



Research Article

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The Role of Emotional Intelligence as a Mediating Variable in Predicting Intrinsic Motivation in Solving Mathematical Problems among Fourth-Grade Students in the Sultanate of Oman

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Abstract

This study aimed to investigate the role of emotional intelligence as a mediating variable in intrinsic motivation prediction of the ability to solve mathematical problems among fourth-grade students in the Sultanate of Oman. The study sample consisted of 183 male and female students from six schools of the first cycle of basic education. The study tools are: Goleman's Emotional Intelligence Scale, the Intrinsic Motivation Scale of Lepper, and a mathematical problem-solving test prepared by the researchers. The content validity, and internal consistency reliability of the three tools were measured. The results found a weak and negative correlation between the ability to solve mathematical problems and each of: emotional intelligence, intrinsic motivation, and weak and positive correlation between emotional intelligence and intrinsic motivation. The results of this study also indicated that there is no mediating role for emotional intelligence in predicting intrinsic motivation in the ability to solve mathematical problems.

Keywords: *Intrinsic motivation, emotional intelligence, mathematical problem solving*

1. Introduction

Problem solving in mathematics education is one of the prominent areas of research that aims to understand and relate the processes involved in problem solving to students' development of mathematical knowledge and problem-solving competencies (Liljedahl et al, 2016). The most important objectives of solving mathematical problems include working to improve students' readiness to experience exposure to problems, attitudes and perseverance when solving them, improving their self-perceptions regarding their ability to solve problems, and developing their level of awareness that problems can be solved in more than one way, thus developing their abilities to choose the appropriate solution (Reiss & Torner, 2007).

In light of the interest of specialists in the standards of the mathematics curriculum and their

reformulation, the directions of global studies of mathematics and science were considered the Trends in International Mathematics and Science Study (TIMSS), as global tests in which students' attitudes are assessed in the extent of their achievement in mathematics and science, and their evaluation in the fourth and eighth grades every four years (Al-Hamami, 2015). The results of the global study in mathematics and science (TIMSS 2015) in the Sultanate of Oman were not satisfactory. The results of the study indicated that the fourth-grade students obtained a low level of performance in mathematics; as the Sultanate of Oman ranked 39th internationally out of 49 participating countries, fourth place in the Arab world out of eight participating Arab countries, and fourth among the countries of the Gulf Cooperation Council. The results of the same study indicated that the lowest levels of performance according to the thinking dimensions of fourth-grade students were in Paragraphs targeting reasoning and problem solving (Ministry of Education, 2016).

Therefore, the Ministry of Education in the Sultanate of Oman sought to develop mathematics curricula. It implemented a project to develop these curricula in several phases, based on the application of the curricula of the Global Mathematics and Science Series offered by the University of Cambridge, starting from the academic year 2017/2018. The Ministry of Education aimed to implement the Global Mathematics Series curricula to bring about a qualitative change in the curricula in a relatively short period, to benefit from global experiences in the field of education. The ministry also aims to create a generation capable of competing in global platforms, by paying attention to scientific and mental skills and developing them, the most important of which are: analysis, deduction, induction, criticism, problem solving and decision-making (Ministry of Education, 2019).

Mathematics problems are the key to acquiring the cognitive skills that students need when they apply different types of mathematics skills. Students are taught in the first stage of basic education and evaluated in solving mathematical problems that include both numerical operations and mathematical word problems, which they can apply in new situations (Bjork & Crane, 2013).

The ability to solve mathematical problems is defined as “the method used by the student to find a solution to a problem” (Bahri & Faris, 2014, p. 37). Students' ability to solve mathematical problems does not depend on mental processes only, instead it is largely influenced by the learner's personality traits. Motivation is one of the important trait that relate to mathematics achievement (Marsono, et al., 2019; Shaalvik & Shaalvik, 2004; Seaton et al., 2014) such as intrinsic motivation. Therefore, the learners will be persistent in practicing activity depending on their motivation, and they don't give up easily and tries in several ways to reach a solution (Zahran, 2018).

Intrinsic motivation emphasizes involvement in a behavior for its personally rewarding value (Lee et al., 2012). It is important that the task itself be enjoyable, with no external reward being expected for it.

