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**Original Article**

# Executive Functions as a Mediator of the Correlation between Intelligence and Student-Teacher Relationship with Behavioral Problems

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## Abstract

**Background:** It is important to address individual and interpersonal factors involved in behavioral problems to prevent their serious consequences. This study investigated the mediating role of executive functions in the correlation between intelligence and student-teacher relationship with behavioral problems.

**Methods:** This was a cross-sectional study with a descriptive-correlational approach. The statistical population included the students of the first grade to third grade in Bojnord, Iran. Using the cluster sampling method, two elementary schools (first period) were selected for data collection from February 2023 to April 2023. The study participants were 351 students aged 6 to 10 years old. The parents completed the Child Behaviour Checklist (CBCL/6–18), and Behavioral rating inventory of executive functions (BRIEF). The teachers completed the Student-Teacher Relationship Scale (STRS) for each student, and the students were tested individually by the Colored Progressive Matrices Test (CPMT). The data were analyzed using PLS version 4 and SPSS version 22 by correlation test and structural equation model.

**Results:** The findings showed that executive functions have a significant impact on behavioral problems ($\beta$=0.43, P<0.001) and the intelligence and conflicts in the student-teacher relationship strongly affect executive functions ($\beta$=-0.44, P<0.001, and $\beta$=0.41, P<0.001, respectively). Also, our results showed that intelligence and conflicts in the student-teacher relationship indirectly through executive functions affect behavioral problems ($\beta$=-0.19, P<0.001, and $\beta$=0.17, P<0.001, respectively).

**Conclusion:** Positive teacher-student relationships are vital for improving self-regulation skills, academic performance, and emotional and social well-being of elementary school students.

***Keywords:*** Executive functions, Intelligence, Student, Teacher, Problem behavior

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## 1. Introduction

Most children experience some behavior problems at certain times. Behavioral problems are deviations from the general level of mental and behavioral balance among people with natural intelligence in the society. Although the intensity, extent, and continuity of behavioral problems change at different times and places, it can interfere with academic performance and relationships with others (1). Behavioral problems have caused major health concerns due to their high prevalence. In the US, approximately 2.26 million primary school students had a current behavioral problem in 2016 (2). A study reported that 42.1% of Iranian children and adolescents have behavioral problems (3). Behavior problems arise from conditions within the child or from external factors, the effects of which are often not noticed or understood by others.

Intelligence predicts important social consequences in all stages of development (4). A recent longitudinal study has confirmed that lower levels of intelligence were a strong predictor of increased behavioral problems (5). Previous studies indicated that intelligence was correlated with conduct disorder, antisocial personality disorder, and psychopathic traits (6). Another study showed that even after controlling for impulsivity, intelligence was negatively associated with aggression in high school students (7). In a large sample of children at-risk for abuse or neglect, it was confirmed that intelligence indirectly affects behavioral problems by influencing executive functions (8).

The executive functions are cognitive processes needed to regulate behavior, thoughts, and emotions associated with multiple aspects of daily functioning such as academic achievement (9), social relationships (10), and behavioral problems (11) in clinical and non-clinical populations.

Several studies have used neuropsychological tests to measure executive functions. Due to the major concern about the lack of ecological validity of neuropsychological tests (12), the present study used the behavioral assessment scale to measure executive function.

