



## The Relationship Between Emotional Competence and Mathematics Achievement in Primary Education: Effects of Group Work Intervention

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### Abstract

*This research starts from the assumption that emotional intelligence plays an important role in learning mathematics, as it helps students manage stress, anxiety, and interpersonal relationships in the classroom. Within this framework, the study explores the concept of emotional competence as an applicable aspect of emotional intelligence that can be developed through pedagogical interventions. The aim of the research was to examine whether more frequent use of group work in mathematics teaching influences the development of students' emotional competence and whether there is a relationship between emotional competence and academic achievement in mathematics. The study was conducted as a quasi-experimental design with a sample of 32 sixth-grade primary school students. In the first phase, class 6.a served as the experimental group and class 6.b as the control group, while in the second phase the group roles were reversed. The intervention included more frequent group work and project-based tasks during the instructional units Triangle and Quadrilateral. Emotional competence was assessed using the UEK-D questionnaire, and academic achievement was measured by a mathematics skills test and final grades. The data were analysed using the Mann-Whitney and Wilcoxon tests and Spearman's correlation. The results showed no statistically significant changes in the level of emotional competence after the intervention, nor between the experimental and control groups. However, a statistically significant positive correlation was found between emotional competence and mathematics achievement ( $\rho = 0.530$ ;  $p = 0.002$ ), confirming that emotional skills play an important role in academic performance. A particularly interesting finding relates to the decline in positive attitudes toward group work among students who were more frequently engaged in collaborative activities, indicating the need for a deeper understanding of the emotional dynamics within group work.*

**Keywords:** Emotional competence; Mathematics achievement; Group work; Primary education; Quasi-experimental design

### 1. Introduction

Students around the world face many challenges during their development, and in the context of school and education, most students experience difficulties in coping with academic stress and anxiety (Sood et al., 2024). This opens space for the introduction of innovative learning methods in which the emphasis is placed not only on cognitive skills, but also on emotional intelligence and its development. In addition, data show that many students possess highly developed academic abilities, especially in mathematics, but a lack of emotional intelligence prevents them from demonstrating these abilities (Sahara, 2024).

Although emotional intelligence is highly valued, its application in mathematics education, as well as in education in general, remains limited (Fotopoulou et al., 2023). There are several reasons for this, one of which is the lack of teacher education in the field of emotional intelligence (Cristóvão et al., 2023). Most school mathematics curricula are based on the development of cognitive and analytical skills, neglecting the emotional component. Students who experience anxiety while solving mathematical tasks are unable to achieve their full potential and are disadvantaged compared to students who do not face this problem (Cantero et al., 2020).

Mathematics anxiety can be described as a set of strongly negative feelings toward mathematics and is defined as a feeling of tension, apprehension, or fear that interferes with mathematical performance. Study models (Skagerlund et al., 2019) indicate that mathematics anxiety affects mathematical outcomes both directly and indirectly. Research conducted by Švecová in 2024 confirms the existence of a significant negative relationship between the level of mathematics anxiety and success in solving mathematical problems, with students experiencing higher anxiety achieving poorer results. In



addition, it was shown that students with lower levels of anxiety more frequently use effective problem-solving strategies, whereas anxious students more often display uncertain approaches (Švecová, 2024).

Interestingly, according to the same study, mathematics anxiety occurs more frequently among girls, although gender differences in achievement are not always equally pronounced. The author emphasizes the importance of emotional safety and support in the educational environment, suggesting that the creation of a positive classroom climate and the development of students' emotional skills can have a protective effect against the development of mathematics anxiety. These findings support a broader theoretical framework according to which emotional competences and emotional intelligence are important predictors not only of students' emotional well-being, but also of their academic effectiveness.

### **1.1. Concept of Emotional Intelligence**

Emotional intelligence is described as the ability to recognize the meaning of emotions and the relationships between them, as well as the ability to reason and solve problems based on emotions (Ciarrochi et al., 2006).