Aljarrah (2011) explained that there is a positive correlation between the ability to solve mathematical problems and the internal factors of the individual and social intelligence, which is one of the aspects of emotional intelligence. Salovey & Mayer (1990) explained that emotional intelligence is the ability of an individual to understand and perceive his own feelings and emotions, organize and control them, understand the feelings and emotions of others and deal with them with wisdom and compassion, and work to employ this understanding to guide thoughts and actions.

Abu Afash (2011) indicates that there is a relationship between emotional intelligence with its five components and the ability of individuals to make decisions and solve problems. Al-Jarrah (2011) explained that there is a positive correlation between the ability to solve mathematical problems and the internal factors and drivers of the individual and his social intelligence, which is one of the aspects of emotional smartness. The result of Al-Shehri study (2012) indicated that students' ability to solve mathematical problems can be predicted through their emotional intelligence. In contrast study by Marsono et., (2019) found that there was no relationship between emotional intelligence and math achievement. Ogundokun and Adeyemo (2010) found that emotional intelligence, age, and academic motivation predicted mildly to mathematics achievement.

The study of Abu Al-Rayaat and Almorsi (2013) indicated that there is a positive correlation between the high level of intrinsic motivation and the high scores of students in the mathematical

problem-solving test, and Sarhan's study (2015) indicated that personal traits such as intrinsic motivation contributes positively to academic achievement and students' ability to solve mathematical problems, and this also agrees with Caprara, et al, (2011). The results of the studies of (Cokley, 2003; Davis, et al, 2006; Habok et al., 2020; Komarraju, et al, 2009) concluded that academic performance and thinking abilities can be predicted through intrinsic motives. However, the studies of (Baker, 2003; Marsono et., 2019) concluded that there is no relationship between intrinsic motives and students' ability to think and achieve in mathematics.

In terms of gender study by Shaalvik and Shaalvik (2004) showed that male had higher intrinsic motivation, and self-enhancing ego orientation in mathematics than female. This finding was in contrast with study of Habok et al., (2020) which found that female was higher than male in intrinsic motivation.

2. Literature Review

Motivation has emerged as one of the personality traits that the learner depends on in developing ability to solve problems. Hassan (1999) confirms the important role that intrinsic motivation plays in pushing the learner towards academic or professional achievement; where the study indicated that the learner is more persistent, strong and stable if he is driven by an internal motivation. This is because it helps itself achieve self-gratification more than it affects external impulses. The learner rewards himself as a result of what he has done voluntarily, because he is driven internally to work and achievement and enjoys doing so without regard to material incentives (Karaki, 2018).

Ryan and Deci (2000) confirmed the existence of intrinsic motivation within individuals, and its presence also in the relationship between individuals and activities, and intrinsic motivation can be determined either in terms of an interesting task, or in terms of the satisfaction gained when the individual participates in a motivated task. The social context that supports the feelings of the individual, independence and relationship, is one basis for preserving intrinsic motivations to become more specific with regard to external motives. They indicated that in schools, it is necessary to facilitate conditions in the classroom to achieve more self-learning, in a way that allows the basic human needs that are met. The social context also supports the innate needs to feel connected, effective, and practical, for individuals who are exposed to new ideas, exercises, and skills.

Panait and Bucinschi (2018, p. 439) defined emotional intelligence as "the ability to understand and control our own emotions and the emotions of those around us." Emotional intelligence, according to Goleman (1995) model, consists of five components that can be classified into two groups of competencies: Personal competencies, which are: self-awareness, management and regulation of emotions, intrinsic motivation, and social competencies which are: empathy, and social skills (Goleman, 1998).

Intrinsic motivation is one of the components that has a personal, subjective dimension to emotional intelligence and is closely related to it. Jaber (2010) argued that intrinsic motivation means controlling negative emotions such as anxiety, anger, frustration, and positively dealing with harsh circumstances and situations that an individual is exposed to. Individuals who possess intrinsic motivation skills and emotional intelligence seek feedback for their work. They find out the cause of their shortcomings and weaknesses and overcome them, while individuals who do not possess these skills or have weaknesses in them withdraw from work or activity as soon as they feel a failure.

Goleman (1998) stated that there are several skills indicating the existence of motivation in the individual, including: the desire to succeed, the ability to complete difficult tasks that require a long time to complete, not giving up when facing obstacles, and the ability to switch unproductive habits into productive and useful ones. The results of Sarhan's study (2015) emphasized the importance of the relationship between emotional intelligence and motivation to learn and their important role in students' academic achievement and their ability to solve problems. Students' ability to solve problems increases with increase in their emotional intelligence and intrinsic motivation, which is in agreement with the proposed model for the study.

