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Competences development in financial mathematics at the secondary technical school: case study

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ABSTRACT

The need to educate students about finance and financial operations is a frequently discussed topic in today's society. How to manage money, create savings or invest it that is the important educational basis for students during school education. At secondary technical schools, the mentioned issue of financial mathematics has specified content with appropriate number of teaching hours within the study subject Mathematics. Main aim of this paper was the analysis of students' knowledge from the topics of Financial Mathematics. In the contribution, it is presented an analysis of the point score in solving tasks on Financial Mathematics. The research group consisted of students of the 1st year at the secondary technical school in the school years 2021/2022 and 2022/2023. The analysis was processed using descriptive statistics and the Mann-Whitney U Test. Conclusions showed statistically significant differences in the point scores between students in relation to students' gender and according to the school year. Nevertheless, students confirmed very good level of knowledge in financial topics. Mastering the basics of financial mathematics concerns all students at secondary schools, so that they could properly handle financial resources in practical cases.

KEYWORDS: financial mathematics, study outcomes, test points score, descriptive statistics, statistical testing

JEL CLASSIFICATION: C50, D40, M10

INTRODUCTION

A lot of research and practical areas are connected with methods of mathematics where exact solving procedures are applied. Calculations and estimations of financial mathematics are important for planning and decision making in financial management. Investing money is the basis for capital appreciation for companies and for every person.

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Mutual relations between mathematics, economics, but also with other subjects can improve students' interest in mathematics and mathematical calculations. Cross-curricular relationships in a broader sense were the subject of the research study by Machado-Vidal and Carrascal-Torres (2020), which aimed to explore how mathematics, economics and finance education improves other competences and abilities of students. The results showed the positive impact of integrated tasks on the development of pupils' civic competences, i.e. j. ethical and social principles.

An unfavorable trend in current education is a reduced interest in mathematics and its application, which develops students' logical thinking and calculation skills. Effective cross-curricular connections help students to appreciate the importance of science and science knowledge. Training of students was affected by the Covid-19 pandemic in 2020 and 2021. The consequences of some restrictions, online education and isolation of students are reflected in the level of knowledge so far (Maros et al., 2022).

Motivating students and integrating financial numeracy into mathematics is the goal of innovation in the content and methods of education. Successful implementation of financial numeracy in mathematics classrooms requires unique and innovative didactic ideas (Savard & Cavalcante, 2021; Amirullah et al., 2022). Topics from the field of finances and investments belong to the important part of mathematical applications with the impact on students' financial literacy (Brown et al., 2016).

Mathematics teachers need to update their didactic knowledge about the possibility of teaching through information technology and mathematical modules. The approach of teachers to modern educational methods supports their implementation in education, therefore it is important to innovate the training of future teachers of financial mathematics. Many studies are devoted to this topic, which are also focused on cultural differences in education. Authors (Said et al., 2022) present the structure and development of a financial education module for mathematics teachers for the 21st century, focusing on future teachers' perceptions of learning resources. The created module incorporates elements from the Malaysian culture that may differ from Western cultural expectations.

Education at secondary schools (upper secondary education) is an important part of the education system in the Slovak Republic. In secondary schools, it is the initial preparation of young people for a future profession, which the graduate will obtain either after completing secondary school or after completing university studies (Vargová, 2010). At secondary school, the student's relationships with both general and specialized subjects are gradually formed, which has an impact on decisions about future qualifications and work profession. As stated by Průcha (2009), upper secondary education has either the character of a final phase of education (graduates go directly to the labor market), or it has the character of a transit phase of education (it prepares graduates for post-secondary or tertiary education).

Information about historical development can increase the interest of students in mathematics topics. Pires and Corrêa (2021) addressed this question in their research and focused on publication sources that reported on studies related to the history of Financial Mathematics from basic education to higher education.

By solving tasks from financial mathematics, we develop students' creative and logical thinking, which improves the conditions for further study of theoretical methods and their application. At Slovak universities the Financial Mathematics is represented as a subject within

economic study programs or as a study program at some universities (Hornýák Gregáňová, 2017; Hornýák Gregáňová et al., 2018). The professional competences acquired from financial mathematics will expand the possibilities of students for increasing their qualifications and making the right decisions in the field of financial capital.

