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The relationship between metacognitive strategies and emotional intelligence with students' academic achievement

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Abstract

Emotional intelligence and metacognitive strategies are among the factors that have a significant impact on students' academic achievement. Given the importance of the subject, the present study was conducted with the aim of investigating the relationship between emotional intelligence and metacognitive strategies with mathematics academic achievement in third-grade middle school students.

To conduct the present research, a sample of 112 male students from the third grade of middle school in Lordegan County was selected through simple random sampling. The research instruments included the Bar-On Emotional Intelligence Test (2005), the Dawson and McInerney Metacognitive Strategies Questionnaire (2004), and the second-semester mathematics score. The research design was correlational. Pearson correlation coefficient and stepwise regression were used for data analysis.

The research findings showed that there is a significant positive relationship between students' academic achievement in mathematics and metacognitive strategies ($p < 0.01$). Students' academic achievement in mathematics also has a significant positive relationship with some components of emotional intelligence ($p < 0.01$).

The planning variable from the metacognitive strategies components is the strongest predictor, and the self-control variable from the emotional intelligence components is the weakest predictor of academic achievement in mathematics. Based on the research results, it can be concluded that metacognitive strategies and emotional intelligence are effective factors for improving and enhancing students' academic performance in mathematics.

Keywords: Emotional intelligence, Metacognitive strategies, Academic achievement, Mathematics.

Introduction

Academic life is one of the most important dimensions of individuals' lives that greatly affects other aspects of life. Among the fundamental issues and problems of the educational system is the problem of academic failure and low levels of academic performance in mathematics (1). Intelligence, as one of the most important factors influencing students' academic performance in mathematics, includes concepts such as interpersonal intelligence, social intelligence, and emotional intelligence. Emotional intelligence has a great impact on individuals' success in various dimensions of life. The origin of emotional intelligence can be traced back to Darwin's early works; Darwin emphasized the importance of emotional tools for survival and adaptation (2). Salovey and Mayer defined emotional intelligence as an individual's ability to control their own feelings and emotions (3). Goleman defined emotional intelligence as a better way of using IQ through self-control, enthusiasm, perseverance, and self-motivation. He believes that the individual components of emotional intelligence include self-awareness, self-regulation, and motivation, and its social components include empathy and social skills (4). Emotional intelligence can be considered the intersection of advanced abilities and skills in accurately understanding daily life (5). Bar-On also defines emotional intelligence as effective understanding of oneself and others, establishing appropriate relationships with others, and adapting and coping with the environment for more effective dealing with environmental demands (6).

Various studies, including those by Parker et al. (7), Vela (5), Boyle (9), Nelson and Nelson (10), Stottlemyer (11), Nelson and Low (12), and Elkins and Low (13), have been conducted regarding the relationship between emotional intelligence and students' academic achievement. These studies indicate the relationship between emotional intelligence components and academic achievement in mathematics and other subjects, and according to their results, emotional intelligence components can be considered important predictors of students' academic success. Saraf (14) stated in his study that in many cases, the impact of emotional intelligence in educational interactions is greater than that of cognitive intelligence. Researchers such as Mayer, Perkins, and Salovey have stated that students with higher emotional intelligence have greater ability to recognize their own and others' feelings and use this recognition to guide their behavior (15). Contrary to the above views and studies, Van der Zee and Schaal (2002), in their study of the relationship between emotional intelligence and academic achievement among 116 18-year-old students, stated that there was a weak relationship between emotional intelligence and academic success, while the relationship between emotional intelligence and extraversion was significant (16).

Another factor influencing students' academic performance is metacognitive strategies. Metacognition is a new field of thinking whose background can be traced back to the 1970s. Flavell was the first person to introduce the term metacognition in 1979. From his perspective, metacognition refers to awareness of cognition and cognitive processes and control over cognition. Almost the majority of researchers have a consistent view regarding the definition of metacognitive strategies. For example, Slavin defines metacognition as an individual's knowledge about how they learn (17). Woolfolk, from the perspective of information processing theory, defines metacognition as executive control processes such as attention, review and practice, organization, and manipulation of information (18). Generally, the term metacognition[8] refers to an individual's knowledge about their own cognitive processes and how to optimally use them to achieve learning goals (19). Brown defines metacognition as methods used to regulate cognitive processes. From Wells' perspective (20), metacognition shapes the evaluation and impact of various strategies we use to regulate our thoughts and feelings. Metacognitive processes have two independent but interrelated aspects: knowledge