This study sought to investigate the effect of the student-teacher relationship on behavioral problems through executive functions. A review of the literature showed that teacher-student relationship can predict students' behavioral adjustment (13). Pianta's model of the teacher-student relationship suggests that the teacher's perspective on the relationship with students is reflected in his/her interactions with students, which in turn affects the student's adaptation to the school environment (14). Positive and emotional teacher-student relationships promote cognitive, emotional, and social development (15). Teachers who provide emotional support to students protect the communication functioning of students who may face behavioral problems (16). Also, teachers' views of teacher-student relationship are related to students' behavioral problems (17) so that teachers who are less tolerant of students' behavioral problems in the classroom show a negative view of students' behavioral problems (18). Students with fewer behavior problems, when entering the school, have a positive relationship with the teacher (19) while higher levels of behavioral problems may predict poorer student–teacher relationships in the future (20). Sensitivity and emotional warmth of teacher-student moderate the negative effects of children's tendency toward disruptive behaviors (21). A study among students with autism spectrum disorders showed that higher externalizing problems predicted negative student–teacher relationships in the same school year and the subsequent school year, even if intelligence did not moderate the correlation between the quality of early student–teacher relationships and subsequent externalizing problems (22). However, previous research showed that the quality of student-teacher relationships is related to executive functioning (23). Recently, a meta-analysis study confirmed the correlation between the student-teacher relationship and executive functions of students (24). A study has investigated the role of students' social-emotional skills and teacher-student relationship in the prediction of students' behavioral problems. Previous research indicated that students' social-emotional skills are more strong than teachers' interpersonal behavior in the prediction of behavioral problems (25). Meanwhile, other study found that student-teacher relationship was a strong predictor of children's behavioral problems (26).

Therefore, the present study aimed to simultaneously investigate the role of intelligence, executive functions, and teacher-student relationship on students' behavioral problems. Especially, this study had an innovative aspect in that it examined the mediating role of executive functions in the simultaneous correlation between intelligence and student-teacher relationship with primary students' behavioral problems.

## 2. Methods

This study was a cross-sectional study with a descriptive-correlational approach. The statistical population included the students of the first grade to third grade in Bojnord, Iran. Using the cluster sampling method, two girls' and boys' elementary schools were selected from February 2023 to April 2023. In each school for each grade, there were two classes, and all of the classes were selected for the study (12 classes). According to Cochran's formula for limited population, the sample size was determined to be 386 people. After removing incomplete questionnaires, the data from 351 people were analyzed. The inclusion criteria were: no vision problems to perform the Colored progressive matrices test, attending school during the testing, no severe mental disorders. In addition, the exclusion criteria were: parents' unwillingness to complete the questionnaires, student's unwillingness to take Colored progressive matrices test, and distorted or incomplete questionnaires.

### *2.1. Procedure*

In order to involve students in the study, parental consent was obtained. The parents and teachers participating in the study were assured that their information will remain confidential and will not be shared with any person or organization. The parents completed the Child Behavior Checklist (CBCL/6–18) and Behavioral rating inventory of executive functions (BRIEF). The students were tested individually by the Colored progressive matrices test. The teachers (n=12) completed the Student-Teacher Relationship Scale for each student. The data were analyzed using PLS version

4 and SPSS version 22 through correlation test and structural equation model. The level of significance was set to be α=0.05.

*2.2. Instruments*

**2.3.1. The Child Behavior Checklist (CBCL/6–18):** CBCL is part of Achenbach System of Empirically Based Assessment with 113 items. It measures internalizing (anxiety, depression, somatic complaints) and externalizing problems (attention problems, conduct, and oppositional behavior) in children and adolescents. It uses a 3-point Likert scale (0="Absent", 1="Occurs sometimes", 2="Occurs often") (27). The internal consistency of the subscales is in the range of 0.78 to 0.97 and for total scale is 0.90. The test-retest reliability was 0.95 over one week. Also, the correlation between subscales were ranging from 0.85 and 0.89 both in mother and father reports (27). In Iran, it was reported that the correlation of the subscales of behavioral and emotional problems for parents, and the total scores were in range of 0.62 to 0.88. Also, the Cronbach's alpha was reported to be 0.90 (28).