The importance of this study lies in the relationship between its variables and the lack of previous studies related to the problem of the study that were conducted in the Sultanate of Oman, and the problem of this study differed from previous studies in that it investigated the possibility of intrinsic motivation predicting the ability to solve mathematical problems with the mediating role of emotional intelligence among fourth-grade students. On the other hand, it was found that all the aforementioned studies were applied to different samples of students in the academic stages: preparatory (second cycle), secondary, and university and college students, samples of administrators, teachers, and employees in the public and private sectors. The study of a sample of students in the class was not addressed; the fourth basic level, whether at the foreign or Arab level, or even at the local level in the Sultanate of Oman. The study was determined in answering the following two questions:

1. What is the size and direction of the relationship between emotional intelligence, intrinsic motivation and solving mathematical problems for fourth-grade students?
2. Does the intrinsic motivation predict the ability to solve mathematical problems when the emotional intelligence variable is a mediator among fourth-grade students?

3. Study design

3.1 Sample

The study population consisted of all students of the fourth basic grade, in the first cycle schools (1-4) of basic education in the Wilayat of Al-Masnah in the Governorate of South Al-Batinah, which numbered 1,600 students, 806 males and 794 females, distributed in nine schools. The study sample consisted of 183 male and female students, which represents approximately 11% of the size of the community. The random cluster technique was used to select study sample which consisted of six classes.

3.2 Tools

3.2.1 Emotional Intelligence Scale

It is a scale provided by Goleman (1995) which fits with the theory used in this study. The scale contained 18 items, representing the five components of emotional intelligence according to the Goleman model (1995) in general without dividing the items on the components of emotional intelligence, and the responses of the five-pointed scale were changed to become three as follows: (correct, I do not know, incorrect).

the validity of the content was used which includes: the item's validity, and the sampling validity. The content validity was measured by 16 specialists. Reliability was measured by the internal consistency method using Cronbach's alpha equation. The scale was applied to a sample of 30 students from the fourth grade, and the results showed that the general reliability coefficient of the scale was $\alpha = 0.79$, which is an appropriate value for the reliability.

3.2.2 Intrinsic-motivation scale

This scale was provided by Lepper et al., (2005) which was consistent with this study. The scale contained 17 items, and it was divided into three dimensions 1) Love of challenge: This dimension measures the preference for difficult school work versus easy assignments that solve the least effort, and the number of its items is six. 2) Curiosity and Desire: It measures the behavior that is stimulated by curiosity versus the desire to please the teacher and obtain good grades, and the number of its items is six. 3) Independent mastery: It measures the preference for mastering academic subjects independently without relying on the teacher much, and the number of its items is five, and the responses of the five-point scale were changed to become three as follows: (correct, I do not know,

incorrect).

To check the validity of the intrinsic-motivation scale, the validity of the content was. The scale was presented to a number of 15 specialists. The reliability of the scale was measured by the internal consistency method using the Cronbach alpha equation, where the scale was applied to a sample of 30 male and female students of fourth grade in the state of Al-Musanna, and the results showed that the reliability coefficient of the scale was $\alpha = 0.79$, which is an appropriate value for the reliability of personal studies as indicated by Cronbach (1970).

3.2.3 Mathematical problem solving test

The researchers prepared the test based on the following sources: 1) a teacher's guide, student books, and activity for the fourth grade, 2) an evaluation document for students' learning of the subjects of the second field for grades (1-4), 3) educational literature, research and studies related to solving mathematical problems, and how to measure them, 4) specialists in evaluating mathematics strings in the Ministry of Education. In preparing the test, the researcher relied on three axes for the first and second semesters of the academic year 2018/2019, which are: numbers, number system, arithmetic operations, and measurement, and the total of test questions was 10, max mark of each question was one.

To check the validity of the mathematical problem solving test, the validity of the content was used. The test was presented to a number of 14 specialists in mathematics and its teaching methods. The test's reliability was measured by the internal consistency method using the Cronbach alpha equation, where the test was applied to a sample of 37 male and female students from the fourth grade, and the results showed that the reliability coefficient was $\alpha = 0.85$, which is an appropriate value for the reliability of tests. According to Cronbach (1970), the scale is thus applicable.