Over the past decades, various theoretical models have been developed to explain the role of emotions in cognitive processes and learning. Different authors have proposed different models, with Mayer and Salovey (1990) focusing on emotional intelligence as a cognitive ability, while Goleman views it as a set of personal and social competencies. Emotional intelligence was first defined in 1990 as a distinct type of intelligence, which includes the ability to recognize, understand, express, and regulate emotions, as well as to use them in decision-making and reasoning. Earlier models portrayed emotional processes as interfering factors in rational thinking, whereas Salovey and Mayer introduced emotional intelligence as a concept that plays an important role in the processes of thinking and decision-making (Salovey & Mayer, 1990).

Goleman also states that emotional intelligence contributes to the development of enthusiasm, self-confidence, social competence, and positive personality traits (Goleman, 1995).

The development of theoretical models of emotional intelligence has paved the way for numerous empirical studies confirming its importance in the educational context. In the primary school context, emotional intelligence plays a preventive role in the emergence of later mental disorders, and therefore its development should be encouraged from the early stages of development. In recent years, school-based emotional intelligence intervention programs have shown promising results in fostering the development of emotional skills.

For example, a study conducted in Italy (2023) on 68 students aged approximately 10 years showed that a short eight-week emotional intelligence training program (1 hour per week) increased students' emotional abilities. Students in the experimental group demonstrated a better understanding of complex emotional experiences and greater knowledge of different emotions. A reduction in negative emotions was also observed, as well as a decreased tendency to use distraction as a coping strategy, which is interpreted as an improvement in emotional understanding and greater awareness of one's own emotional processes (Pauletto et al., 2023).

Despite theoretical and practical contributions, emotional education is still not sufficiently integrated into teacher education programs, as confirmed by recent analyses (Cristóvão et al., 2023).

Given that the emotional competences of teachers and students significantly influence learning and school functioning, understanding emotions in specific subject areas, such as mathematics, becomes particularly important. One of the most frequently studied emotional states associated with mathematics is mathematics anxiety.

### **1.2. Mathematics Anxiety**

Mathematics anxiety (MA) is a psychological state that refers to feelings of fear, tension, and apprehension that an individual experiences in relation to mathematics (Ashcraft, 2002). Although it is common for students to feel anxiety when faced with solving more complex mathematical tasks, for students with mathematics anxiety it can be very stressful to perform everyday activities, such as entering the mathematics classroom or solving simple calculations (Orabuchi & Yeh, 2013).

Numerous studies indicate that mathematics anxiety has a strong impact on students' achievement in mathematics as well as on their attitudes toward the subject and mathematics in general (Ashcraft, 2002; Balt et al., 2022; J. Furner, 2017; Khorramian et al., 2025; N. Verdeflor et al., 2025).



The most significant impact of mathematics anxiety relates to the reduction of students' working memory capacity. This is evident in stressful situations in which students with pronounced mathematics anxiety have greater difficulty retaining information in working memory, which reduces their ability to engage in logical reasoning (Ramirez et al., 2018).

The teacher's role in the development of mathematics anxiety is also emphasized by O'Hara et al. (2022), who state that mathematics anxiety emerges and develops within the classroom. Factors influencing this include emotional climate, social relationships, teaching style, and the psychological atmosphere. Bautista et al. (2023) emphasize that teachers can significantly contribute to reducing mathematics anxiety through supportive instructional practices, including mindfulness techniques, affirmations, motivational strategies, and systematic support for students.

The development of a positive classroom climate and students' emotional safety is directly related to teaching methods and interactions among students. One approach that contributes to reducing anxiety while simultaneously promoting a deeper understanding of mathematical concepts is collaborative learning.

### **1.3. Collaborative Learning and Group Work**

Collaborative learning empowers students to engage with real-life problems, collaborate with peers, think critically, and develop 21st-century skills. Unlike traditional teaching, this approach involves students in authentic situations and places emphasis on experiential learning and teamwork. One of the significant advantages of collaborative learning in mathematics, as stated by Rehman et al. (2024), is its potential to improve the understanding of mathematical principles through hands-on activities. During collaborative learning activities, the understanding of mathematical ideas is encouraged, and critical thinking skills are sharpened. At the same time, students become more skilled in recognizing patterns, establishing connections, and forming logical arguments for problem-solving.

