different sources of information and representations and flexibly translate them. Students at this level are capable of advanced mathematical thinking and reasoning. They can apply their insights and understandings together with full control of symbolic and formal mathematical operations and ratio, to develop new approaches and strategies to cope with new situations. Students at this level can precisely formulate and explain their actions and thoughts regarding their findings, interpretations, claims, and the compatibility level between all these and the original situations.
5	607	Level 5 students are able to develop models of complex situations and work with it, identifying constraints and detailing assumptions. They can select, compare, and evaluate suitable problem-solving strategies to cope with complex problems associated with these models. Students in this level are able to work strategically using the broad and highly developed skills of thinking and reasoning, suitable associative representations, symbolic and formal features, and insights of these situations. They can examine their actions and formulate and explain their interpretations and conclusions.

[2] https://www.oecd.org/pisa/pisaproducts/Draft%20PISA%202015%20Mathematics%20Framework%20.pdf

4	545	Level 4 students are able to effectively work with explicit models of complex concrete situations that may include constraints or require the student to make assumptions. They can choose different representations, including symbolic representations, to combine them and connect them directly to aspects of real-world situations. Students in this level are able to use developed skills and flexibly explain these contexts with certain insights. They can build and convey explanations and claims based on their interpretations, claims and actions.
3	428	Level 3 students are able to perform clearly defined procedures, including procedures that require a series of decisions. They are able to choose simple strategies to solve and apply problems. Students in this level can interpret representations based on different information sources, use them, and explain directly on the basis of these representations. They can develop short explanations for their interpretations, results, and reasons.
2	420	Level 2 students are able to interpret and identify situations in contexts that require only direct analogy. They can extract relevant information from one source and use one representative model. Students in this level are able to apply basic algorithms, formulas, procedures, or conventions. They can directly conclude and literally interpret the results.
1	358	Level 1 students are able to answer questions that include familiar contexts in which the relevant information is presented, and the questions are clearly defined. They are able to identify information and perform routine procedures according to direct instructions in explicit situations. They are to perform clear actions that immediately arise from given stimulator.

The proficiency level in mathematics grades the student achievements and points on their performance ability. The higher their proficiency level, the higher their ability to solve high difficulty level problems. Each proficiency level indicates the student is capable of performing assignments in lower proficiency levels (for example, if a student has successfully solved assignments in proficiency level 3, it means he can also successfully solve levels 1 and 2 assignments).

A study examined the factors influencing student achievements in mathematics (based on the Pisa data for 2015 and the Mackenzie report grouped) corroborate all the variables that are expected to influence mathematical literacy scores into this several categories (Kerlitz & Keshet, 2018):

- General thinking patterns: which include motivation (calibrated, achievement and instrumental) and exam anxiety.
- Subjective-oriented thinking patterns: environmental awareness, enjoyment of science, expression of interest in broad topics in science, activity related to science.
- Behaviors of students: use of technology in and out of school hours, transition between schools, pre-school activities.
- Home environment: socio-economic background, education and parenting professions, home property, spoken language at home.
- Factors that related to the teachers: Promoting professional training of teachers, research-oriented scientific learning practices, directing teachers to science studies.
- Factors that related to the school: The average class size in the school, the size of the school, the autonomy of the school.

In this article I will discuss the question what is the main success factor in mathematics in Israel compared to Finland according to the 2015 PISA test results. The research findings are based on the correlation between the PISA questionnaires and student achievement in mathematics.

2. The Israeli education system and the Finnish education system

The Israeli education system, which began operating with the establishment of the State of Israel, was graded in the years 2006-2018 lower than the average in mathematics in particular and in literacy in general. It may be said that there is a crisis in mathematics studies in Israel for many years. On the contrary, the Finnish education level, which began operating over forty years ago, as encouragement to economics rehabilitation program, was graded in the years 2006-2018 among the first places in the international student evaluation test, the PISA test. The research results have proved that the leading students in mathematics are in Finland (see figure 1).