MATERIAL AND METHODS

The research material for this contribution was collected during the didactic research, which took place in the years 2021/2022 and 2022/2023 at the Secondary Technical School of Civil Engineering in Žilina. The main goal of the research was to analyze the level of students' knowledge, specifically from the thematic unit Financial Mathematics. This unit is incorporated into the study course Mathematics taught in the second half of the 1st year. The teaching includes two parts: theoretical preparation hours and practical exercises (eight hours in total).

An individual project was part of the study of financial topics. For the taught topic, the students had to collect the necessary data and prepare Financial Diary during one month at home. Required data were about incomes and expenses, e.g. pocket money from parents, income from part-time work, etc. or they had to write down monthly expenses within the family budget. After a month, they made a final evaluation of incomes and expenses. This task resulted from discussions organized by bank employees at the secondary school with the aim to teach students the meaning of financial concepts and processes associated with borrowing money. Family indebtedness is often accompanied by ignorance of obligations in case of non-repayment of debts and possible problems.

In school year 2021/2022 the research sample consisted of 31 students, and in year 2022/2023 the research sample consisted of 30 students. In Table 1 there are data about students from the research sample: frequencies in particular school years and percentage of students by gender (girls, boys).

Table 1 Number of students and percentage by gender

Gender	Year 2021/2022		Year 2022/2023		Total for both years	
	Number	%	Number	%	Number	%
Boys	16	51.61	20	66.67	36	59.02
Girls	15	48.39	10	33.33	25	40.98
Overall	31	100.00	30	100.00	61	100.00

Source: authors' calculations

During the pedagogical research, each student wrote a control test that consisted of the four tasks on financial issues. The methodological procedure was based on the analysis of students' scores in this test within years 2021/2022 and 2022/2023. Due to the range of analyzed data and the fact that data did not satisfy the condition of normal distribution, we applied the Mann-Whitney U test, which belongs to the category of non-parametric tests (Markechova et al., 2011). Obtained results are summarized in the following part.

RESULTS AND DISCUSSION

The adult generation feels a lack of knowledge related to financial capital, its investment and appreciation. Therefore, we focused on the survey about financial topics and the knowledge level of students at the secondary technical school.

Figure 1 presents graphic form of data about students in the research sample. The number of students in each year was approximately the same. Differences are in the number of girls and boys, where in 2022/2023 there were 10 girls and 20 boys in the sample.

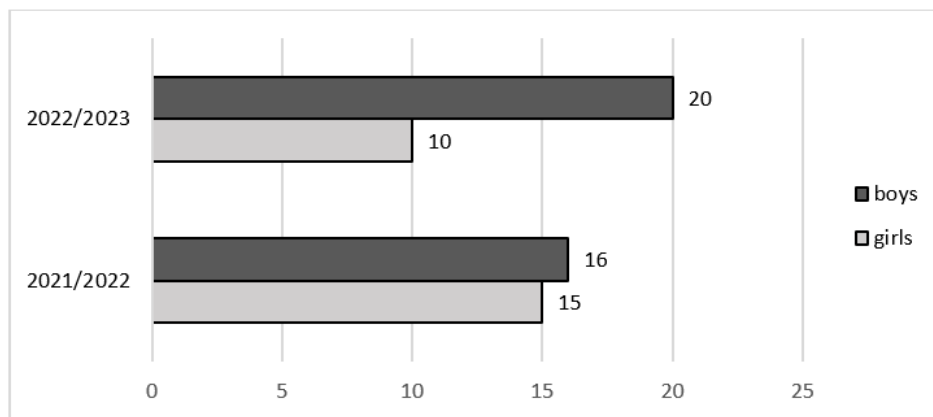


Figure 1 Graphical presentation of the number of girls and boys in the research sample by year
Source: authors' processing

The aim of the research was to evaluate the point score of the financial mathematics test, in which students solved the following tasks.

Task 1: The invoiced price of the goods including 20% value added tax (VAT) is 1419.64 €. What is the price of the goods without VAT and what is the amount of VAT?

Task 2: The price of the television after the 12% discount was € 530.17. What was the original price of the television?

Task 3: We will save the principal amount of € 3,000 for 5 years at an interest rate of 1.9% p.a. Calculate the amount of interest.

Task 4: The financial capital of € 1,000 was deposited for 3 years at 2% p.a. Then the interest rate increased by 0.5% and the capital was saved for another 2 years. What was the final value of the financial capital?