about metacognition and metacognitive experiences (21). The impact of metacognitive skills on effective learning has been clearly demonstrated in numerous studies, including the research by Pintrich and De Groot, which established the positive relationship between metacognition and students' academic achievement in various subjects, including mathematics (22). According to Bransford's research, students who use self-regulation strategies more have better academic performance. Self-regulation forces the student to be actively involved in managing their thinking and learning metacognitively, motivationally, and behaviorally, and to take control of their learning (23). According to Paris and Winograd, metacognition plays a central role in the learning process. For both the teacher and the learner, relying on metacognition means that learners can enhance their learning by becoming aware of their thinking while reading, writing, and problem-solving (24). Kenneth and Nowack, in their research, identified the combination of emotional intelligence and metacognitive strategies as a key factor in knowledge development, health promotion, learner care, and academic success in mathematics and science (25). Besharati (17) showed in his research that there is a positive relationship between emotional intelligence and students' academic success, and that girls' emotional intelligence level is higher than boys'. Zahra Kara (1) also found a positive relationship between emotional intelligence components and academic performance.

Since our educational system still emphasizes IQ and its impact on all aspects of life, and few studies have been conducted on the impact of emotional intelligence and metacognitive strategies on students' academic performance in deprived areas of the country, and given the importance and key role of emotional intelligence and metacognitive strategies in students' success in mathematics, the main goal of this research is to investigate the relationship between emotional intelligence and metacognitive strategies with students' academic achievement in mathematics. Additionally, another goal of this research is to estimate the predictive power of each component. Therefore, the question is whether there is a significant relationship between emotional intelligence and metacognitive strategies with students' achievement in mathematics.

Method

The present research is of a descriptive-cross-sectional type, in which the relationship between emotional intelligence and metacognitive strategies with mathematics academic achievement in students was examined.

Population, sample, and sampling method

The population of this research included all third-grade middle school students in Lordegan County who were studying in this grade during the 2021-2022 academic year. The study sample consisted of 112 third-grade middle school students who were selected through simple random sampling. In this study, after selecting the sample, we familiarized parents and students with the purpose of the research, and after obtaining parental consent, the research was conducted. For data analysis, both descriptive and inferential statistical methods were used with SPSS software. Pearson correlation coefficient was used to determine the relationship between variables and academic achievement in mathematics, stepwise regression was used to identify the explanatory contribution of each variable, and one-way analysis of variance was used to determine the relationship between variables with metacognitive strategies and emotional intelligence.

The data collection instruments were:

Bar-On emotional intelligence scale

This scale, developed by Bar-On in 1997, is used to measure emotional intelligence. The scale consists of 90 questions. This test measures both the overall emotional intelligence score and the score of 15 emotional intelligence components. Since the options are arranged on a 5-point Likert scale, scoring is from 5 to 1 (strongly agree = 5, strongly disagree = 1), and for some questions with negative content, scoring is from 1 to 5

(strongly agree = 1, strongly disagree = 5). The total score of each scale equals the sum of scores for each of its questions, and the total test score equals the sum of scores for the 15 scales. The test reliability was calculated as 0.88 using the split-half method and α = 0.93 using Cronbach's alpha.

Dawson and McInerney metacognitive strategies Test

This questionnaire, developed by Dawson and McInerney (2004), is used to measure skills related to metacognitive strategies. The questionnaire consists of 18 five-option questions on a 5-point scale with scoring from 1 to 5. Every 6 questions measure one metacognitive skill: the first 6 questions relate to planning, the second 6 to control and monitoring, and the last 6 to regulation. After data collection, the calculated average was used as the descriptive criterion. The Cronbach's alpha coefficient for this questionnaire was reported as 0.86.

Academic achievement in mathematics

In the present study, after consultation with relevant teachers and several university specialists and professors, the students' second-semester mathematics scores were used to measure academic achievement.

Implementation procedure

The required data for this research were obtained through group administration of questionnaires to the target samples. As in other similar studies, there was a possibility of subjective bias among participants regarding the test content. To prevent this, the name and content of the test were announced after administration, and scores were provided to those who wished. Out of 125 distributed questionnaires, 112 completed questionnaires were used for analysis.

Results

Table 1 presents the mean and standard deviation of emotional intelligence, metacognitive strategies, and mathematics academic performance variables. As observed, the highest mean was for the planning variable (30) and the lowest for regulation (17).

