MATHEMATICS TEACHERS' EMOTIONAL SUPPORT RELATED TO STUDENTS' MOTIVATION, MINDSET, ANXIETY, AND SKILLS

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Perceived teachers' emotional support can have a significant role in students' learning motivation and achievement. The aim of the current study is to better understand the interplay between mathematics teachers' emotional support and students' motivation and how both emotional support and motivation relate to achievement. The sample includes 4192 Estonian students (15-year-olds, 50% female) who filled in a questionnaire regarding perceived emotional support and mathematics motivation, and a few weeks later took the national mathematics exam. The results indicated that perceived emotional support did not predict mathematics exam results directly; however, it did predict the exam results indirectly through self-efficacy, task persistence, fixed mindset, and anxiety.

INTRODUCTION

A positive affective teacher-student relationship plays an important role in students' motivation and achievement (Roorda et al., 2017; Sakiz et al., 2011). Moreover, two of the most prominent theories of achievement motivation – the Self-Determination Theory (SDT, Ryan & Deci, 2020) and Situated Expectancy Value Theory (SEVT, Eccles & Wigfield, 2020) – emphasize the importance of students' perceptions of the learning context and their affective experiences with specific subjects. Both theories are complementary to each other; while SDT specifies the fulfillment of basic psychological needs in learning situations, SEVT gives detailed connections between social and personal characteristics that lead to successful learning outcomes. Accordingly, the current study is based on both the SDT and SEVT to better understand how perceived mathematics teachers' emotional support relates to students' motivation, emotions, and mathematics exam results. More specifically, we aim to find out whether students' motivational characteristics, mindset, and anxiety mediate the effect of mathematics teachers' perceived emotional support on mathematics achievement. The results provide further insight into the role of teachers' emotional support in students' motivation and achievement.

Perceived Emotional Support

Self-Determination Theory (Ryan & Deci, 2020) posits that people are inherently prone toward learning, mastery, and connection with others; however, to successfully

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achieve learning goals, people need to feel competent, autonomous, and related to others, i.e., their psychological basic needs need to be fulfilled. In the current study, we concentrate on the need for relatedness (sense of belonging and connection) that can be partially fulfilled by students' perceived emotional support from their mathematics teachers. Roorda and colleagues (2011) indicate that a positive teacher-student relationship can lead directly to higher achievement but the relationship can also be more nuanced. More specifically, it has been shown that academic self-efficacy and mathematics behavioural engagement mediate the relationship between teachers' emotional support and mathematics performance (Roorda et al., 2017; Yang et al., 2021). Thus, perceived teachers' emotional support might not directly relate to students' performance, but it can enhance their motivation to learn, which in turn supports their skill development.

Learning Motivation

The Situated Expectancy Value Theory (SEVT, Eccles & Wigfield, 2020) proposes a comprehensive model of motivated achievement-related choices, persistence, and performance. The model includes a wider cultural context (such as social roles, gender) and also students' beliefs, goals, affective reactions, expectations, and subjective task values. In the current study, mathematics-related expectation of success (i.e., self-efficacy), interest, persistence, fixed mindset, and mathematics anxiety are investigated as possible direct predictors of mathematics achievement. Mathematics-related interest can be defined as the enjoyment of mathematics that is accompanied by positive emotions, attention, and task-persistent learning behavior (Eccles and Wigfield, 2020). Interest is especially important for acquiring high mathematics skills (Mädamürk et al., 2018). High self-efficacy, as the belief in one's ability to complete mathematics tasks successfully (Bong & Skaalvik, 2003), has also shown a constant positive relation to mathematics skills (Arens et al., 2020). Task persistence is an effortful behavior, even when tasks become difficult (Zhang et al., 2011), it supports better academic achievement and could be especially important while solving complicated mathematics tasks (Kikas et al., 2020).