**2.3.2. Behavioral rating inventory of executive functions (BRIEF)-parent form:** Gioia and colleagues designed BRIEF in 2000 (29). It measures behavioral evaluation of executive functions among children aged 5 to 18 years. BRIEF has 86 items with teacher and parent reporting forms, which are answered based on a three-point Likert scale (never, sometimes, and often). This questionnaire has 8 clinical subscales, which include inhibition, shifting, emotional control, planning, initial, working memory, material organization, and monitoring. Higher scores indicate problems of executive functions. The designers of this questionnaire standardized it among 1419 normal children and 852 children with clinical problems. The internal consistency of the parents form is reported to be in the range of 0.80 to 0.59, with a test-retest reliability of 0.81 (in the range of 0.76 to 0.85). The test-retest reliability of the parents form in the clinical sample was 0.79 (in the range of 0.72 to 0.84) (29). In Iran, a study with an eight-factor model reported that the internal consistency was 0.91, and Content Validity Index (CVI) and Content Validity Ratio (CVR) were 0.71 and 0.81, respectively (30).

**2.3.3. Student-Teacher Relationship Scale (STRS):** This scale was developed by Pianta in 2001 to measure teachers' perception of relationship with students from preschool to grade 3 (31). STRS has 28 items and three subscales of dependency (5 items), closeness (11 items), and conflict (12 items). The response scale is based on a 5-point Likert scale (1=completely false to 5=completely true). A high score in the dependency subscale indicates which teacher perceives a student's dependence on him/her, such as requesting help when not needed. A high score in closeness indicates affection, warmth and open communication with students. A high score in conflict indicates which teacher perceives his/her relationship with students as negative and conflictual. Exploratory factor and confirmatory factor analyses verified the existence of three subscales with favorable indices. It was reported that the internal reliability for three scales of a close relationship, conflict relationship, and dependence was 0.88, 0.90, and 0.78, respectively (32). In Iran, confirmatory factor analysis, provided evidence for the three-factor structure of STRS with scales indicating satisfactory internal consistency (33).

**2.3.4. Colored Progressive Matrices Test (CPMT):** Colored Progressive Matrices assess general intelligence in elementary school students. This test contains 36 matrices and students have to choose an image from 6 separate images that complete the image of the matrix of each question. Due to the wide use of CPMT in different countries, its Psychometric properties have been extensively investigated and its reliability and validity were reported to be acceptable. Iran and other countries obtained Intelligence Quotient (IQ) equivalents for children (average 100 & standard deviation 15) in CPMT. The correlation coefficient of this test with the Stanford Binet intelligence test has been reported to be 0.758, which indicates the convergent validity of the test. The reliability of both Cronbach's alpha and test-retest was more than 0.70 (34).

## 3. Results

The study findings showed that the age range of students was 6 to 10 years with an average of 8.10 and a standard deviation of 1.50. A total number of 160 girls (45.58 percent) and 191 boys (54.42 percent) participated in the study. In terms of the level of education, 26.6% of fathers had a higher education diploma, 42.4% diploma, and 31% were without a diploma. Also, 16.2% of mothers had a higher education diploma, 45% diploma, and 38.8% were without a diploma.

In this section, descriptive analyses are presented first. Then, the analyses related to gender indifferences are reported. Finally, structural equation analyses are reported based on the proposed model.

Table 1 shows that there is a significant correlation between the variables of behavioral problems, intelligence, and executive functions. The dependent subscale of the teacher-student relationship is not correlated with behavioral problems and intelligence. Also, the conflict subscale is not correlated with intelligence.

Table 2 shows that there is no significant difference between girls and boys in terms of the level of behavioral problems, executive functions, and intelligence. Therefore, the proposed model can be analyzed without considering the effect of gender.

Table 3 shows that executive functions have a significant impact on behavioral problems, as indicated by a moderately high f-square value ($f^2$=0.227, P<0.001). Also, intelligence affects significantly executive functions with a high f-square value ($f^2$=0.322, P<0.001). Finally, the impact of the student-teacher relationship on executive function is significant, with a relatively high f-square value ($f^2$=0.274, P<0.001).

Table 4 shows the total indirect effects of intelligence and the student-teacher relationship on executive functions and behavioral problems. Also, Table 4 shows that intelligence impacts behavioral problems through executive functions. The negative coefficient (-0.192) suggests that an increase in intelligence is associated with a decrease in executive functions, which subsequently leads to a decrease in behavioral problems. Also, a significant positive indirect effect (0.177) suggests that conflicts in the student-teacher relationship enhance problems of executive functions, which, in turn, increases behavioral problems.