Table 1. Mean and standard deviation of studied variables and correlation coefficients between predictor variables and criterion

Variables	Mean	SD	r^2	P-value
Planning	30	2.41	0.334	0.01
Control and Monitoring	24	2.28	0.318	0.01
Regulation	17	1.25	0.246	0.01
Empathy	28	3.14	0.008	Not significant
Assertiveness	18	3.10	0.008	Not significant
Self-Esteem	21.40	3.15	0.221	0.01
Self-Actualization	22.50	2.80	0.198	0.01
Independence	19.19	2.93	0.209	0.01
Interpersonal Relationships	28.50	3.11	0.007	Not significant
Problem Solving	21.23	3.16	0.212	0.01
Flexibility	19.18	3.08	0.219	0.01
Reality Testing	18.90	3.00	0.201	0.01

Stress Tolerance	17.01	2.96	0.241	0.01
Happiness	18.19	3.30	0.009	Not significant
Optimism	21.22	3.40	0.219	0.01
Self-Awareness	20.16	3.10	0.196	0.01
Self-Control	17.80	4.40	0.136	0.01
Responsibility	23.12	3.02	0.198	0.01
Academic Performance	14.62	4.20	0.196	0.01

To investigate the relationship between emotional intelligence and metacognitive strategies with mathematics academic achievement, the data related to predictor variables were analyzed using correlation coefficients. As observed in Table 1, the results of data analysis indicate that students' academic achievement in mathematics has a significant positive relationship with predictor variables at the 0.01 level. The highest correlation was for the planning variable with 0.334, and the lowest was for self-control with 0.136. The variables of empathy, happiness, interpersonal relationships, and assertiveness were not significant.

To determine the explanatory contribution of each emotional intelligence and metacognitive strategies variable in predicting students' academic achievement in mathematics, multiple regression analysis was used. In this study, 18 variables were selected by the researcher as predictor variables, and mathematics scores were considered as the criterion variable. Multiple regression was calculated using the stepwise method. The regression analysis findings show that 14 out of 18 variables entered the regression model and were evaluated. As observed in Table 2, the calculated correlation coefficient between the 14 variables entered into the model and the criterion variable is 0.596, and the coefficient of determination is 0.354, indicating that about 35.4% of the criterion variable's changes are explained by the variables entered into the model. The remaining changes in the criterion variable (64.6%) are explained by other variables such as family, cultural, and educational facility variables, which were not evaluated in this study. The adjusted R^2 value is 0.354. Of the total 35.4% of the coefficient of determination (explained variance) of the criterion variable, 5.1% is explained by planning, 3.8% by control and monitoring, 3.6% by regulation, 3.4% by self-awareness, 3% by self-esteem, 2.7% by self-actualization, 2.5% by independence, 2.3% by problem solving, 1.9% by flexibility, 1.7% by reality testing, 1.6% by stress tolerance, 1.5% by optimism, 1.4% by responsibility, and 1% by self-control. Table 2 presents the multiple correlation values, coefficient of determination, adjusted R^2, standard error, and the amount of change.

Table 2. Summary of multiple regression results based on variables presented in the study

Model	Multiple Correlation Coefficient	R^2	Adjusted R^2	Std. Error	R^2 Change
1	0.302	0.095	0.093	2.23	0.051
2	0.322	0.103	0.102	2.21	0.038
3	0.411	0.175	0.181	2.11	0.036
4	0.425	0.224	0.220	2.12	0.034

5	0.508	0.264	0.253	2.10	0.030
6	0.518	0.384	0.384	2.11	0.027
7	0.522	0.272	0.271	2.15	0.025
8	0.537	0.301	0.301	2.10	0.023
9	0.545	0.297	0.296	2.13	0.019
10	0.563	0.316	0.315	2.14	0.017
11	0.581	0.336	0.333	2.18	0.016
12	0.584	0.337	0.336	2.16	0.015
13	0.591	0.349	0.349	2.11	0.014
14	0.596	0.354	0.354	2.12	0.010

To confirm the predictive power of the variables, as observed in Table 3, F = 8.02 is significant at $p < 0.01$, indicating that at least one of the independent variables is effective in predicting the criterion variable, and the regression is also significant, which itself emphasizes the predictive nature of the independent variables.

