

MATHEMATICAL WELLBEING PREDICTORS OF MATHEMATICS ACHIEVEMENT IN DIFFERENT EDUCATIONAL TRACKS: CASE OF SLOVENIA

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Abstract

The role of students' mathematical wellbeing in explaining mathematics achievement has gained increasing attention in national and international research, particularly within large-scale assessment studies (e.g. PISA, TIMSS). Among the dimensions of mathematical wellbeing, mathematics anxiety, mathematics self-efficacy, and proactive mathematics study behaviour have consistently been identified as significant predictors of mathematics achievement. The latest PISA 2022 results for Slovenia show that Slovenian 15-year-olds report substantially higher levels of mathematics anxiety and lower levels of mathematics self-efficacy and proactive study behaviour compared to their OECD peers. Given the long-term negative trend in Slovenian students' mathematics performance, this study addresses a research gap by examining the contribution of different aspects of mathematical wellbeing to explaining mathematics achievement. Since previous national studies have shown that educational programme is an important source of differences in learning behaviour and academic outcomes in Slovenia, the study also explores how the predictive effects vary across educational tracks. The analysis is based on Slovenian PISA 2022 data from a representative sample of 6,721 15-year-old students, of whom 1,486 (22.1%) attended general education and 1,339 (19.9%) vocational education programmes. From the student questionnaire, we used scales measuring mathematics anxiety, mathematics self-efficacy (formal and applied), and prosocial mathematics behaviour, while mathematics achievement was measured using ten plausible values from the cognitive database. All scales showed good internal consistency in the Slovenian sample. Linear regression analysis was applied to examine the effects of predictors within educational tracks, with multicollinearity checked prior to analysis. Data were analysed using IEA IDB Analyzer (Version 5.0.50), which accounts for PISA's two-stage sampling design by applying student and sample weights and estimating standard errors using the Bootstrap method. The results showed that mathematics anxiety and mathematics self-efficacy related to formal and applied mathematics were the most significant predictors of students' mathematics achievement in the Slovenian context, regardless of educational programme. Analyses of the model's explanatory power revealed notable differences between educational programmes, as the predictors explained 16% of the variance in mathematics achievement in general education, but only 5% in vocational education. These findings highlight the importance of strengthening students' socio-emotional wellbeing related to mathematics and fostering supportive student-teacher relationships as key pathways for improving mathematics achievement, thereby emphasizing the need to systematically address mathematics anxiety and enhance mathematics self-efficacy, while also implementing differentiated pedagogical approaches that take into account students' prior knowledge, motivational characteristics, and specific educational needs.

Keywords: *Mathematics achievement, mathematics anxiety, mathematics self-efficacy, educational tracks, PISA 2022 study.*

1. Introduction

In the international research context, recent studies consistently show that higher levels of mathematics anxiety are associated with lower mathematics achievement, even when controlling for contextual factors such as cultural background, students' age and educational level, task difficulty, and the type of mathematics assessment (Barroso et al., 2020; Esposito et al., 2025; Zhang et al., 2019). Furthermore, studies (e.g., Al Mutawah, 2015) indicate that mathematics anxiety is particularly pronounced among students who hold negative beliefs about mathematics and report low levels of mathematics self-efficacy. At the same time, mathematics self-efficacy has been consistently identified as a strong

positive predictor of mathematics achievement (Ding et al., 2024; OECD, 2025; Yang et al., 2024). Studies examining the effects of prosocial behaviour on academic achievement in primary and secondary education (Deveci & Karademir, 2019; Maamin et al., 2022) have found that learning engagement is a significant positive predictor of academic achievement. The research (e.g., Chiu et al., 2016; Ni & Han, 2022) also suggests that it is important to consider different groups of students when examining wellbeing at school, as significant differences exist between student groups.

2. Objectives

Mathematics is a central domain of the educational process and represents an essential foundation for the development of broader knowledge and skills. Results from PISA 2022 indicate that Slovenian 15-year-old students report relatively high levels of mathematics anxiety, low levels of mathematics self-efficacy, and a persistent negative trend in mathematics achievement (OECD, 2023). Previous research has predominantly examined mathematical wellbeing by focusing on single dimensions, such as mathematics anxiety or self-efficacy, while far fewer studies have simultaneously investigated multiple dimensions and their relative contributions to mathematics achievement. Consequently, important gaps remain in understanding how different aspects of mathematical wellbeing jointly relate to mathematics achievement outcomes.

In the Slovenian context, empirical evidence on mathematical wellbeing across educational programmes remains limited, despite consistent national analyses of PISA data (e.g., Štremfel & Šterman Ivančič, 2024) demonstrating large and statistically significant differences in mathematics achievement, particularly between general and vocational education. The objective of this study is to examine the combined and relative effects of multiple dimensions of mathematical wellbeing on mathematics achievement and to test whether these relationships differ across educational programmes.

3. Method

In Slovenia, 6,721 students participated in the PISA 2022 study. To examine differences in predictors of mathematical achievement across educational programmes, the analyses included a representative subsample of 1,486 students (22.1%) enrolled in general education programmes and 1,339 students (19.9%) enrolled in vocational education programmes. Data from the PISA 2022 student questionnaire were used, drawing on separate scales measuring students' perceived mathematics anxiety, mathematics self-efficacy related to formal and applied mathematics, and prosocial mathematics behaviour. All scales demonstrated good internal consistency in the Slovenian sample. Linear regression analyses were conducted to estimate the effect sizes of different predictors in explaining students' mathematics achievement within different groups of students. Prior to the regression analyses, multicollinearity among the variables was examined. The data were analysed using the IEA IDB Analyzer (Version 5.0.48), which accounts for the two-stage sampling design of PISA and enables the application of student and sample weights as well as the Bootstrap method to obtain accurate standard error estimates for the population.

4. Results

The findings indicate that, in both the general education and vocational education programmes, two predictors were consistently identified as significant: mathematics anxiety, which emerged as a negative predictor, and perceived mathematics self-efficacy in formal and applied mathematics, which functioned as a positive predictor of mathematics achievement. Furthermore, analyses of the model's explanatory power revealed notable differences between educational programmes. In the general education programme, the predictors accounted for 16% of the variance in mathematics achievement. In contrast, the same set of predictors explained only 5% of the variance in mathematics achievement in the vocational education programme.

5. Discussion and conclusions

Findings are consistent with previous research demonstrating that mathematics anxiety has a substantial negative effect on mathematics performance, whereas positive beliefs about one's mathematical knowledge and capabilities, reflected in higher levels of mathematics self-efficacy, are associated with higher mathematics achievement (Broda et al., 2023; Holenstein et al., 2021; Yang et al., 2024). Analyses of the model's explanatory power further indicate that aspects of mathematical wellbeing play a more prominent role in academically more homogeneous and higher-achieving student populations. Among

students in the general education programme, whose prior knowledge is relatively uniform and whose average achievement is higher, individual differences in mathematics performance appear to be more strongly related to emotional regulation and beliefs about one's own capabilities. In contrast, within the vocational education programme, a larger share of the variance in mathematics achievement is likely attributable to contextual and structural factors, such as learning gaps, socioeconomic background, work obligations, and attitudes towards schooling, which were not included in the present explanatory model (OECD, 2023; Kuzmina & Carnoy, 2016).

Overall, the findings highlight the need to systematically address mathematics anxiety and strengthen mathematics self-efficacy across educational programmes, while emphasizing the importance of differentiated pedagogical approaches that consider students' prior knowledge, motivational characteristics, and specific needs. These results provide a basis for developing interventions that integrate cognitive and emotional dimensions of learning and support the effective development of mathematical literacy.

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