International Journal of Arts and Social Science www.ijassjournal.com
ISSN: 2581-7922,
Volume 5 Issue 4, April 2022

Do Gender Differences in Mathematics Performance Continue to Exist? A Case-Study Concerning Students of an Urban Junior High School

Zafeira Balampanidou[1] Niki Diamanti[2]
[1]*Regional Centre of Educational Planning of West Macedonia*
Drepano, 501 50 Kozani, Greece
[2]*Primary School Teacher*
61, Ymitou str. Saronida 190 13 Athens, Greece

Abstract: As the issue of gender is considered important in mathematics, mathematics education research has shown particular interest in the performance of boys and girls in recent decades, with results which are often contradictory. This paper attempts to investigate whether there is a difference in mathematics performance between girls and boys during all three grades of a junior high school which is situated in a small town in northern Greece. For this purpose, both the overall average of students' oral and written performance in the three grades of junior high school, as well as the percentage ratios of their grades were compared. Research has shown that the academic performance of both boys and girls declines during junior high school and that girls consistently outperform boys in both oral and written performance. An important finding which emerged from the oral interviews with the girls who excelled in mathematics is that only six (6) out of the twelve (12) stated that they would choose a field of studies which is related to mathematics. Finally, it appears that five (5) of them were examined in Mathematics in order to be admitted to university and only four (4) out of the twelve (12) chose studies that are related to Mathematics.
Keywords: Mathematics, gender, performance differences

1. Introduction

Mathematics education research, both in Europe and in the United States, has focused in recent decades on the differences in boys' and girls' performance in mathematics, especially after the Benbow and Stanley (1980) [1] research in which boys appear to be significantly ahead in mathematics in relation to girls. Indeed Ernest (2007) [2] states that literature takes the existence of a problem in the relationship between girls and mathematics as a given. Also, looking closely at the photos and various publications concerning the success of the Greek team in the 58th International Mathematical Olympiad, it was found that the team did not include any girls. Similar is the image of the Greek team in the International Mathematical Olympiads which were conducted from 2010 until today, while in the 56th and 57th Olympiad girls received only honorable mentions, with boys dominating the first places[1].

Thus, in the above context, it was decided that the present paper would investigate the oral and written performance in mathematics of 112 junior high school students in a provincial urban town during their three years of attendance of junior high school and that it would examine whether there is a relationship between the students' school performance and gender.This paper begins with a reference to research on the subject, continues with the presentation of the methodology, the presentation and discussion of the research results and concludes with suggestions for improving the performance of girls in mathematics.

2. Theoretical Framework

The issue of gender is considered important in mathematics, as it has historically been considered a male field, incompatible with femininity (Hall, 2014) [3]. In 1980 researchers Benbow and Stanley (cited in Ding, Song & Rishardson, 2006) [4] conducted in the United States a survey of gifted seventh graders and found that boys were four times more likely than girls to score over 600 on the SATS math test. This superiority of boys over girls continues to be evident in research on the Higher Education student population in the United States, as well as on Higher Education students with a particular aptitude for mathematics (Ding et al., 2006) [4].

Benbow and Stanley (1980) [1], as well as a number of other researchers (Geary, 1996; Kimura, 1992; Thomas, 1993, cited in Ding et al., 2006) [4], attribute gender differences in learning mathematics to biological differences, as well as structural differences in the brain, resulting in different gender abilities in mathematics. The high publicity of Benbow and Stanley's research results on public media had unpleasant consequences for girls (Fannema, 2002) [5], as in a number of

[1]Today (April 2021), about three and a half years after the research that was conducted in the summer of 2017, the situation regarding the discrimination against girls in the International Mathematical Olympiads remains the same. Thus, in the Mathematical Olympiads that took place in 2018, 2019 and 2020, the Greek team won 8 medals and 6 honorable mentions, however only one honorable mention was given to a girl.

studies inherent biological differences were considered the main reason for the differentiation between the performance of the two genders in mathematics, thus giving this theory a lasting and permanent character (Ding et al, 2006) [4], while at the same time allowing the characterization of certain activities as feminine and excluding others as inappropriate (Rentetzi, 2012) [6].Thus, in 2005 Harvard President Lawrence Summers attributed the under-representation of women at his university to biological differences between men and women, provoking intense debate (Stathopoulou, 2015) [7].