Although individual studies indicate numerous advantages, broader reviews confirm that the successful implementation of these methods is conditioned by multiple factors. A systematic review of studies (2024) conducted between 2019 and 2023 identifies key factors for the successful implementation of collaborative learning, namely students' motivation and attitudes, as well as teachers' awareness and competencies.

The relationship between group work and the development of emotional competences has also been confirmed by previous research. According to a meta-analysis from 2015 (Rivera-Pérez et al., 2020), one of the ways to promote the development of emotional intelligence in teaching is more frequent group work among students.

In line with all the above, the aim of this study is to examine the impact of group work on the emotional development and academic achievement of sixth-grade primary school students.

## **2. Research Methodology**

The aim of this research is to determine whether there are differences in the level of emotional intelligence of sixth-grade primary school students before and after an intervention that includes changes in teaching methods in mathematics instruction (more frequent use of group work and work on a project task during the instructional units Triangle or Quadrilateral). In addition, the aim is to examine whether the level of emotional intelligence influences students' academic achievement in mathematics.

Based on the stated aims, the following research questions are formulated:

1. Are there differences in the level of emotional intelligence of sixth-grade students before and after the intervention (a change in teaching methods through more frequent use of group work)?
2. Do students who participated in the experimental program show a higher level of emotional intelligence after the intervention compared to students from the control group?
3. Is the level of emotional intelligence of sixth-grade students positively associated with their academic achievement in mathematics?

### **2.1. First Phase of the Study**

In the first phase of the study, the experimental group consisted of students from class 6.a (ESA), while the control group consisted of students from class 6.b (KSB).



The measurement instruments used for data collection in the first phase of the study were the UEK–D Questionnaire and the Mathematics Skills Assessment Test.

Before the beginning of the instructional unit *Triangles*, students completed the Emotional Competence Questionnaire for Children (UEK-D) (Stupin et al., 2017) and the Mathematics Skills Assessment Test via a Google Forms questionnaire. The Emotional Competence Questionnaire for Children consisted of three subscales with a total of 15 items measuring the abilities of perceiving and understanding emotions, expressing and naming emotions, and regulating and managing emotions. At the end of the questionnaire, five additional items were included to assess students' attitudes toward group work. For each item, respondents indicated their level of agreement on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

The Mathematics Skills Assessment Test consisted of 15 tasks assessing students' mathematical knowledge and logical reasoning.

After that, instructions of several teaching units from the *Triangle* topic followed. During the instruction, students in the ESA group were arranged into heterogeneous groups according to their overall achievement in mathematics. To avoid students working in the same group continuously, after the first week the groups were rearranged, and new groups were formed according to the same principle as at the beginning.

The intervention consisted of activities that students completed in teams. The activities took place during lessons introducing new instructional content as well as during practice lessons. In addition, part of the intervention included one project task that students completed in teams outside of regular instruction, with a one-week deadline for completion.

Upon completion of the intervention in the first phase, students from both classes completed the UEK-D questionnaire again and, after two class periods of preparation, took a written assessment of educational outcomes from the *Triangle* topic.

## **2.2. Second Phase of the Study**

In the second phase, at the beginning of the instructional unit *Quadrilaterals*, students from class 6.a became the control group (KSA), while students from class 6.b became the experimental group (ESB). The intervention was the same as in the *Triangle* unit: students carried out discovery and practice activities in groups and were assigned one project task.

At the end of the study, both groups completed the UEK–D questionnaire and took a written assessment of educational outcomes from the *Quadrilaterals* unit.

## **2.3. Participants, Ethics, and Validity**

The participants in this study were students from class 6.a (14 students) and class 6.b (18 students). The study was conducted during two instructional units, *Triangle* (15 class periods) and *Quadrilateral* (12 class periods).

The study fully protected the identity of the participants by ensuring that all results will be published anonymously, while the researcher secured the files containing students' names with a password, and only the researcher will have access to these data.