The facility index for the test was calculated with the formula for binary responses to test questions scores (0, 1). To ensure that the difficulty and ease of the test questions are according to the initial application of the survey sample, the difficulty factor was calculated for the test questions, which ranged between 36% as a minimum and 70% as a maximum. They were considered appropriate and acceptable ratios.

The discrimination index was computed for the test questions to verify the question's ability to distinguish between students with higher levels and students with lower levels. It was found that the discrimination indexes for each of the test questions ranged between 0.40 and 0.80. Accordingly, all test questions were accepted because it is within the acceptable limits of discrimination (Ebel, 1972).

4. Results

The result of the first question: What is the size and direction of the relationship between emotional intelligence, intrinsic motivation and solving mathematical problems for fourth-grade students? To answer this question, the Pearson correlation coefficient was calculated. The results showed that the Pearson correlation coefficient between emotional intelligence and the ability to solve mathematical problems is equal $r = -.17$, and this indicates that a weak and negative, statistically significant relationship at the significance level of 0.05. Meaning that if the level of emotional intelligence increases, the ability to solve mathematical problems decreases and vice versa.

The common variance is 3 %, which means that the relationship type is linear, its regularity between the two variables is poor, and the remaining 97 % express an unsystematic relationship.

The results showed that the Pearson correlation coefficient between intrinsic motivation and the ability to solve mathematical problems is equal $r = -.23$, and this indicates the existence of a weak, negative, statistically significant relationship at the significance level of 0.01 between the two variables. This implies that if the first variable increases, the second variable decreases. In addition, the common variance is 5 %, which means that the relationship type is linear, its regularity between the two variables is poor, and the remaining 95 % express an unsystematic relationship.

Furthermore, the same results concluded that the Pearson correlation coefficient between emotional intelligence and intrinsic motivation is equal $r = 0.25$, and this indicates the existence of a weak, positive, statistically significant relationship at the significance level of 0.01, meaning that if the first variable increases, the second variable will increase. However, the common variance is 6 %, which means that the relationship type is linear, its regularity between the two variables is poor, and the remaining 94 % express an unsystematic relationship.

Results of the second question: Does the intrinsic motivation variable predict the ability to solve mathematical problems when the emotional intelligence is a mediator? To answer this question, multiple linear regression analysis was used after making sure that the conditions for using multiple regression analysis are met. To perform a multiple regression analysis when the emotional intelligence variable is a moderator, the researcher predicted each variable separately in the dependent variable, so the prediction of emotional intelligence was tested on the ability to solve mathematical problems, and intrinsic motivation predicted the ability to solve mathematical problems, and the results are as follows:

Table 1: A prediction model for mathematical problem-solving ability through emotional intelligence

| Variables | Unstandardized coefficients | | Standardized coefficients Beta | t | Statistical significant |
|-----------|-----------------------------|------|-----------------------------------|-------|-------------------------|
| | B coefficient | St.E | | | |
| constant | 7.89 | 1.46 | | 5.40 | .00 |
| EI | -1.72 | .80 | -.17 | -2.13 | .03 |

Table 1 shows that the level of significance is $P = 0.03 < 0.05$, and this means that the emotional intelligence variable has the ability to predict the variable of solving mathematical problems.

Table 2: Prediction model for mathematical problem-solving ability through intrinsic-motivation

| Variables | Unstandardized coefficients | | Standardized coefficients Beta | t | Statistical significant |
|-----------|-----------------------------|------|-----------------------------------|-------|-------------------------|
| | B coefficient | St.E | | | |
| Constant | 7.83 | 1.05 | | 7.42 | .000 |
| IM | -1.81 | .62 | -.22 | -2.92 | .00 |

Results of table 2 shows that the level of significance is $P = 0.004 < 0.05$, and this means that the intrinsic motivation predict the variable of solving mathematical problems.

Table 3: Model summary of the prediction of intrinsic motivation in solving mathematics problems when Emotional Intelligence is a Moderator

| Model | R | R squared | Adjusted R squared | Standard error of modification |
|-------|-----|-----------|--------------------|--------------------------------|
| 1 | .26 | .066 | .054 | 2.461 |

The table shows that the value of R squared ratio is 0.05, and this means that the percentage of the contribution of the emotional intelligence and intrinsic motivation variables in explaining the variance of the grades of the fourth grade students in the mathematical problem solving test is equal to 5%, which is considered a simple ratio, and the remaining 95% of the variance in the problem-solving test may be explained by other factors.