Fannema and her colleagues, who carried out a series of studies during the 70s and 90s (Chronaki, 2013) [8], are looking for an alternative explanation for the gender differences in mathematics performance. In these studies, the above researchers try to prove that the performance of girls in mathematics is related to the context in which parents, teachers and students construct mathematical knowledge, inside and outside the school (Chronaki, 2009) [9]. Fennema (2002) [5] reports that although gender differences in mathematics performance appear to be shrinking, they continue to exist in high cognitive fields, where men appear to excel, as well as in different career choices. However, Coley's reference (2001, cited in Psalti, Sakka & Deligianni-Kuimtzi, 2007) [10] to the USA showed that boys excel in mathematics only in elementary school, while in junior high school and high school there are no differences in the performance of boys and girls. On the other hand, studying the literature Faitar & Faitar (2013) [11] report that while gender differences in mathematics performance are relatively minor at the elementary level, they begin to increase during the last year of junior high school. In Greece, research by Tressou and Samourkasoglou (1996) [12] showed that when mathematics starts to become more abstract and complex, girls fall behind boys. Ding et al (2006) [4] report that the results of research on the time of occurrence of gender differences in mathematics vary and are often contradictory, with some researchers arguing that differences are evident from the first grade of primary school and others claiming that they show up in junior high school. However, Gilia Hanna (2003, cited in Chronaki, 2009) [9] after reviewing relevant studies conducted over the last 30 years, concluded that there were no more gender differences in mathematics performance. Research in the United States, such as that of Ding et al (2006) [4], shows that girls have a higher average in mathematics than boys. However, although girls seem to be gaining ground in mathematics performance, boys continue to increase their dominance in the field of sciences, while girls are driven to traditionally female carrier paths (Chronaki, 2009) [9].

3. Presentation of the research

3.1 Methodology and Conducting the Research

Taking into account the above contradictory findings of the research on the existence and time of occurrence of gender differences in mathematics performance, it was decided to investigate the existence of gender differences in the mathematics performance of students attending the third grade of a junior high school in an urban provincial town.In case differences were identified, it was decided to investigate, in addition, how these differences were formed during the three years of junior high school. In addition, it was considered important to study the future professional choices of girls who have excellent performance in the third grade of junior high school.

Thus, the research presented in this article is part of a longitudinal research. The section presented is a small-scale "ex-post study", where there is an ex post facto comparison of different groups (Cohen & Manion, 2000) [13]. In the comparison of different groups, the relationship between variables is studied. To this end, groups of subjects are selected which already differ from each other in terms of one variable, which is called differential, and are compared in terms if another variable, which is called comparable (Paraskevopoulos, 1993) [14]. In the present study, the gender of students was defined as a differential variable and the performance of students in mathematics was defined as a comparable variable (the average of the oral grade in the four month- or the three month-periods and the grade in their written exams).In researches such as the one conducted herein it is important to limit the influence of "outside factors" that affect students' school performance, such as individual characteristics, educational level of parents, etc. At the moment this was not possible but as the research is ongoing, the effect of the variable"educational level of parents" is the one that is planned to be studied next.

Research information was extracted from the records of a junior high school with 112 students in the third grade. Based on the purpose of the research, students were grouped by gender. Then, the oral and written performance of the above students in mathematics during their junior high school years was recorded. In addition, semi-structured interviews were conducted with the 12 girls, who had an excellent written performance in third grade mathematics, in order to record their future professional expectations.

At the time of presentation of the research results, the above students have completed their studies in Secondary Education and the majority attends higher education. Thus, we were able to contact them via telephone and inquire as to the university faculties they now attend.

Regarding statistical methodology, the groups were compared in terms of a continuous numerical variable, their school performance. The comparable indicators are the average, the median and the standard deviation of the school performance of the groups, as well as the percentage ratios.

3.2 Presentation of results

Data processing was performed using SPSS 17.0 software. Below, the results of the research are presented and discussed.

