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Professional paper

THE ACHIEVEMENTS OF FIFTH GRADE PUPILS IN OPERATIONS WITH NUMBERS IN MATHEMATICS

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Abstract

Mathematics is a science dedicated to the study of measures, numbers and space and is one of the first sciences developed by humans because of its great importance and utility. Mathematics is a scientific field with several scientific areas in which forms, space, changes, numbers and how they are used are studied largely in abstraction. It includes, among other things, the application of arithmetic calculations, algebraic manipulations, measurement, drawing logical conclusions and solving problems. The number sense that is important for learning mathematics takes root early in life, long before children enter school. Mathematical tasks are central to the learning of mathematics. The purpose of this research is to analyze the achievements of pupils at the end of the fifth grade of primary school in the tasks of knowledge and understanding of mathematics. The research was conducted in four schools in the city of Skopje and Tetovo, in which 188 pupils are included. As an instrument for measuring pupils' achievement in mathematics at the end of the fifth grade, the mathematics knowledge test from the topics "Numbers" and " Number operations" consists of seven tasks selected from the TIMSS (Trend in International Mathematics and Study Science), three of which are for knowing and understanding. The obtained data were processed by means of the SPSS Statistic 25 program applying appropriate a parametric Independent Samples Test as a reference for testing the differences between the data on an ordinal scale. From the solution of the tasks, we can see that boys have shown better results compared to girls.

Keywords: mathematics, pupils, comparison, knowing and understanding

Introduction

Mathematics is a science dedicated to the study of measures, numbers and space and is one of the first sciences developed by humans because of its great importance and utility. Mathematics is a scientific field with several scientific areas in which forms, space, changes, numbers and how they are used are studied largely in abstraction. It includes, among other things, the application of arithmetic calculations, algebraic manipulations, measurement, drawing logical conclusions and solving problems. According to Sharma (2021), "Mathematics is a tool in our hands that allows us to live a more comfortable life. The more mathematical our approach is, the more rational our thinking will be." Historically, numbers and number operations have been the cornerstone of the entire mathematics curriculum (NCTM, 1998). Furthermore, numbers and number operations are fundamental to most daily activities. Understanding their applications is a basic survival skill in our society as a key foundation of mathematical literacy, which is as important as language literacy.

It is often claimed that mathematics is specially tailored for boys' minds. In academic circles, as well as in the everyday narrative in schools, the view persists that boys generally perform better than girls on formal mathematics assessments. But is this true?

According to data published by the State Examination Center (https://dic.edu.mk), the average mathematics achievements of fourth-grade male and female students in both the TIMSS 2019 and TIMSS 2023 studies (the only two periods when grade-school students in the RNM are

covered) are completely identical (both male and female students have an average of 472 points in TIMSS 2019, i.e. an average of 474 points in TIMSS 2023), which means that the difference between the average mathematics achievements between fourth-grade students of different genders in the RSM is zero. The TIMSS 2019 report states: "Statistically significant differences between the average achievements of girls and boys in mathematics in favor of girls are found in only 4 countries, in favor of boys in 27 countries, and there are no statistically significant differences in 27 countries" (Lameva and Saracini, 2022, p. 34).

In different education systems, different groups of researchers offer different answers to the question of the existence of gender differences in mathematics achievement and the system of beliefs, motivation, and interest in studying mathematics among school-age boys and girls.

Significant sex differences in mathematical reasoning ability (scores on the Scholastic Aptitude Test) in favor of boys were found in a study of 9,927 gifted high school students (Benbow & Stanley, 1980). Data from the study contradict the hypothesis that differential exposure to mathematical subjects explains the observed sex differences in mathematical ability, but support the hypothesis that these differences are somewhat exacerbated by environmental influences.

Preckel, Goetz, Pekrun & Kleine (2008) investigated gender differences in 181 gifted and 181 average-ability sixth-grade students in terms of achievement, academic self-concept, interest, and motivation in mathematics. Giftedness was conceptualized as nonverbal reasoning ability and defined by a score of at least 95% on the nonverbal reasoning subscale of the German Cognitive Ability Test. Self-concept, interest, and motivation were assessed by questionnaire. In both ability groups, boys scored significantly higher on tests, but there were no gender differences in scores. Girls scored lower on academic self-concept, interest, and motivation. Gender differences were greater among gifted than average ability students. Differences in ability groups for self-concept and interest were found only among boys in favor of gifted students. The results support the assumption that gender differences in self-concept, interest, and motivation in mathematics are more prevalent among gifted students than among average ability students.