Table 4: Coefficients of problem solving regression on intrinsic motivation and emotional intelligence

| Model | Sum of squares | Degrees of freedom | Average of squares | variance | Sig |
|------------|----------------|--------------------|--------------------|----------|-----|
| Regression | 65.37 | 2 | 32.68 | 5.39 | .00 |
| Residual | 926.85 | 178 | 6.05 | | |
| Total | 992.23 | 180 | | | |

Table 4 shows that value of $F= 5.396$, ($df = 2, 178$), $P = 0.005$, that is, the P value <0.05 , and this indicates that the independent variables (emotional intelligence and intrinsic motivation) can predict the dependent variable (ability to solve mathematical problems).

Table 5: Regression of intrinsic motivation and emotional intelligence

| Model | Unstandardized coefficients | | Standardized coefficients | | T | Sig |
|----------|-----------------------------|----------------|---------------------------|--|-------|-----|
| | B | Standard Error | Beta | | | |
| Constant | 9.62 | 1.59 | | | 6.02 | .00 |
| IM | -1.57 | .64 | -.19 | | -2.46 | .02 |
| EM | -1.21 | .81 | -.12 | | -1.48 | .14 |

Through the data of the regression model coefficients in table 5, the regression coefficient of the intrinsic motivation reached $\beta = -0.199$, and significance level $P = 0.02 < 0.05$, which is an indication that the prediction of the intrinsic motivation was faded by this model. The regression coefficient of the emotional intelligence variable is $\beta = -0.120$, and the level of significance $P = 0.14 > 0.05$, meaning that the role of emotional intelligence as an intermediate variable in predicting intrinsic motivation in the ability to solve mathematical problems is not statistically significant.

5. Discussion

The result of the relationship between emotional intelligence and solving mathematical problems is consistent with the result of Hafez (2011) and Ajwa (2002) who indicated that there is no statistically significant relationship between emotional intelligence and mathematics achievement, and this result contradicts the result of the study of Aljarrah (2011) which concluded that there is a strong and positive relationship between emotional intelligence and the ability to solve problems. Moreover, Abu Afash (2011) study found a positive relationship between emotional intelligence and the ability of individuals to solve problems and make decisions. In addition, the study of Kaddouri and Lahssan (2016) concluded that there is a statistically significant direct relationship between emotional intelligence in its five components and students' ability to solve problems.

The weak association between the two variables among students of the fourth grade may be attributed to their weak ability to use their emotional intelligence in trying to solve problems in mathematics, and this contradicts the emphasis by Goleman (2000) who found that the emotional intelligence of individuals contributes to 80% of success in life, work, or study.

With regard to the relationship between intrinsic motivation and the ability to solve mathematical problems, the result is consistent with that of Baker (2003) which indicated a weak relationship between intrinsic motivation and students' ability to think and solve problems in mathematics, while the result inconsistent with (Abu Afash, 2011; Sarhan, 2015; Caprara et al, 2011; Legault , 2016), whose results concluded that the stronger the intrinsic motivation of the learner, the more he is able to solve mathematical problems. In addition, the study of Abu Al-Rayah and Al-Morsi (2013) also demonstrated the existence of a positive correlation between high intrinsic motivation and the level of students in solving mathematical problems.

The weakness of the relationship between the two variables may be attributed to the tendency of children in the stage of physical processes, according to Piaget's theory, to a love of exploration, invention and innovation of machines and devices that suit their thinking and ages, and their lack of preference for paper activities and tests, as they feel bored when answering the tests questions, and this is what the researchers noticed through their work in the educational field for a period of 14 years. The results of students' performance in practical activities, classroom and extra-curricular projects were better than their performance in the written tests.

The result of the relationship between emotional intelligence and intrinsic motivation is consistent with the result of Sarhan's (2015) that indicated a positive correlation between emotional

intelligence and intrinsic motivation; and a study of Sayfeyah and Abdul Karim (2018), which found a positive correlation between emotional intelligence and the motivation to learn. Al-Shehri (2012) study confirmed the existence of a significant correlation between emotional intelligence and intrinsic motivation among middle school students.