3.2.1 Presentation of results

In a total of 112 students, 58 (51.78%) are boys and 54 (48.22%) are girls. As shown in Table 1 below, girls have a

very good oral performance average, which ranges at about 17 in all three grades of junior high school and shows a decrease of only 0.7 over the three-year period. The median of the average oral grade follows a similar trend. The average performance grade of girls in the final written exams which take place in June is lower and ranges from 15.4 in the first grade to 13.3 in the third grade; while the median ranges from 16.5 to 14. Consequently, 50% of the girls have a written score of over 16.5 in the first grade, over 15 in the second grade and over 14 in the third grade. There is also a relatively small standard deviation from the average of their average oral performance. Thus, the average oral performance is 1.9 to 2.3 points from the average value. On the contrary, there is a large deviation from the average written grade in all three grades of junior high school (SA = 4.5, SB = 4.3, SC = 5), i.e. the written performance seems to be "far" from the average value.

Table 1: Descriptive statistics data for the group of girls

	Girls (54-48.2%)							
	1st Grade			**2nd Grade**			**3rd Grade**	
	AG of oral performance	AG of written exams		AG of oral performance	AG of written exams		AG of oral performance	AG of written exams
Average	17.5	15.4		17.1	14.6		16.8	13.3
Median	17.6	16.5		17.3	15		16.5	14
Range	8.33	17		7.33	14		7	16
Standard deviation	1.9	4.5		2.3	4.3		2.3	5.0
Coefficient of variation	0.11	0.30		0.13	0.29		0.14	0.38

Regarding the school performance of boys in mathematics in the three grades of junior high school, we can observe in Table 2, that the average of the oral grade remains at around 16 in all grades, while the median remains at around 16,5. On the contrary, the average performance of boys in the final written exams which take place in June is much lower, starting at 14.5 in the first grade and ending at 11.7 in the third grade. Also, the median ranges from 16.5 in the 1st grade to 12 in the second and third grades. That is, 50% of the boys in the last two grades of junior high school score under 12. There is also a relatively large standard deviation from the average of their average oral performance, which seems to be 2.4 to 2.7 points from the average value. In addition, there is a large deviation from the average written grade in all three grades of junior high school (SA = 5.2, SB = 5.0, Sc = 5.6).

Table 2: Descriptive statistics data for the boys' group

	Boys (58-51.8%)							
	1st Grade			**2nd Grade**			**3rd Grade**	
	AG of oral performance	AG of written exams		AG of oral performance	AG of written exams		AG of oral performance	AG of written exams
Median	16.3	14.5		16.2	12.5		16.0	11.7
Median Range	16.7 9	16.5 18.0		16.0 9	12.0 17.0		16.5 7.5	12.0 17.0
Standard deviation	2.5	5.2		2.7	5.0		2.4	5.6
Coefficient of variation	0.15	0.30		0.17	0.40		0.15	0.48

Comparing the average oral school performance of boys and girls in the three grades of junior high school, we observe

that girls consistently outperform boys; however, the difference is decreased from the 1st grade to the 3rd grade. Similar is the situation with regard to the average written performance in the final exams of each grade, with the difference, however, remaining at high levels, since girls prevail over boys by 1.6 points in the 3rd grade. As far as the median is concerned, we also observe a superiority of the girls by about 1 point in the oral grade and about 3 points in the written grade of the 2nd and 3rd grades. Also, studying the relevant frequencies, it is found that in the percentage of students who excel in mathematics there is a clear superiority of girls, who among excellent students exhibit high percentages in both oral (38.2%, 34.5%, 40% respectively in the first, second and third grade) and written performance (35.2%, 29.1%, 22.2%).Thus, they are superior to boys with regard to their oral performance at percentages that range from 6.9% to 15.8% (depending on the grade) and with regard to their written performance at percentages that range from 2.7% (1st grade) to 15.3% (3rd grade). In terms of homogeneity, the samples are inhomogeneous, however in both oral and written performance the group of girls shows greater homogeneity, i.e. smaller deviations from the average performances. Finally, regarding their future professional expectations out of the 12 girls who had an excellent performance in the written examinations (19 or 20) of the 3rd grade, 6 expressed their desire to continue their studies in Faculties of Engineering or Faculties of Science, 2 in Medicine or Biology, 2 in Theoretical Studies and 2 stated that they have not decided yet as they are afraid of high school mathematics.

With regard to the current situation, it turns out that four (4) students pursued theoretical studies and did not sit for a Mathematics examination in order to be admitted to university. Three (3) attended the science division courses in High School and are currently studying Medicine and Biology, while one (1) student took an exam in Mathematics in order to be admitted to university but eventually chose to pursue a carrier in teaching. Only four (4) of the 12 students are currently studying at Faculties of Engineering.