**Table 1:** Mean, standard deviation, and correlation of variables

| Variables | | M | SD | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|
| Behavioral problems | | 20.87 | 15.87 | 1 | | | | | |
| Executive functions | | 126.93 | 33.96 | 0.41** | 1 | | | | |
| Intelligence | | 90.55 | 19.80 | -0.26** | -0.46** | 1 | | | |
| Student-teacher relationship | Conflict | 25.30 | 9.44 | 0.21** | 0.42** | -0.05 | 1 | | |
| | Dependence | 14.24 | 4.86 | 0.03 | 0.20** | 0.02 | 0.40** | 1 | |
| | Closeness | 37.27 | 6.18 | -0.21** | -0.27** | 0.26** | -0.16** | 0.48** | 1 |

M: Mean; SD: Standard Deviation

**Table 2:** Gender differences in the studied variables

| | Sex | Mean | Standard Deviation | Independent T-Test | P |
|---|---|---|---|---|---|
| Intelligence | Girls | 88.97 | 20.26 | -1.45 | 0.14 |
| | Boys | 92.14 | 19.34 | | |
| Conflict | Girls | 24.16 | 9.15 | -1.70 | 0.09 |
| | Boys | 26.45 | 9.94 | | |
| Closeness | Girls | 38.40 | 6.25 | 1.63 | 0.10 |
| | Boys | 36.61 | 7.05 | | |
| Dependence | Girls | 14.83 | 4.37 | 1.50 | 0.12 |
| | Boys | 13.88 | 5.09 | | |
| Executive function | Girls | 123.76 | 33.24 | -1.34 | 0.18 |
| | Boys | 128.81 | 34.33 | | |
| Behavioral problem | Girls | 18.05 | 14.64 | -1.90 | 0.07 |
| | Boys | 22.54 | 16.36 | | |

**Table 3:** Direct effects and F square on paths in the proposed model

| | Direct effects | | | F square | | |
|---|---|---|---|---|---|---|
| | β | t | P | Coefficient | t | P |
| Executive functions -> Behavioral problems | 0.430 | 8.714 | <0.001 | 0.227 | 3.377 | <0.001 |
| Intelligence -> Executive functions | -0.445 | 10.453 | <0.001 | 0.322 | 4.255 | <0.001 |
| Student-teacher relationship -> Executive functions | 0.410 | 10.096 | <0.001 | 0.274 | 4.179 | <0.001 |

| **Table 4:** Mediating effects in the proposed model | | | |
|---|---|---|---|
| Indirect effects | β | t | P |
| Intelligence -> Executive functions -> Behavioral problems | -0.192 | 6.298 | <0.001 |
| Student-teacher relationship -> Executive functions -> Behavioral problems | 0.177 | 6.535 | <0.001 |