Ashcraft (2002) defines mathematics anxiety as a feeling of tension, apprehension, or fear that interferes with mathematics performance. Students with higher anxiety towards learning mathematics tend to have lower mathematics achievement (Barroso et al., 2020). A fixed mindset about mathematical ability (often termed an "entity theory") assumes competence is innate and cannot be significantly improved through effort or learning (Dweck, 2006). This belief is especially impactful in mathematics, where challenges and setbacks are common. Students with a fixed mindset are more likely to interpret difficulties as signs of low inherent ability rather than as opportunities for growth, leading to lower motivation and skill development (Blackwell et al., 2007; Yeager & Dweck, 2012).

Perceived emotional support has been associated with a range of positive student outcomes in mathematics, including increased motivation, reduced anxiety, and higher

achievement. Evidence indicates that emotional support is positively related to students' self-efficacy and sense of belonging in mathematics classrooms (Sakiz et al., 2012), and it is indirectly linked to mathematics performance through students' behavioral engagement and academic self-efficacy (Yang et al., 2021). Additionally, a comprehensive meta-analysis confirms that affective teacher–student relationships are significantly associated with both student engagement and academic achievement (Roorda et al., 2017).

Estonian Educational Context

In Estonia, all schools follow the requirements specified in the national curriculum (Estonian Government, 2011/2022). Estonian children typically start elementary school at age 7 and must pass nine grades to finish upper-middle school. In the present study, we investigate Grade 9 students, that is, 15-year-old students who were completing their mandatory education (from 2025, students must continue learning until age 18).

Estonian students show strong mathematics knowledge and skills in international comparisons, consistently ranking at the top of PISA results since 2006, when Estonia first participated in the survey (e.g., OECD, 2007; OECD, 2023). Mathematics is studied 4-5 lessons (45 min) per week, and at the end of Grade 9, all students must take the national mathematics exam. As a result, many teachers specifically concentrate on teaching content typically found in this exam. For students, passing the exam is essential for finishing mandatory education and entering secondary school. If a student fails the national exam, they must take and pass the school exam to finish Grade 9. Although the exam result must be at least 50% to pass, and the exact result higher than that is not essential for further educational path, the importance of passing the exam well still poses stress for students.

Current Study

The current study aims to understand how perceived mathematics teachers' emotional support relates to students' mathematics interest, self-efficacy, task persistence, fixed mindset, anxiety, and mathematics exam results. The research questions are as follows:

1) How is the students' perceived emotional support related to their mathematics interest, self-efficacy, task persistence, fixed mindset, anxiety, and mathematics exam results?

2) How do students' perceived emotional support, mathematics interest, self-efficacy, task persistence, fixed mindset, and anxiety predict their mathematics exam results?

3) Do mathematics interest, self-efficacy, task persistence, fixed mindset, and anxiety mediate the effect of emotional support on mathematics exam results?

METHOD

Participants and Procedure

The study uses secondary data collected by the Estonian Education and Youth Board. The sample included 4192 Estonian students (15-year-olds, 50% female)

from 190 schools. Data was collected in 2021 as part of the national background survey administered in spring a few weeks before the national mathematics exam. The survey focuses on students' thoughts, feelings, and behaviours related to learning mathematics, and aims to gather information about the learning environment, students' motivation, and their perceptions of teachers' emotional support. Participating in the survey was voluntary; a questionnaire was administered by school personnel during regular school hours using an online platform (Estonian Exam Information System). All participating schools received general feedback. The compulsory national mathematics exam took place in June. For the current study, the questionnaire answers and exam results were combined by the Estonian Education and Youth Board. The researchers received completely anonymized data.

The questionnaire included statements regarding perceived mathematics teachers' emotional support, mathematics-related interest, self-efficacy, task persistence, beliefs, and anxiety. All statements were answered with a 5-point rating scale.

Perceived emotional support was assessed using four items describing the teacher's emotionally supportive behaviour (e.g., "My teacher truly understands how I feel"), based on Kikas and Mägi (2016). Interest (three items, e.g., "I enjoy solving arithmetic and mathematics-related tasks at school."), and self-efficacy (three items, e.g., "I am capable in mathematics.") were assessed with a questionnaire based on the SEVT (Eccles & Wigfield, 2020). Task persistence was assessed with five statements, including both persistence and avoidance statements (e.g., "If something in mathematics class is difficult, I leave it unfinished."; Zhang et al., 2011). Fixed mindset was assessed with four items (e.g., "Mathematical ability is something that cannot be changed much."; Yeager & Dweck, 2012). Mathematics anxiety was assessed with five items (e.g., "I feel anxious when I have to complete a mathematics worksheet independently."; Ashcraft, 2002).