Hargreaves, Homer & Swinnerton (2008) investigated gender differential performance in "gifted and talented" 9-year-old and 13-year-old children on mathematics achievement assessments in England. Boys' and girls' attitudes towards mathematics and their views on which gender is better at mathematics were also examined. The study involved the use of a matched sample of boys and girls, so that school, age and previous mathematics achievement were controlled for while investigating performance on tasks from the World Class Test. The main result of this research was that there was no significant gender difference in the performance of students at the ages of 9 and 13. However, differences in attitudes were found, including the common stereotypical view of mathematics as a subject for boys. These results are important because in the higher years of education, the choice of advanced mathematics subjects by girls is weak. Further findings revealed that where "gifted" girls demonstrated equally high achievement in mathematics as "gifted" boys, their confidence in the subject was lower than would be expected from their performance.

Fennema & Petersson's (1985) research discusses a model that provides a partial explanation for why female students do not achieve parity in mathematics education. The model consists of four stages and explores the mediating factors of autonomous learning that exist between socialization influences and learning.

According to Walkerdine (2012), the issue of girls' mathematics achievement involves various myths, false "evidence" and theorizing about gender differences in mathematical intelligence. Detailed theoretical and empirical research conducted over a period of more than ten years by a team of researchers led by Walkerdine addresses the biases, examining the relationship between evidence and explanation: why are girls still considered "not good" at mathematics

even when they achieve high scores, and why are boys recognized as mathematically superior even when they do not achieve high scores?
The purpose of this research is to evaluate students' achievements in mathematics related to numbers and operations with numbers, taking as an assessment the test composed of tasks selected from the international study TIMSS (Trend in International Mathematics and Science Study) which includes numbers, expressions, simple equations and operations with them, fractions and decimals. In the research, we focus on confirming the following research hypothesis:
H_A: There are differences in students' achievements in mathematics at the end of grade school depending on gender.

Method

The sample of respondents consists of students aged 10-11, comprising 188 students in four primary schools in two cities in the Republic, Skopje and Tetovo, at the end of the fifth grade of primary education (the last two weeks of the school year). The sample in this study is not representative of the population of fifth grade students in primary education because the selection was made by selecting entire classes in four schools in two cities.
To measure students' achievements in mathematics at the end of the fifth grade, a test of mathematical knowledge on the topics "Numbers" and "Number Operations" was used, consisting of seven selected exempt tasks from TIMSS (Trends in International Mathematics and Science), three of which are at the level of knowledge and understanding, and four tasks are at the level of application of knowledge, in accordance with their classification within TIMSS (Appendix).
The problem, subject, purpose and hypotheses of the research, the characteristics and size of the selected sample, as well as the selected measurement instruments, determine the basic methods for data processing applied in this research. Data analysis was conducted in the SPSS Statistic 25 program using an appropriate parametric test of independent samples as a reference for testing differences between data on an ordinal scale, as well as standard descriptive procedures.

Results

Table 1 presents data on the achievements of fifth grade primary school students at the end of the school year included in the sample, by gender, on tasks at the Knowledge and Understanding level. Of the 188 students from the Skopje and Tetovo region, 99 students are male and 89 students are female. The male sample is composed of 54 students in Macedonian and 45 students in Albanian as the language of instruction, and the female sample is composed of 40 female students in Macedonian and 49 female students in Albanian.
The descriptive data (mean and standard deviation of the achievements on the tasks at the Knowledge and Understanding level) in Table 1 show a difference between boys and girls. It is noted that boys showed a slightly higher level of tasks at the Knowledge and Understanding level compared to girls.

Table 1. Number of students of different genders according to the number of correctly solved tasks at the Knowledge and Understanding level

	(1) male, (2) female	N	Mean	Std.deviation	Std.Error deviation
Knowledge and Understanding level	male	99	1.92	.841	.085
	female	89	1.80	.956	.101

Table 2 shows the number of students, boys and girls, who correctly solved zero, one, two or all three tasks at the Knowledge and Understanding level.

Table 2. Number of students according to the number of correctly solved tasks at the Knowledge and Understanding level

Count						
		Knowledge and understanding of Mathematics				
		0 correct solutions from 3 tasks	1 correct solution from 3 tasks	2 correct solutions from 3 tasks	3 correct solutions from 3 tasks	Total
(1) male, (2) female	male	5	24	44	26	99
	female	7	30	26	26	89
Total		12	54	70	52	188

To see if there is a statistically significant difference between the achievements of boys and girls in relation to the tasks at the Knowledge and Understanding level, we use the t-test for independent samples. From the test results (Table 3) we note that for the tasks at the Knowledge and Understanding level the value of Sig.(2-tailed) is p=.355, not less than p=0.05 with a 95% confidence level. We conclude that there is no significant difference between boys and girls in the success in solving tasks at the Knowledge and Understanding level in the topics "Numbers" and "Number Operations".