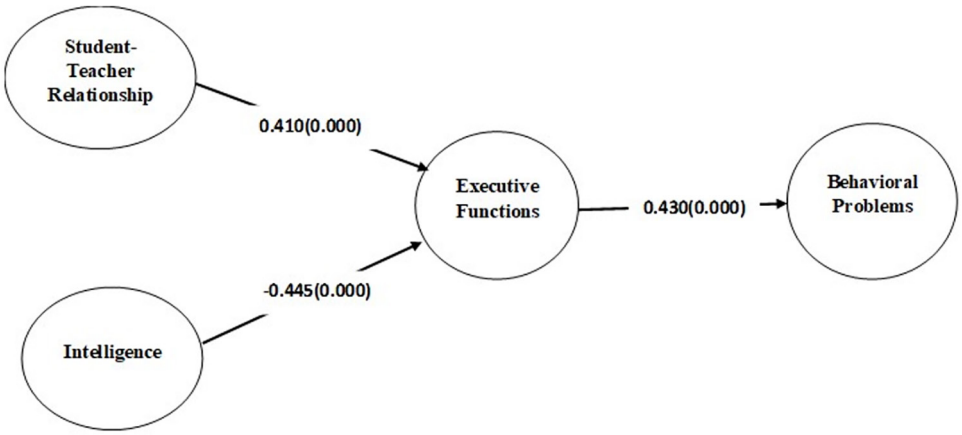


**Figure 1:** The figure shows the proposed model.

Figure 1 shows the direct effect in the paths of the proposed model. The effect of the observed variables on the latent variables are displayed in Table 5 to prevent overcrowding of the model. The findings showed that the R-square adjusted value for behavioral problems and executive functions suggested 0.18 and 0.38 percent of variations in behavioral problems and executive functions explained by predictors in the model. Also, the results indicated that Cronbach's alpha coefficient of behavioral problems, executive functions, intelligence and student-teacher relationship are 0.92, 0.98, 1, and 1, respectively. Ideally, a Cronbach's alpha value above 0.7 is desirable for good reliability. It is suggested that all of the variables have high internal consistency. The average variance extracted (AVE) of behavioral problems, executive functions, intelligence and student-teacher relationship are 0.64, 0.85, 1, and 1, respectively. It is used as a discriminate validity index to evaluate the quality of the reflective measurement model. It is suggested a minimum value of 0.5 for this index. According to this criterion, all of the variables are acceptable in terms of the validity of the diagnosis.

The criterion of the Standardized Root Mean Square Residual (SRMR) is used to measure the goodness of fit of the model in PLS-SEM in order to avoid model misspecification. SRMR evaluates

| **Table 5:** The effects of observed variables on latent variables | | |
|---|---|---|
| **Path** | **Coefficients** | **P value** |
| Attention problem <- Behavioral problems | 1.018 | <0.001 |
| Depression <- Behavioral problems | 0.812 | <0.001 |
| Anxiety <- Behavioral problems | 0.590 | <0.001 |
| Conduct <- Behavioral problems | 0.867 | <0.001 |
| Oppositional <- Behavioral problems | 0.685 | <0.001 |
| Somatic <- Behavioral problems | 0.775 | <0.001 |
| Conflict <- Student-teacher relationship | 1.000 | <0.001 |
| Emotional control <- Executive functions | 0.946 | <0.001 |
| Inhibit <- Executive functions | 0.950 | <0.001 |
| Initiate <- Executive functions | 0.968 | <0.001 |
| Working memory <- Executive functions | 0.928 | <0.001 |
| Monitor <- Executive functions | 0.899 | <0.001 |
| Organization material <- Executive functions | 0.896 | <0.001 |
| Plan <- Executive functions | 0.909 | <0.001 |
| Shift <- Executive functions | 0.892 | <0.001 |
| Intelligence <- Intelligence | 1.000 | <0.001 |

the average value of the differences between the observed and expected correlations as an absolute measure of model fit. It is suggested for SRMR a cutoff point of 0.06 to 0.11 in the maximum likelihood estimation method and a cutoff point below 0.08 in the covariance-based structural equation method (35). As the value of SRMR is 0.05 in this analysis, it can be said that the proposed model has an acceptable fit.

Also, d_ULS (squared Euclidean distance) and d_G (geometric distance) were introduced as two different methods to calculate the difference between the empirical covariance matrix and the implied covariance matrix. If the difference between the empirical covariance matrix and the implied covariance matrix is very small, this small value is attributed to sampling error (36). The values of d-ULS and d-G indices are 0.36 and 0.24, respectively. As these values are in the range of 95 to 99%, the difference between the empirical covariance matrix and the implied covariance matrix is not caused by sampling error and the model has a good fit.

## 4. Discussion

This study aimed to investigate the mediating role of executive functions in the correlation between intelligence, student-teacher relationship, and behavioral problems among primary school students. The results revealed several important findings that contribute to our understanding of these complex associations.

This study demonstrated a significant impact of executive functions on behavioral problems. This suggests that individuals with problems with executive functions are highly likely to exhibit behavioral problems. In this line, previous research confirmed that low cognitive ability is related to increased risk for behavioral problems (11).