Table 3. Results of one-way analysis of variance for predictor variables

Source of Variation	SS	df	MS	F	P-value
Regression	47.68	2	23.84	8.02	0.01
Error	288.56	97	2.97		
Total	856.26	99			

To determine which variables have the greatest or least impact on the criterion variable, standardized and unstandardized beta coefficients were evaluated. Based on Table 4, the unstandardized coefficients B for different variables range from 0.143 to approximately 0.499, with the highest value for control and monitoring at 0.499 and the lowest for self-control at 0.143. In this table, the standardized beta coefficients for predictor variables entered into the model range from 0.108 to 0.403, with the highest belonging to planning at 0.403 and the lowest to self-control at 0.108. This result indicates that the planning variable has the greatest impact and the self-control variable has the least impact on the criterion variable.

Table 4. Results for predictor variables in this study

Variables	B	Std. Error	Beta Standard
Constant	5.11	0.301	-
Planning	0.489	0.026	0.403
Control and Monitoring	0.499	0.032	0.380
Regulation	0.328	0.034	0.302

Self-Awareness	0.324	0.032	0.298
Self-Esteem	0.321	0.021	0.289
Self-Actualization	0.309	0.031	0.274
Independence	0.298	0.029	0.261
Problem Solving	0.289	0.025	0.256
Flexibility	0.264	0.031	0.245
Reality Testing	0.255	0.038	0.218
Stress Tolerance	0.218	0.041	0.125
Optimism	0.207	0.028	0.118
Responsibility	0.206	0.034	0.116
Self-Control	0.143	0.039	0.108

Discussion

The results of this study showed that the academic achievement of third-grade middle school students in mathematics has a significant positive relationship at the 0.01 level with 11 predictor variables related to emotional intelligence and 3 variables related to metacognitive strategies. Regarding the relationship between emotional intelligence and academic achievement, previous studies by Zahra Kara (1), Besharati (17), Boyle (9), Vela (8), and Parker et al. (7) had reached similar findings. Also, regarding metacognitive strategies, this study aligns with previous studies by Skitka (23) and Akinb (24), which support the existence of a significant positive relationship between metacognitive strategy variables and academic achievement. This study showed that the highest significant positive correlation with the criterion variable was for the planning factor from metacognitive strategies components, and the lowest correlation was for the self-control variable from emotional intelligence factors. Among the emotional intelligence variables and components, no significant relationship was observed between empathy, happiness, interpersonal relationships, and assertiveness with mathematics academic achievement. This study showed that 14 metacognitive and emotional intelligence components (planning, control and monitoring, regulation, self-awareness, self-esteem, self-actualization, independence, problem solving, flexibility, reality testing, stress tolerance, optimism, responsibility, and self-control) are suitable predictors of students' academic achievement in mathematics, which aligns with previous studies by Akbarzadeh (15), Nelson and Vela (5), Stottlemyer (11), and Nelson and Nelson (10). Contrary to the above views and studies, Van der Zee and Schaal (16), in their study of the relationship between emotional intelligence and academic achievement, stated that there was a weak relationship between emotional intelligence and academic success. According to the results of the present study, it can be said that students with higher emotional intelligence achieve more success in their education, including learning mathematics and progressing in this subject. This study aligns with the research by Akbarzadeh (15). Overall, there is a significant positive relationship between emotional intelligence and metacognitive strategies with students' mathematics academic achievement, and emotional intelligence and metacognitive strategy components can be considered important predictors of academic success in mathematics. It

can be said that metacognitive strategies and emotional intelligence are among the effective factors for improving and enhancing academic performance and learning in various fields, especially in the field of mathematics. A look at the sample of conducted studies shows that metacognitive strategies and emotional intelligence have a considerable impact on children's mathematical learning. Documenting the impact of these factors on students' academic achievement in various subjects, including mathematics learning, may provide a way for students to enhance their learning and performance levels.

Conclusion

The study results emphasize the positive relationship with mathematics achievement, but the more important question was whether these variables have the same relationship with students' academic achievement in other subjects separately. The limitation of the research to male gender, limited research population, and failure to examine achievement in other subjects were among the limitations of this study. It is suggested that researchers in future studies strive to address these limitations. Research evidence indicates that many mathematical problems and their transfer stem from a lack of skills and strategies. It seems that not only learning knowledge but also learning how to use these strategies in learning is of great importance. Therefore, based on the findings of this study, it can be said that teaching, strengthening, and paying attention to metacognitive skills and emotional intelligence is essential for students' academic achievement in mathematics, and it is recommended that middle school administrators and mathematics teachers use the findings of this study to improve students' performance in mathematics.

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