Each task with correct solution was rated with 1 point, and the maximum number of points for a correctly solved test was 4 points. Grades were assigned based on the valid scale of technical school:

- Grade 1: 3.75-4 points,
- Grade 2: 3-3.5 points,
- Grade 3: 2-2.75 points,
- Grade 4: 1.5-1.75 points,
- Grade 5: 0-1.25 points.

Figure 2 graphically shows the frequency of test grades by year. In 2021/2022, the highest frequency was grade 2. In 2022/2023, the highest frequency was grade 1. This is also related to the overall grade point average, which was better in 2022/2023.

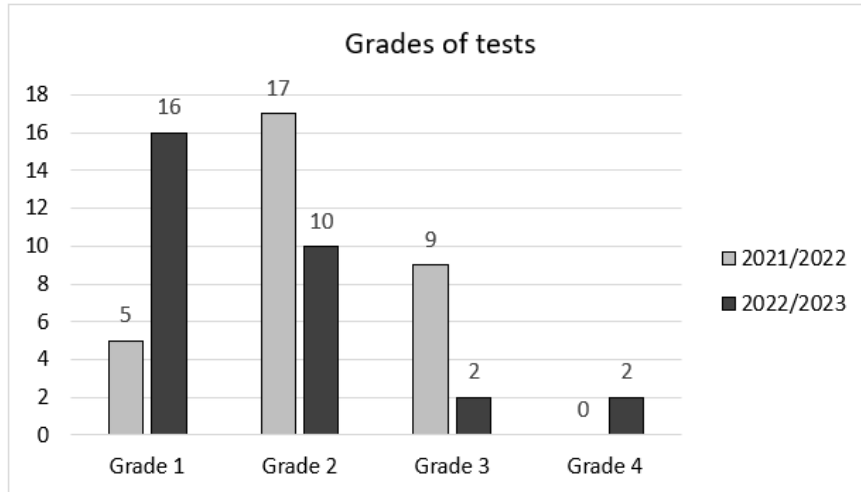


Figure 2 Grades of tests obtained in individual years
Source: authors' processing

A graphical representation of the average number of points for individual tasks and for each year is shown in Figure 3. In each year, students received approximately the same number of points for the tasks. The average point score in the test was better in 2022/2023 (3.42 points).

Statistically significant difference was tested between the average point scores for the total number of tasks in each year using the Mann-Whitney U Test. The calculated p -value is $0.029 < 0.05$; therefore, the result is significant at the significance level $\alpha = 0.05$.

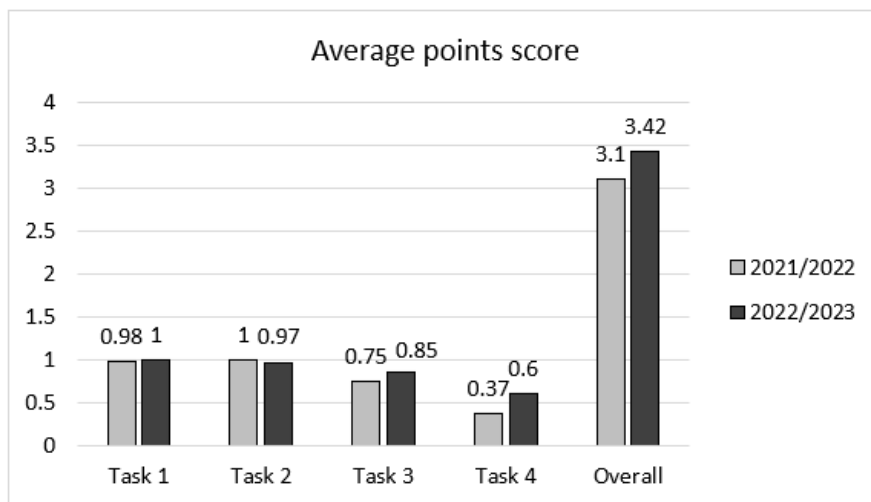


Figure 3 Average point score according to tasks and overall test
Source: authors' processing

Figure 4 shows the test scores by year in a box-plot format. The graph shows that in 2022/2023, students achieved a better score on the test than in 2021/2022. Via the Mann-Whitney U Test, it was verified if there was a statistically significant difference between the scores in each year. The p -value is $0.012 < 0.05$; the result is significant at the significance level $\alpha = 0.05$.