Executive functions refer to cognitive processes such as planning, decision-making, self-control, and working memory. Therefore, it can be inferred that individuals with well-developed executive functions have a greater control over their behavior and are more capable of regulating their emotions and impulses.

The present study found that intelligence is negatively correlated with problems of behavior and executive functions. In this line, previous evidence suggested that irrespective of environmental threat, intelligence is negatively associated with behavior problems across childhood (6-8). Also, this study indicated that a strong direct effect of intelligence on executive functions. This implies that higher levels of intelligence are associated with low levels of executive function problems.

Intelligence is traditionally defined as an individual's capacity for logical reasoning, problem-solving skills, abstract thinking ability, and overall cognitive abilities. These findings suggested that individuals with higher intelligence may possess superior capabilities for effective self-regulation and cognitive control.

Furthermore, closeness in student-teacher relationship is negatively correlated with behavioral problems. Also, conflict is positively correlated with behavioral problems. Previous studies suggested that student-teacher conflict is the strongest predicted behavioral problem for later years (37). In teacher-student relationships, conflict may increase problems of behavior (16, 20, 22, 26). In contrast, close student-teacher relationships appears to protect children at risk of behavior problems (13).

This study indicated that conflict, closeness, and dependence in a student-teacher relationship were correlated with executive functions. Also, the results indicated that conflicts within the student-teacher relationship can also impact executive functions. Consistent with this result, effect sizes in a Meta-Analysis study suggested that student-teacher interactions are related to executive functions especially these correlations were stronger in studies with children at the beginning of primary school (24). Other studies showed that students' positive relationships with teachers can promote executive functions, while negative relationships weaken executive functions (23, 38). Recently, a study demonstrated that quality classrooms influence children's progress in executive function development (39). However, this study added to this knowledge by highlighting how conflicts within these relationships can affect key cognitive processes involved in self-regulation. Consistent with this result, a systematic review study indicated that children in treatment groups manipulating the teacher-student relationship as compared with controls, show high performance

in executive functions and self-regulation (40). The importance of early relationships with the school teacher implicitly relies on the rationale that such relationships serve as resources and resilience mechanisms to counter the effects of problems in family relationships. It seems that teachers promote students' executive functions by creating a structured classroom environment stimulating positive emotional and cognitive processes.

Interestingly, the indirect effects observed in this study suggest a potential pathway through which both intelligence and conflicts in student-teacher relationships influence behavioral problems, namely via their impact on executive functions. The indirect effect indicates that intelligence indirectly influences behavioral problems by influencing executive function capacities. This implies that higher levels of intelligence may lead to improved regulation skills via enhanced executive function abilities, resulting in a reduced likelihood of behavioral problems. Similarly, the indirect effect of conflicts in student-teacher relationships on behavioral problems was found to be mediated by executive functions. This suggests that conflicts within the student-teacher relationship increase problems of executive functions, subsequently increasing the likelihood of behavioral problems among students.

### *4.1. Limitations*

There were some limitations in this study. First, the study population were students from the first to third grades of elementary school, and generalization to other ages and grades should be done with caution. Second, the data collection tools were parent and teacher-reported, which could be associated with bias. Third, the effect of demographic variables such as socio-economic status on the study variables was not controlled.

## 5. Conclusion

The present study emphasizes the importance of considering executive functions as a mediator between intelligence, student-teacher relationship, and behavioral outcomes. The results shed light on how individual cognitive capacities and interpersonal dynamics can influence behavior in educational settings. Understanding these complex associations can inform interventions and strategies aimed at fostering a positive student-teacher relationship and promoting better self-regulation skills for improved academic performance and socio-emotional well-being among students.

## Ethical Approval

The Ethics Review Board of University of Bojnord, Iran approved the present study with the code of IR.UB.REC.1402.021. Also, informed consent was obtained from parents of students**.**

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## Authors' Contribution

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

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