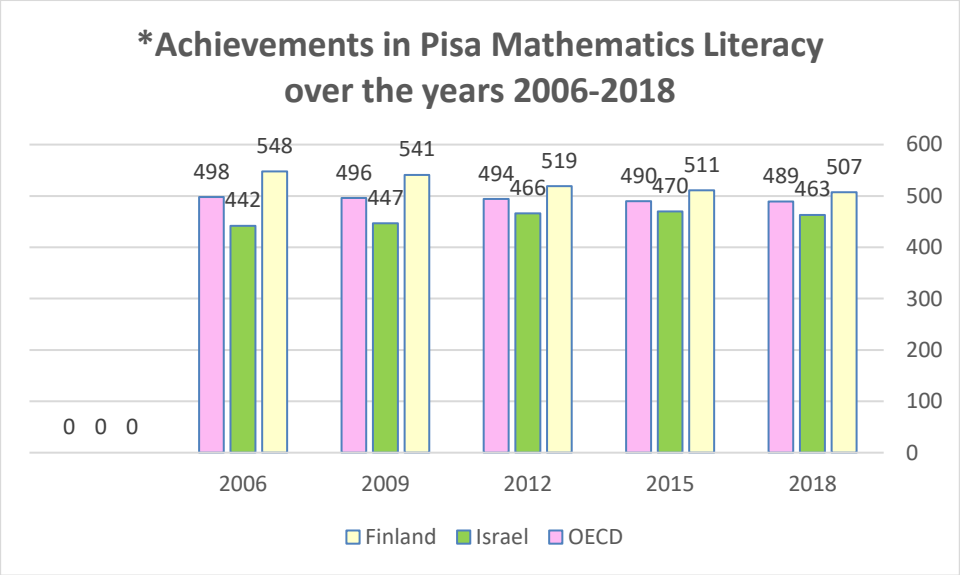

Figure 1 Achievements in Pisa Mathematics Literacy over the years 2006-2018[3]

It was also found that grades distribution in Israel is one of the highest among all participating countries and economic entities and the highest among OECD member countries. The rate of Israeli students who fail the mathematics test is one of the highest in the organization countries, comparing to Finland that was considered all the years to be one of the countries with the best performance of its education system. This country is one of the countries that have the lowest achievements gaps among the OECD countries (Table 2), since it offers a gap reducing model and promotes weakened populations, children with difficulties, students with learning disabilities and special needs.

[3] From: National Center For Education Statistic https://nces.ed.gov/surveys/pisa/pisa2012/pisa2012highlights_3d.asp

Table 2. The gap between the 10th percentiles to 90th percentile

	2006	2009	2012	2015	2018
Finland	208	213	220	210	213
Israel	277	271	275	269	285
OECD	234	237	238	231	235

Table 3 shows that the percentage of excellent Finnish students (level 5-6) in the years 2006 – 2018 is about 11% - 24% and higher than the OECD average that is 11% - 13%, and comparing to Israel that its excellent students average is lower than the average and is 6% - 9% in these years.

A similar look in this table (table 3) on the data showing the percentage of students with difficulties notes that Finland also succeeds to present percentage of students with difficulties much lower than the OECD average (the percentage of students with difficulties in Finland is 6% - 15% in the years 2006-2018 comparing to approximately 21% - 37% the OECD average), while in Israel we find much worse data – the percentage of students with difficulties is much higher and is approximately 32% - 42% in the years 2006-2018. It was also found that the rate of Israeli students who have failed the mathematics test was one of the highest among the organization countries.

Table 3: The average rate of outstanding students who have difficulty

		2006	2009	2012	2015	2018
Finland	Outstanding (Levels 5 and 6)	24.40%	22%	16%	11.7%	11.1%
	difficulty (below level 2)	5.90%	8%	12%	13.6%	14.9%
Israel	Outstanding (Levels 5 and 6)	6.10%	6%	9%	9%	8.80%
	difficulty (below level 2)	42%	39%	34%	32.1%	34.10%
OECD	Outstanding (Levels 5 and 6)	13.30%	13%	12%	10.70%	10.90%
	difficulty (below level 2)	21.30%	36%	37%	37.40%	23.90%

Using these data, we may conclude and understand that there is a serious problem in reducing learning gaps between students in the State of Israel. Many education researchers have been dealing with this problem over the years and many articles were written. Out of this question, I, as an education researcher, would also like to examine the following questions in my research:

- what is the main success factor in mathematics in Israel compared to Finland according to the 2015 PISA test results?
- what can we learn from this difference?

2. 1. Data Analysis

The research findings that will be presented in this article are taken from a profound statistical analysis I have performed as part of my Ph.D. dissertation, which deals with the factors and the parameters influencing student achievements in mathematics. The findings were collected from the PISA research conducted among 15-16 years old students in 2015. The research sampled 5882 Finnish students (out of which about 5422 students were born in 1999 and about 460 students were born in 2000) and about 6594 Israeli students (all born in 1999). I have measured the correlation between all the variables in the students' background questionnaires and their grades in mathematics. The following table (table 4)

presents the correlation coefficients (by Spearman index) graded from the highest to the lowest, for both countries: Israel and Finland.