3.2.2 Discussion of research results

The purpose hereof was to study the differences between the two genders in terms of their performance in mathematics in the three grades of junior high school. For this purpose, the performance of 112 students at a junior high school in an urban provincial town during all three grades was studied. The study of the data has led to two important conclusions: First, both the oral and written performance of boys and girls in mathematics follows a declining course from the 1st to the 3rd grade. Second, girls performed better than boys, both in the oral and in the written examination, in all three grades of junior high school, a finding consistent with that of Ding et al (2006) [4], who see girls' assessment based on their effort in the classroom and not their mathematical knowledge and skills as a possible explanation. However, they claim that if the average is a valid indicator of measuring mathematical performance, then it becomes clear that girls can maintain their mathematical advantage over boys and learn high-level mathematics, refuting the arguments of researchers who attribute gender differences to inherent biological differences. Besides, Ernest (2013) [15] emphasizes that internationally the situation regarding the performance of boys and girls in mathematics has been reversed.

Although the situation seems to have been reversed and girls excel in mathematics, research (Theodoraki & Deligianni-Kuimtzi, 2005[16]; Faitar & Faitar, 2013[11]) shows that stereotypes about gender differences still exist and cause girls to perform worse than they could have and to choose professions that are not related to the science of mathematics, without high prestige and high salaries (Chronaki, 2009) [9].

Indeed, out of the twelve (12) students of the 3rd Grade of Junior High School who excelled in Mathematics[2] and were interviewed, six (6) stated that they did not intend to pursue studies and professions related to mathematics, while for the rest, the question whether eventually their wish to pursue studies related to mathematics would be realized remained unanswered throughout the carrying out of the research.

Today, after completing their high school studies, we observe that only four (4) out of twelve (12) students attended studies that are related to Mathematics. While five (5) of them attended studies that lead to stereotypical female professions. As Ernest (2013, p.51) [15] emphasizes, *"the problem has shifted from female underperformance to lower female participation"*.

Mathematics, however, and engaging in sciences related to mathematics provide more career opportunities in high-paying jobs. Mendick, Moreau & Hollingworth (2008) [17], wanting to emphasize this very dimension of mathematics, described them as a "critical filter in the labor market", which keeps women away from professions related to mathematics. Chronaki (2009) [8] states that the 'glass ceiling'[3] in relation to women and STEM studies or professions is the result of gender stereotypes, which present a "problematic" relationship between mathematics and women. These gender stereotypes eventually tend to constitute discursive practices[4], which construct the relationship between woman and mathematics as undesirable or even impossible (Chronaki, 2009) [9].

Regarding the education system, it seems (Ding, et al., 2006) [4] that it is necessary to educate teachers on gender issues in order for them to first understand their stereotypical views and then to train them in the use of friendly practices towards girls, as a supportive school environment can help them succeed in STEM professions (Faitar & Faitar, 2013) [11].

[2]At the time of the research

[3]"The term 'glass ceiling' was adopted in 1986 by journalists of the Wall Street Journal. It is used to describe the invisible barrier (based on prejudices) that limits the promotion of women to higher positions in their professional careers "(Vozemberg, 2015, p. 15).

[4]As Barry (2013) states, discursive practices concern the way in which power is internalized through speech by those it weakens, so that there is no need for constant external enforcement.

Finally, research on the parents' own perceptions regarding gender differences in mathematics would be interesting, because, as shown in the research of Faitar & Faitar (2013) [11], the family environment is a strong indicator of girls' success in mathematics and STEM professions. The results of such research could be used in the context of parental counseling. After all, as Ding et al. (2006) [4] point out, if we expect girls to perform well in mathematics it is clear that girls can learn mathematics.