The reliability of this study was partially ensured. For equalizing the experimental and control groups, a pre-test consisting of 15 tasks from different areas of mathematics was constructed. Cronbach's alpha was 0.328, indicating low internal consistency. This finding suggests the need for further psychometric analysis of the test in future research. Despite this, the test served for basic orientation regarding students' prior knowledge and not as a standardized measurement instrument. For the UEK–D questionnaire, Cronbach's alpha was very good or good on all three occasions (0.844, 0.797, 0.823).

## **2.4. Emotional Competence Questionnaire for Children (UEK–D)**

The Emotional Competence Questionnaire (UEK-45, Takšić, 1998, 2002) is based on a model of emotional intelligence defined as the ability to perceive and express emotions, integrate emotions into thinking processes, understand emotions, and manage emotions.



### 3. Research Results

The collected data were processed using the statistical software package SPSS (Statistical Package for the Social Sciences; SPSS 23, IBM).

#### 3.1. Results of the First Phase of the Study

Descriptive statistics of the mathematics skills pre-test results show that students in both groups achieved similar results in terms of prior mathematical knowledge. Students in the experimental group achieved an average score of 10.50 points (SD = 1.87), while students in the control group had an average score of 10.94 points (SD = 1.92) (Table 1).

Component	Group	N	M	SD	Min	Max	Median	Mod
Mathematics skills pre-test	ESA	14	10,50	1,871	7	13	11,00	13
	KSB	18	10,94	1,924	6	13	11,00	11*

**Table 1.** Descriptive Statistics of the Mathematics Skills Test

To examine whether there were differences in prior knowledge between students in the experimental and control groups before the intervention, a Mann–Whitney U test was conducted on the total scores of the mathematics skills pre-test.

The results obtained indicate that there was no statistically significant difference between the two groups ( $U = 101.5$ ;  $p = 0.344$ ). This means that students in both groups had a similar level of mathematical knowledge at the beginning of the study, that is, the groups were equivalent prior to the intervention.

The reliability of the Emotional Competence Questionnaire for Children (UEK-D1), which consisted of 15 items, was assessed using Cronbach's alpha coefficient. The obtained value of  $\alpha = 0.844$  indicates high internal consistency of the scale (Nunnally & Bernstein, 1994), confirming that all items consistently measure emotional competence.

To statistically examine whether there were significant differences between the groups at the beginning of the study, the Mann–Whitney U test was applied. The results showed that a statistically significant difference between the groups was found only for the component "Expression and regulation of emotions" ( $U = 63.00$ ;  $p = 0.016$ ), with the control group having higher ranks. For the other components, no statistically significant differences were found: "Perception and understanding of emotions" ( $p = 0.063$ ), "Regulation and management of emotions" ( $p = 0.127$ ), and "Attitudes toward group work" ( $p = 0.435$ ).

Since a significant difference between the groups was identified at the beginning of the study for the component "Expression and regulation of emotions", this component was not further included in the analysis of the intervention effect.

#### 3.2. Comparison of Groups After the Intervention

In order to determine the effect of the intervention, differences in post-test results between the experimental ESA group and the control KSB group were analysed for two UEK-D subscales. Cronbach's alpha for the UEK–D questionnaire after the intervention was 0.797.

Descriptive statistics (Table 2) show that mean values for the components of emotional competence were slightly higher in the control group, while a larger difference was observed in attitudes toward group work in favour of the control group, with a higher mean score ( $M = 3.84$ ) compared to the experimental group ( $M = 2.23$ ).

Component	Group	N	M	SD	Min	Max	Median
Perception and understanding of emotions	ESA	14	3.457	0.708	2.4	4.6	3.4
	KSB	18	3.578	0.686	2.6	5.0	3.4
Regulation and management of emotions	ESA	14	3.657	0.557	2.6	4.6	3.7
	KSB	18	3.789	0.772	2.4	5.0	3.8
Group work	ESA	14	2.229	1.016	1.0	4.2	2.0
	KSB	18	3.844	0.888	1.2	5.0	4.0

**Table 2.** Descriptive Statistics of the UEK–D After the Intervention in the First Phase



For the statistical examination of differences between the groups, the Mann–Whitney U test was applied. The results showed that a statistically significant difference was found only in attitudes toward group work ( $U = 31.50$ ;  $p < 0.001$ ), with students in the control group expressing significantly more positive attitudes. For the components “*Perception and understanding of emotions*” ( $p = 0.606$ ) and “*Regulation and management of emotions*” ( $p = 0.528$ ), no statistically significant differences between the groups were found.