Table 4. The highest correlation (Spearman) coefficients for both countries (Israel and Finland) from the highest to the lowest

Positive:				
	Finland		Israel	
	Coefficient	Variable	Coefficient	Variable
1	Index of economic, social and cultural status (WLE)	0.372	Students' expected occupational status (SEI)	0.404
2	Index highest parental education in years of schooling	0.302	Index of economic, social and cultural status (WLE)	0.367
3	Environmental Awareness (WLE)	0.256	Environmental Awareness (WLE)	0.287
4	Learning time (minutes per week) - <Mathematics>	0.236	Cultural possessions at home (WLE)	0.279
5	Home possessions (WLE)	0.216	Home possessions (WLE)	0.278
6	ICT Resources (WLE)	0.191	Student Atttidudes, Preferences and Self-related beliefs: Achieving motivation (WLE)	0.271
7	Disciplinary climate in science classes (WLE)	0.168	Index highest parental education in years of schooling	0.244
8	Students' expected occupational status (SEI)	0.136	Instrumental motivation (WLE)	0.198
				Negative
	Finland		Israel	
	Coefficient	Variable	Coefficient	Variable

1	ICT available at School Index (Sum)	-0.283	Personality: Test Anxiety (WLE)	-0.271
2	Environmental optimism (WLE)	-0.272	Teacher Fairness (Sum)	-0.221
3	Perceived Feedback (WLE)	-0.271	Collaboration and teamwork dispositions: Value cooperation (WLE)	-0.180
4	Out-of-School Study Time per week (Sum)	-0.246	Out-of-School Study Time per week (Sum)	-0.167
5	Use of ICT at school in general (WLE)	-0.178	Perceived Feedback (WLE)	-0.135
6	Collaboration and teamwork dispositions: Value cooperation (WLE)	-0.148	Environmental optimism (WLE)	-0.95

It may be seen that the highest positive correlation that is first in Israel is between the social – cultural – economic index and the student achievement (0.372). The higher the student's social – cultural – economic status, the higher his achievements. This index was calculated by the occupation and education level of the student's parents, the accessibility to educational, cultural and economic resources at home (as textbooks, poetry books, art, writing desk, computer and additional means that indicate on the student's economic status). In Finland, this factor was found to be the **second most influencing factor** on student achievements in mathematics (correlation of 0.367).

In the second place in Israel was the correlation of the first category deeper picture – it was found that the higher the parent education, the higher the student achievements in mathematics. However, in Finland this factor was graded **seventh** (correlation of 0.244).

It is very interesting that the correlation between expectations of students for future occupation and their achievements in mathematics in Israel was graded eighth (correlation of 0.136), while in Finland this correlation was the most influencing (correlation of 0.404) on student achievements in mathematics.

3. Conclusion

I found that the two background factors with the strongest positive correlation to student achievements in mathematics in Israel are: the social – cultural – economic status and parent education, while the two factors with the strongest positive correlation in Finland are student expectations to future occupation and the social – cultural – economic status.

Therefore, we may ask, why the gaps of Israeli student achievements in mathematics are the highest in the world? And why the gaps of Finnish student achievements in mathematics are the lowest in the world? And may we conclude about the social – cultural – economic status of the two societies?

It is known that education, occupation and income have a significant correlation in our society due to the occupation structure in modern society, which is sometimes called "experts society" (Cohen, 2020). Moreover, education is perceived as the most important means to social mobility, while the required

expertise level for many professions is rising every year. School provides the individual a starting point to meet the expectations of society and the occupational system and serves as cataloging mechanism for allocating people in society. Although school has to be open to all and **provide full opportunity equality**, the findings show that a crucial factor in student achievements in mathematics is significantly correlated to social – cultural – economic background of the child. Therefore, we may say that equality does not exist even when the child begins his school studies and the gaps that already exist when the child enters school project on his future success (Chief Economist Division, 2017).

Therefore, what may be said about the Finnish and the Israeli social mobility due to the gaps described above?

Regev (2011) explains that children of parents with low or lack of cultural capital have much more difficulties to meet the success demands set by the education system, although seemingly meeting the education system requirements is usually perceived as a result of personal abilities as hard working, diligence, perseverance, investment and even intelligence. An additional interesting result is that the future occupational horizon is the main and crucial factor for good achievements in mathematics in Finnish students while in Israel it is graded eights and considered a less influencing factor.

In addition, the Institute for Economic and Social Research conducted a study in 2017, that examined the causes of the low achievement of students of the State of Israel according to the results of the Pisa 2012 test in which the main topic was mathematics. The findings of the study show that the reason for Israel's low achievements would seem to be rooted in poor quality of formal instruction that caused as a result of low level of discipline in Israel's education system. Moreover, this study found that the level of inequality is the highest in the developed world and students 'achievements are highly correlated with their parents' education (Gruber, 2017):

"parental education levels have a significant impact on all pupils in the classroom and not just on their own children. On average, pupils of less-educated parents studying in a "highly-educated" classroom perform better scholastically compared with pupils with highly-educated parents studying in "less educated" classrooms. This underscores the great importance of cautiously and sensitively integrating pupils from socioeconomically disadvantaged backgrounds into strong schools. A small percentage of pupils from socioeconomically weak homes in a strong school will greatly improve these pupils' achievements without seriously compromising pupils of affluent backgrounds" (p. 33).

It seems that in order to answer these wonderings a depth research must be performed to examine the reasons for these gaps and maybe as a result of this understanding the State of Israel will manage to learn from Finland how to operate a more efficient education system in mathematics studies and reduce the gaps.

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