The national mathematics exam assesses students' mastery of the mathematics curriculum and is designed to cover all major content domains specified in the national curriculum, including arithmetic, data, algebra, and geometry. In addition, tasks represent three cognitive domains required by the curriculum: factual and procedural knowledge, application of knowledge in routine and non-routine situations, and reasoning. The exam consisted of five compulsory tasks (each 8 points) and one optional task (10 points), from which students completed six tasks in total. The maximum score was 50 points. The tasks required a range of mathematical competencies, including symbolic manipulation, functional reasoning, geometric problem-solving, modelling, and interpretation of real-world contexts.

Results

Data was analyzed using the IBM SPSS Statistics version 24 and Mplus 8.2 (Muthén & Muthén, 1998–2017). Descriptive statistics and internal reliabilities are presented in Table 1. To answer the first research question, Spearman's correlation was used (Table 1), to answer the second and third research questions, multiple linear regression was used (Figure 1).

Table 1: Descriptive statistics, bivariate correlations, and internal reliabilities of the measures

Measure	1.	2.	3.	4.	5.	6.	7.
1. Mathematics exam	-	.					
2. Perceived teachers' emotional support	.24*	-					
3. Self-efficacy	.62*	.31*	-				
4. Task persistence	.48*	.36*	.61*	-			
5. Interest	.46*	.33*	.64*	.62*	-		
6. Fixed mindset	-.27*	-.18*	-.22*	-.29*	-.20*	-	
7. Mathematics anxiety	-.31*	-.15*	-.43*	-.32**	-.27*	.22*	-
Min-Max	0-50	1-5	1-5	1-5	1-5	1-5	1-5
Mean	29.71	3.54	3.19	3.45	3.10	2.18	2.77
SD	13.42	0.86	1.13	0.84	1.04	0.82	1.10
Cronbach's α	-	.86	.90	.80	.84	.83	.89

First, we analyzed how perceived emotional support is related to students' interest, self-efficacy, persistence, fixed mindset, anxiety, and mathematics exam results. The results indicated that perceived emotional support was positively related to interest, self-efficacy, task persistence, mathematics exam results, and negatively related to anxiety and fixed mindset.

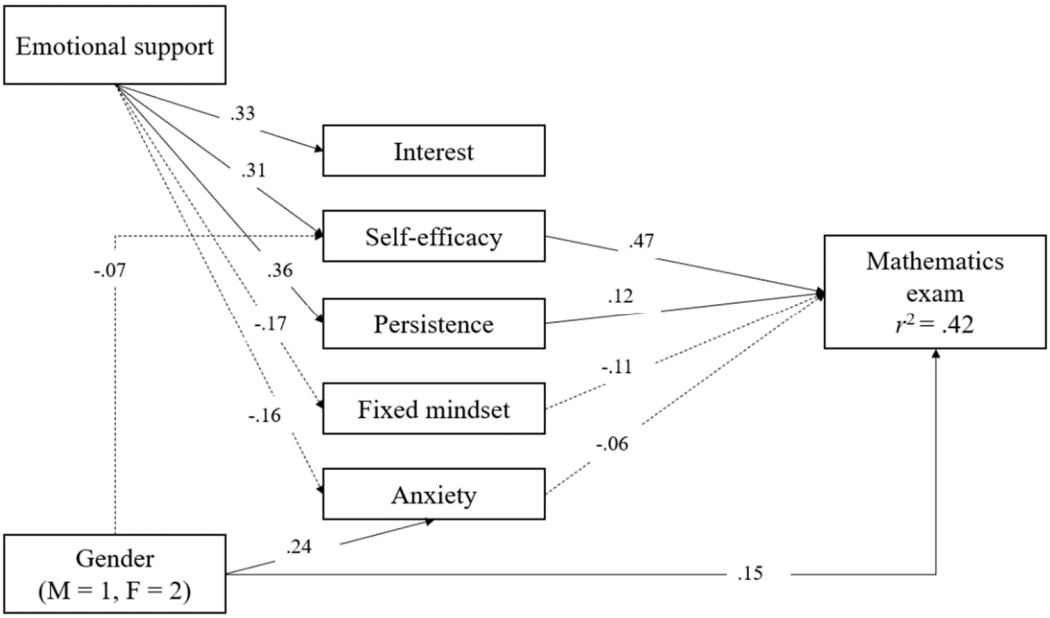
Second, we analyzed the direct predictors of mathematics exam results (Figure 1). Mathematics exam results were directly predicted by self-efficacy (β = .47, *S.E.* 0.02, $p < .001$), task persistence (β = .12, *S.E.* 0.02, $p < .001$), fixed mindset (β = -.11, *S.E.* 0.01, $p < .001$), and anxiety (β = -.06, *S.E.* 0.02, $p < .001$). Thus, students with higher self-efficacy, task persistence, and lower anxiety and fixed mindset tended to have higher mathematics exam results.