References

[1]. Benbow, C.P., & Stanley, J.C. (1980). Sex differences in mathematical ability: Fact or artifact? *Science*, 210, 1262–1264.
[2]. Ernest, P. (2007). Questioning the gender problem in mathematics. *Philosophy of Mathematics Education Journal*, 20, 1-11.
[3]. Hall, J. (2014). Unpacking 'Gender Issues' Research. *Philosophy of Mathematics Education Journal*, 28, 1-10.
[4]. Ding, C.S., Song, K. & Rishardson, L. (2006). Do Mathematical Gender Differences Continue? A Longitudinal Study of Gender Difference and Excellence in Mathematics Performance in the U.S.. *Educational Studies*. 40(3), 279-295. Doi: 10.1080_00131940701301952.
[5]. Fannema, E. (2002). Mathematics, Gender, and Research. In G. Hanna (ed), *Towards Gender Equity in Mathematics Education. New York: Kluner Academic Publisher.*
[6]. Rentetzi, M (2012). Oh. I Thought You Were a Guy! The Relationship between Gender and Physics: An Unsolved Puzzle. In S. Athanasopoulou-Kypriou, P. Voutsina, M. Kotzampasi, M. Nikiforidis, R. Pothitaki (Eds.), *To Look with Different Eyes to See Differently, Gender Approaches in Education* (pp. 61-90). Athens: Moraitis School
[7]. Stathopoulou, Ch. (2015). Excluding Girls: Girls and Maths Book Presentation with a Critical View. *Scientific Year book, Department of Early Childhood Education, University of Ioannina*, 8, 1-24.
[8]. Chronaki, A. (2013). Introduction by the Editor.Excluding Girls: Myths, Shadows and Realities about Gender and Mathematics. In A. Chronaki (Ed.), *Excluding Girls: Girls and Mathematics* (pp. 13-43). Athens: Gutenberg.
[9]. Chronaki, A. (2009). Gender and Mathematics. *In fylopedia*. Retrieved on 2January, 2016 from http://www.fylopedia.uoa.
[10]. Psalti, A., Sakka, D. & Deligianni- Kouimtzi, B. (2007). Male and Female Identities at School:Educational Choices and Gender. In V. Deliganni-Kouimtzi, & D. Sakka (eds.), *From adolescence to adulthood: studies on gender identities in modern Greek reality* (pp. 65-84). Athens: Gutenberg.
[11]. Faitar, G.M. & Faitar, S.L. (2013). *Gender gap and stem career choices in 21st century American education*. Retrieved 1 January, 2016, from www.sciencedirect.com
[12]. Tressou, E. & Samourkasoglou, E. (1996). Students' Attitudes Towards Mathematics: Results of a Small Scale Research Coducted in Selected Junior High Schools and High Schools of Thessaloniki. In I. Paraskevopoulos (Sel.), *Transgender Relationships I*. Athens: Ellinika Grammata.
[13]. Cohen, L.,Manion, L.(2000).Research Methods in Education. Athens: Metaichmio.
[14]. Paraskevopoulos, N.I. (1993). *Methodology of Scientific Research*. Athens: University of Athens.
[15]. Ernest, P. (2013). Introduction, Changing Perspectives on the 'Gender Problem' in Mathematics. In A. Chronaki (Ed.), *Excluding Girls: Girls and Mathematics* (pp. 315-328). Athens: Gutenberg.
[16]. Theodoraki, A. & Deligianni - Kouimtzi, B. (2007, September). Girls and sciences: the perceptions of Primary School teachers about science subjects and scientific professions from the perspective of gender. *Conferance paper in the 5th Interdisciplinary Interuniversity Conference of the N.T.U.A. and the M.I.R.C. of the N.T.U.A.*. Retrieved 5 January, 2016, from http://www.ntua.gr/MIRC/5th_conference/5th_conference_ergasies.htm
[17]. Mendick, H., Moreau, M.P., & Hollingworth, S. (2008). 'Who says you can't do maths in stockings?' An exploration of representations of women doing mathematics in popular culture. Paper presented at the *11th International Congress on Mathematics Education, Monterrey, Mexico*.

Author Profile

Zafeira Balampanidou studied Mathematics at the Aristotle University of Thessaloniki. She holds a Master's Degree in Education (MA in Ed) from the Helllenic Open University and a Master's Degree (MSc) in the teaching of mathematics from the Aristotle University of Thessaloniki. She has a long teaching experience in both primary and secondary education. She has now been working as an Education Coordinator in the Region of West Macedonia, Greece

Niki Diamanti took her bachelor's degree in Primary Education from the Democritus University of Thrace. She holds a Master's Degree (Msc) in the teaching of mathematics from the Aristotle University of Thessaloniki and a Master's Degree in Special Education from the university of Cyprus. She is currently working as a teacher in primary education.