The hypothesis that there is a significant difference in the mathematics achievements of students of different genders at the end of grade school is not confirmed in the segment of achievements at the Knowledge and Understanding level.

*Table 3.*Independent Samples Test: Knowledge and Understanding tasks

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Knowledge and understanding of mathematics	Equal variances assumed	5.799	.017	.927	186	.355	.121	.131	-.137	.380
	Equal variances not assumed			.920	176.433	.359	.121	.132	-.139	.382

Also, the number of pupils who solved the tasks is presented through the graph, from where it can be seen that in 2 correct answers out of a total 3, the number of boys is greater than the number of girls.

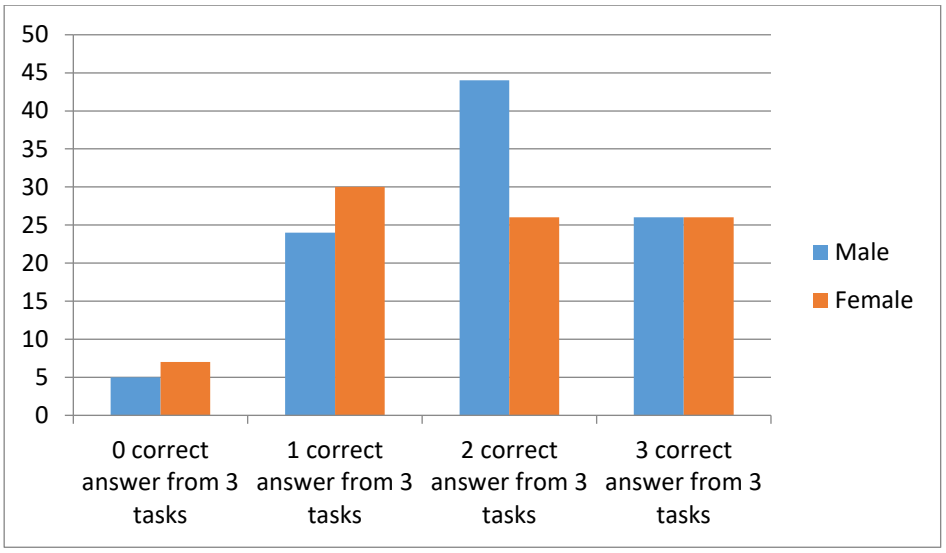

Figure 1. Bar chart for pupils who have solved the tasks

Conclusion and discussion

The results obtained in our research regarding the absence of a significant difference in mathematics achievements between boys and girls and in relation to tasks classified at the Knowledge and Understanding level are in line with the results published by the State Examination Center. Students in the Republic of North Macedonia have shown gender parity in average mathematics achievement in the TIMSS 2019 and TIMSS 2023 assessments. Based on the international results of TIMSS 2019, fourth-grade boys had higher average achievement than girls in approximately half of all 58 participating countries.

The reasons for the differences (or lack thereof) in mathematics achievement between students of different genders have been the focus of research teams from various scientific fields. There are many, even conflicting, reasons for gender differences in mathematics. (Fennema, Peterson, 1985; Gallagher, De Lisi, 1994). More than 30 years ago, Kimball (1989) presented an examination of the little-noticed gender differences in classroom performance. In contrast to standardized tests of mathematical achievement, girls were observed to score higher in mathematics than boys. Three hypotheses have been proposed to explain this difference. The first hypothesis suggests that boys' greater mathematical experience facilitates their performance on standardized tests. The second hypothesis proposes that learning styles in mathematics are responsible for the observed differences. It is assumed that behaviors associated with autonomous learning facilitate performance on standardized tests, while learning according to classroom instructions facilitates performance on classroom tests. The third hypothesis proposes that boys and girls respond differently to new and familiar situations in which achievement is measured. It is assumed that girls are better at dealing with familiar situations such as classroom exams, while boys are better at dealing with new situations such as standardized tests.

In their research, Schleepen and Van Meir (2016) on the effects of math anxiety on arithmetic competence, reading comprehension, and fluid intelligence in fifth-grade children, they studied possible gender differences while controlling for the effects of test anxiety. The results indicated significant gender differences in the relationship between math anxiety and cognitive abilities,

showing that only in girls was math anxiety negatively correlated with arithmetic competence, reading comprehension, and fluid intelligence. In boys, no significant correlations were found between math anxiety and the three cognitive abilities. Such differences occur at every level of education. The results of Keller's (2002) study showed that high school-age female students in a condition of increased salience of negative stereotypical expectations underperformed compared to their counterparts in the control group.