The result of the existence of a significant correlation between emotional intelligence and intrinsic motivation may be attributed to the fact that intrinsic motivation is one of the components of emotional intelligence according to Goleman model (1995) and its association with it, and intrinsic motivation and emotional intelligence are considered psychological components of the human personality that are related to each other, and of course if students' emotional intelligence capabilities grow, intrinsic motivation will increase, and vice versa. In addition, Sarhan study (2015) indicated that students who have the desire to learn and seek to prepare their lessons continuously without the presence of external incentives, and who have the ability to control their emotions during their interaction with their teachers and peers in the school, have emotional intelligence, and the degree of their possession of emotional intelligence varies according to the degree of maturity they have attained.

The result of question two is consistent with study of Ogundokun and Adeyemo (2010), and it also consistent with the results of Al Shehri's study (2012), which reached the possibility of predicting students' ability to solve mathematical problems through the intrinsic motivation component, one of the emotional intelligence components according to Goleman (1995) model. The result of the study by Abdel-Wahab and Al-Wolily (2011) confirmed the ability of emotional intelligence to predict academic achievement or its positive relationship with it. The results of this study contradicted the result of Alawi study (2011) and Habok et al., (2020) which concluded that emotional intelligence does not have the ability to predict academic achievement and solve problems. The reason for the difference in the results may be attributed to the difference in the study sample, who are young, and the difference in the scale used in this study to measure emotional intelligence from the measures of previous studies.

Moreover, the result corresponds to the proposed study model based on previous studies in Part (A); where it was possible to predict each of: emotional intelligence, and intrinsic motivation, the ability to solve mathematical problems. The outcome of this question does not correspond with the model proposed for the study in Part (B); where the model suggested that the emotional intelligence play a mediating role in the prediction of intrinsic motivation in the ability to solve mathematical problems, and the results of this study showed that emotional intelligence does not have a mediating role in prediction. This may be due to the difference in the sample of this study from the samples of previous studies, which is the sample of children in the early stages of education. The researchers did not find any study that used emotional intelligence as a mediating variable to predict intrinsic motivation with the ability to solve mathematical problems, given the novelty of the subject of the mediating variable, and the lack of studies that dealt with these three variables and their effect on each other. The reason for the lack of mediation of emotional intelligence in the prediction of intrinsic motivation in the ability to solve mathematical problems on the basis of the nature of the stage of the first stage of basic education may be explained, as children may not be able to employ psychological traits and personal characteristics to achieve success, excellence and high grades, and the tendency of children at this stage may not give them extra minutes to think about the question and find more than one way to solve it.

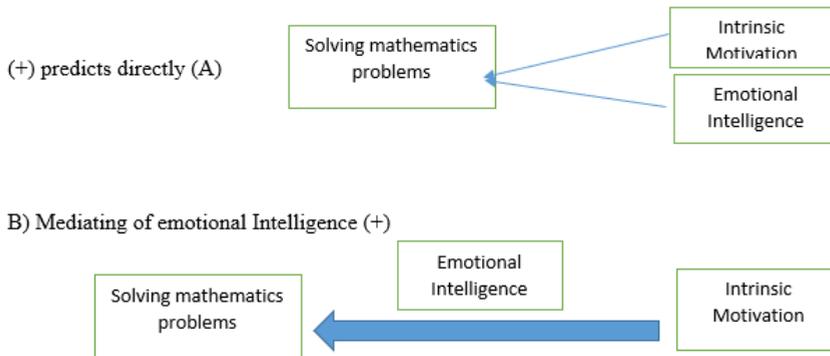


Figure 1. Study model

6. Conclusion

This quantitative study was designed using a predictive approach that relied on its design on correlation coefficients between two subjects related to personality traits, namely: intrinsic motivation and emotional intelligence, and a cognitive mental issue, which is solving mathematical problems. Given that the relationship between the three study variables was weak, the mediating role of emotional intelligence in predicting intrinsic motivation in solving mathematical problems was also weak. Despite the importance of students' personal characteristics in academic achievement, the small age level of students did not help them well in expressing these characteristics in the statements of the questionnaire. This study was applied to a young sample, and thus it opens the way for researchers to measure different personality traits of this age group and their correlation or predictions with academic achievement in different subjects, and other methodologies and different measurement methods can also be used.

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