Gender was a significant predictor of self-efficacy (β = -.07, *S.E.* 0.02, $p < .001$), anxiety (β = .24, *S.E.* 0.01, $p < .001$), and mathematics exam results (β = .15, *S.E.* 0.01, $p < .001$). Thus, girls tended to have higher mathematics exam results but also higher anxiety and lower self-efficacy. Overall, 42% of the variability of mathematics exam results was described.

Third, we analyzed whether mathematics interest, self-efficacy, task persistence, fixed mindset, and anxiety mediate the effect of emotional support on mathematics exam

results. Perceived emotional support did not predict mathematics exam results directly; however, indirect effects were from emotional support through self-efficacy (β = .15, *S.E.* 0.01, $p < .001$), task persistence (β = .04, *S.E.* 0.01, $p < .001$), fixed mindset (β = .02, *S.E.* 0.003, $p < .001$), and anxiety (β = .01, *S.E.* 0.003, $p < .001$).

Figure 1: Direct effects of perceived emotional support, motivation, mindset, and anxiety on mathematics exam results



Note. All presented effects are statistically significant, $p < .01$

DISCUSSION

The purpose of this study was to better understand how perceived mathematics teachers' emotional support relates to students' mathematics interest, self-efficacy, task persistence, fixed mindset, anxiety, and mathematics exam results. Findings indicated that perceived mathematics teachers' emotional support was not a direct predictor of mathematics exam results; however, it was a direct predictor of students' interest, self-efficacy, task persistence, anxiety, and fixed mindset. Thus, perceived emotional support can have a substantial effect on students' motivation, mindset, and anxiety, which in turn also relate to skills.

Students who perceived stronger emotional support tended to have higher interest in mathematics, a stronger sense of self-efficacy, higher task-persistence, a less fixed mindset, and lower anxiety. This relates to previous findings that perceived emotional support can increase motivation, engagement, and decrease anxiety (Sakiz et al., 2012).

Although positive teacher-student relationships can lead directly to higher achievement (Roorda et al. ,2011), in the current study, perceived emotional support was not a direct predictor of students' mathematics exam results. Indirect links between emotional support and mathematics performance have been studied before, mostly through students' behavioral engagement and academic self-efficacy (Yang et al., 2021). With this study, we contribute to the literature by addressing a more comprehensive model uniting aspects of both the Self-Determination Theory (Ryan & Deci, 2020) and Situated Expectancy Value Theory (Eccles & Wigfield, 2020). Accordingly, we found that higher perceived emotional support enhances self-efficacy, task persistence, and reduces fixed mindset and anxiety, which in turn support higher achievement. Notably, this model described 42% of the variance of the national mathematics exam results, indicating that essential motivational and emotional characteristics of learning mathematics were captured.

These results point to students' perceptions as a key mechanism through which emotionally supportive teaching translates into motivational and achievement-related outcomes. Instructional quality may therefore be understood not only as enacted practice, but as a process shaped by learners' subjective experience. Future studies could include the same aspects of learning motivation and emotions to verify the results with various samples and investigate age-related differences.

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