On the other hand, although most research on gender and education rightly focuses on girls, some research in the United States and elsewhere focuses on boys' learning, social outcomes, and school experiences. This "masculine turn" has produced a large body of theoretically and practically oriented research, along with popular and rhetorical works (Weaver-Hightower, 2003).

Mathematics is a subject which, in addition to talent, requires work and dedication. Success in mathematics can be achieved with the desire and will of the pupils. It is the teacher and pupils who give them life based on how they are interpreted and enacted in the classroom. The teacher is critical in shaping the lived task and directing pupils' activities so that pupils have opportunities to engage meaningfully in mathematics through them. He or she could treat a task of high cognitive demand as a low level one or vice versa. There are several factors that could influence this; for example, the teacher's knowledge of content, knowledge of learners, goal for task, instructional orientation, and beliefs about mathematics (Chapman, 2013).

Since "Numbers" and "Number Operations" represent the foundation of the mathematics curriculum (NCTM, 1998), it is preferable for teachers to develop more elaborate mechanisms to pupils' acquire strong mathematical knowledge and skills.

References

[1] Benbow, C. P., & Stanley, J.C. (1980). Sex differences in mathematical ability: Fact or artefact? *Science* , 210 (4475), 1262 – 1264.

[2] Chapman, O. (2013). Mathematical-task knowledge for teaching. *Journal of Mathematics Teacher Education*, *16*, 1-6.

[3] Fennema, E., & Peterson, P. L. (1985). Autonomous learning behavior: A possible explanation of sex-related differences in mathematics. *Educational Studies in Mathematics*, 309-311.

[4] Gallagher, A. M., & De Lisi, R. (1994). Gender differences in Scholastic Aptitude Test: Mathematics problem solving among high-ability students. *Journal of Educational psychology*, *86*(2), 204.

[5] Hargreaves, M., Homer, M., & Swinnerton, B. (2008). A comparison of performance and attitudes in mathematics amongst the 'gifted': Are boys better at mathematics or do they just think they are? *Assessment in Education: Principles, Policy & Practice*, *15*(1), 19-38.

[6] Keller, J. (2002). Blatant stereotype threat and women's math performance: Self-handicapping as a strategic means to cope with obtrusive negative performance expectations. *Sex Roles*, *47*(3), 193-198.

[7] Kimball, M. M. (1989). A new perspective on women's math achievement. *Psychological bulletin*, *105*(2), 198.

[8] Ламева, Б., Сарачини. А. (2022). Извештај за постигањата на учениците во Република Северна Македонија: TIMSS 2019 (Trends in International Mathematics and Science Study), Скопје: Државен испитен центар.

[9] National Council of Teachers of Mathematics, Inc., Reston, Va. (1998). *Principles and standards for school mathematics: Discussion draft*. National Council of Teachers of Mathematics.

[10]Preckel, F., Goetz, T., Pekrun, R., & Kleine, M. (2008). Gender differences in gifted and average-ability students: Comparing girls' and boys' achievement, self-concept, interest, and motivation in mathematics. *Gifted child quarterly*, *52*(2), 146-159.

[11] Schleepen, T. M. J., & Van MIer, H. I. (2016). Math Anxiety Differentially Affects Boys' and Girls' Arithmetic, Reading and Fluid Intelligence Skills in Fifth Graders, *Psychology*, Vol. 7, No. 14, 1911-1920.

[12] Sharma, P., (2021). Importance and Application of Mathematics in Everyday Life, International Journal for Research in Applied Science and Engineering Technology, Vol.9 (11):868-879 DOI:10.22214/ijraset.2021.38869

[13] Walkerdine, V. (2012). *Counting girls out*. (e-book) London: Routledge.
[14] Weaver-Hightower, M. (2003). The "boy turn" in research on gender and education. *Review of educational research*, *73*(4), 471-498.

Appendix – tasks from the tool for measuring achievements in mathematics

Tasks categorized at the level – Knowledge and Understanding:

Task 1. Subtract 428 – 176.

Task 2. Tom ate $\frac{1}{2}$ of the cake and Anna ate $\frac{1}{4}$ of the cake.

How much of the cake did they eat together? Calculate and answer.

Task 3. Six hundred books are to be packed in boxes so that each box contains exactly 15 books.

Which of the following expressions can be used to find the number of boxes needed? Circle.

A. Add 15 to 600 B. Subtract 15 from 600.

C. Multiply 600 by 15 D. Divide 600 by 15.