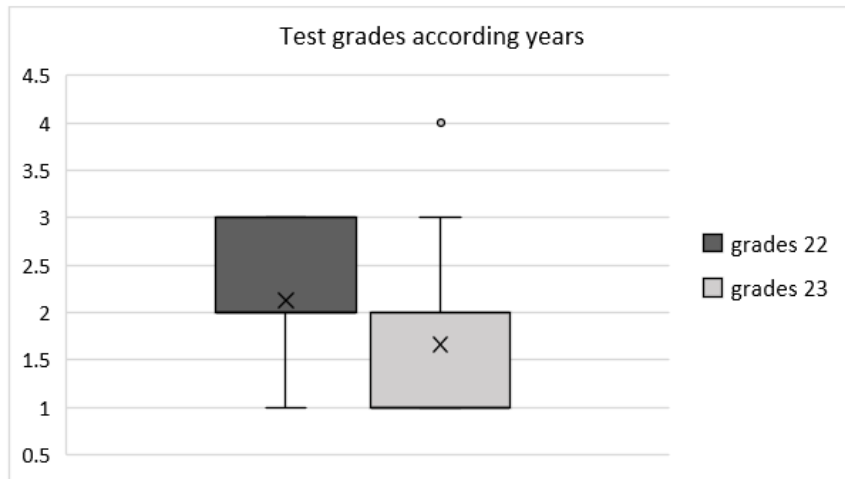


Figure 4 Boxplot of obtained test grades by year
Source: authors' processing

Figure 4 shows students test scores by gender in a box-plot format. It is evident from the graph that boys scored higher on the test.

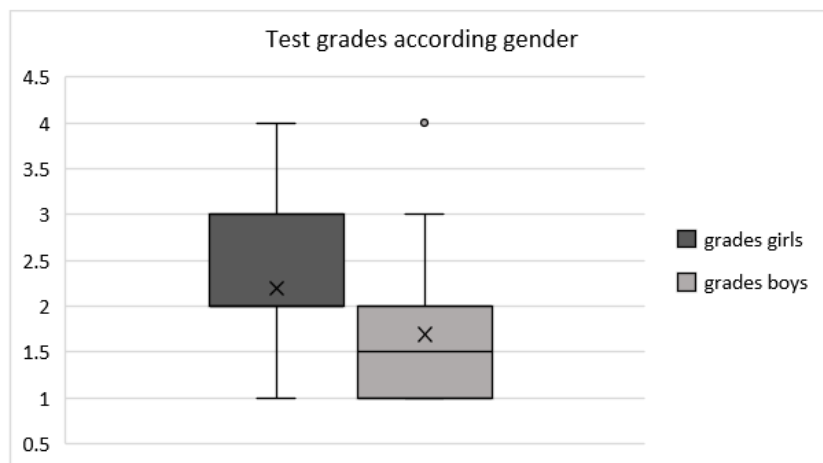


Figure 5 Boxplot of test grades scores by gender
Source: authors' processing

Using the Mann-Whitney U Test it was verified the existence of statistically significant difference in test scores between girls and boys. The p -value is $0.014 < 0.05$; thus, the difference in results is significant at the significance level $\alpha = 0.05$.

Finally, MS Excel tools can be used to develop students' mathematical calculation skills in solving financial problems. Calculation procedures involving sequences and repeated calculations can be simplified by this available software (Huťka and Peller, 2001; Országhová, 2023). Students will also improve their level of digital literacy.

CONCLUSIONS

Financial mathematics provides the apparatus and methods for solving problems in the field of finance and investments. Each of us encounters financial operations in private life, and many financial and banking operations are performed either by employees or by enterprises as a whole. Therefore, financial mathematics has an important place at all levels of education. In this context, the main goal of the presented pedagogical research was to find out how financial mathematics units are integrated into education and to evaluate the level of students' knowledge of financial mathematics topics covered at the secondary technical school.

The research was conducted during two school years 2021/2022 and 2022/2023. Students obtained better average number of points in test (and therefore a better average grade) in the year 2022/2023, which was also confirmed by the Mann-Whitney U Test. Similarly, the Mann-Whitney U Test confirmed the statistical significance between tests grades of girls and boys (boys obtained a better rating).

Given the nature of financial education, it is appropriate to apply integrated teaching in secondary schools, which allows the presentation of educational content as a whole. It leads to the interconnection of knowledge, understanding of contexts and enables the application of acquired skills. The quality of educational content at secondary schools is important for the employment of graduates or for their further education.

Acknowledgement

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