These findings indicate that the intervention had a specific effect on the perception of group work but did not lead to a significant change in the emotional competences measured in the post-test.

### 3.3. Changes Within the ESA Group Before and After the Intervention

To examine changes in emotional competence and attitudes toward group work within the experimental group (6.a), the Wilcoxon signed-rank test was used, given the small sample size ( $N = 14$ ) and a more conservative approach.

Component	Measurement	Mean	Median	Standard Deviation	Minimum	Maximum
Perception and understanding of emotions	Pre - test	3.578	3.4	0.686	2.6	5.0
	Post - test	3.457	3.4	0.708	2.4	4.6
Regulation and management of emotions	Pre - test	3.789	3.8	0.771	2.4	5.0
	Post - test	3.657	3.7	0.557	2.6	4.6
Group work	Pre - test	3.844	4.0	0.888	1.2	5.0
	Post - test	2.229	2.0	1.016	1.0	4.2

**Table 3.** Descriptive Statistics for the ESA Group After the Intervention

On the scale of perception and understanding of emotions, the median score remained unchanged (Med = 3.4) between the pre-test and the post-test (Table 3).

For regulation and management of emotions, a slight increase in the median score was observed from 3.7 to 3.8. The mean value also increased from 3.657 (SD = 0.56) to 3.789 (SD = 0.77). However, the Wilcoxon test did not show a statistically significant difference between the pre-test and the post-test ( $N = 14$ ,  $Z = -1.292$ ,  $p = 0.197$ ). Six students had lower scores after the intervention; six had higher scores, and two students remained at the same level. In conclusion, although a positive shift can be observed, the change was not statistically significant.

In contrast, for the variable “*group work*”, a statistically significant change was found ( $Z = -2.643$ ,  $p = 0.008$ ). The median decreased from 4.0 to 2.0, and the mean value decreased from 3.844 (SD = 0.89) to 2.229 (SD = 1.02). Most students (12 out of 14) had lower values after the intervention, which may indicate a slight decline in the positive perception of group work after repeated experience with this form of instruction.

These results suggest that although the intervention did not lead to statistically significant changes in measures of emotional intelligence, it did influence the perception of group work, which decreased for most students after the implementation of the activities.

### 3.3. Results of the Second Phase of the Study

In the second phase, as previously stated, the experimental group consisted of students from class 6.b ( $N = 18$ , ESB), while students from class 6.a ( $N = 14$ , KSA) formed the control group.

The UEK–D questionnaire and a written assessment from the *Quadrilaterals* unit were administered. The reliability of the Emotional Competence Questionnaire for Children (UEK–D), which consisted of 15 items, was assessed using Cronbach’s alpha coefficient. The obtained value of  $\alpha = 0.823$  indicates high internal consistency of the scale (Nunnally & Bernstein, 1994), confirming that all items consistently measure emotional competence. Accordingly, the results obtained using this questionnaire are considered reliable for further analysis.

### 3.4. Changes Within the ESB Group Before and After the Intervention

The results show that the mean values for the first two components remained relatively stable after the intervention, with very small changes in the mean and median. However, for the component attitudes



toward group work, a decrease in the mean value from 3.84 to 2.23 was recorded, which may indicate a reduction in positive attitudes toward this form of work within the experimental group.

In order to examine the effect of the intervention on emotional competence and attitudes toward group work within the ESB group, the Wilcoxon signed-rank test for dependent samples was conducted. The results presented in the table show that no statistically significant difference was found between the pre-test and post-test for any of the observed components. Specifically, the p-values for all three components (*Perception and understanding of emotions*:  $p = 1.000$ ; *Regulation and management of emotions*:  $p = 0.863$ ; *Group work*:  $p = 0.695$ ) were well above the significance level of 0.05. This suggests that the changes in mean values observed in the descriptive analysis were not statistically confirmed. Therefore, it can be concluded that the intervention did not lead to significant changes in these components within the ESB group.

### **3.5. The Impact of Emotional Competence Level on Students' Mathematics Achievement**

To determine whether the level of emotional competence is associated with students' final grade in mathematics, a Spearman rank-order correlation analysis was conducted between the UEK–D scores (results from the final questionnaire) and the final mathematics grade. The analysis showed a moderate, positive, and statistically significant correlation between these two variables ( $\rho = 0.530$ ;  $p = 0.002$ ;  $n = 32$ ). These results indicate that students with higher levels of emotional competence achieved higher grades in mathematics.

## **4. Discussion**

The results of the first phase of the study showed that the experimental (ESA) and control (KSB) groups were relatively equivalent at the beginning, as confirmed by the analysis of the mathematics skills pre-test results and the UEK–D questionnaire subscales. Although students in the control group (KSB) achieved slightly higher results in some dimensions, the differences were mostly not statistically significant, except for the subscale "*expression and regulation of emotions*", where the KSB group showed a statistically significant higher level; therefore, this component was excluded from further analysis.

In the post-test of the first phase, no significant differences were found between the groups in the dimensions of emotional competence. However, for the variable "*group work*", a statistically significant difference was observed in favour of the control group (KSB), which did not participate in group work. These results may indicate a possible saturation effect in the ESA group, which was exposed to repeated group activities during this period.

Within the ESA group, the Wilcoxon test confirmed that there were no significant changes in emotional competence after the intervention. However, a significant decline in attitudes toward group work was observed, supporting the assumption that excessively frequent implementation of group activities may lead to reduced motivation and a negative perception of this form of work.

In the second phase of the study, the experimental group was class 6.b (ESB), while the control group was class 6.a (KSA). In this phase as well, no statistically significant changes were found in emotional competence or in attitudes toward group work, further confirming that the intervention, in this form and duration, did not produce the desired effect.

These results indicate that group work, as a dominant instructional method, is not sufficient on its own to foster students' emotional development and may even lead to resistance if applied too frequently. Therefore, exclusive or overly frequent use of group work without additional support, clear role definition, and sensitivity to individual differences among students is not recommended. A noteworthy finding of the study is the moderate, positive, and statistically significant correlation between emotional competence and mathematics grades (Spearman's  $\rho = 0.530$ ;  $p = 0.002$ ). This result suggests that higher emotional competence may be associated with higher academic achievement, which is consistent with theories emphasizing the importance of socio-emotional skills for learning success.

Overall, although the intervention did not lead to an increase in emotional competence, it clearly influenced the perception of group work. The results point to the need for a more thoughtful approach to integrating group work into teaching, with an emphasis on the quality of interactions, duration, guidance, and emotional support, to achieve positive effects on students' emotional and academic development.



## 5. Limitations of the Study

Although the study was conducted systematically, it is important to highlight several limitations that may affect the interpretation and generalization of the obtained results. First, the intervention did not last long enough. Emotional competences are characteristics that develop over the long term through continuous practice and reflection. Short-term changes in instructional organization, such as increased use of group work over several weeks, may not be sufficient to produce significant changes in students' emotional competence. For this reason, an additional measurement of emotional competence is planned six months after the completion of the intervention in order to identify possible delayed effects. Second, the sample size was relatively small and included students from only two classes in a single primary school. Such a sample size and specificity limit the possibility of generalizing the results to a broader student population. Third, the instructional method used, group work, does not suit all students equally. Some students do not prefer collaborative activities, which may cause additional stress, reduced motivation, and negative attitudes toward this form of work. This may also be reflected in questionnaire results, particularly in the component related to attitudes toward group work. In such cases, an individualized approach is recommended, that is, adapting instructional methods to students' individual needs.

Fourth, the instruments used, although validated in previous studies, may not be optimally sensitive to short-term changes in children's emotional competence. Despite these limitations, the study offers valuable insights into the effects of group work on students' emotional competence and attitudes, as well as guidelines for future, methodologically stronger studies.

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