

Research Article

Investigation of the effects of secondary school students' psychological resilience and academic grit levels on mathematics achievement

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Article Info

Received: 11 July 2023

Accepted: 2 September 2023

Available online: 30 Sept 2023

Keywords

Academic grit

Mathematics achievement Secondary school

Psychological resilience

Abstract

The aim of the study is to examine the achievement of secondary school students in mathematics courses based on psychological resilience and academic grit. In the research, descriptive survey model, one of the quantitative research methods, was used. In this context, data were collected from 204 students studying in secondary schools in the district of Görükle, Bursa, in the spring term of the 2022-2023 academic year. As a data collection tool "Brief Resilience Scale" adapted by Dogan (2015), "Academic Grit Scale" adapted by Sağkal et al. (2020) was used. In this study, students' mathematics achievement was determined according to the grades in the mathematics course at the end of the semester. While analysis of variance (ANOVA) and t-test were used for group comparisons, correlation analysis was used to determine the relationship between psychological resilience and academic grit levels. According to the research results, it was seen that the psychological resilience levels of the students were medium and their academic grit levels were medium. Although there was no statistically significant difference in the evaluations made in the context of mathematics course achievement, it was observed that the achievement of the course increased as the levels of psychological resilience and academic grit increased. In terms of different variables, it was seen that academic grit levels did not differ according to gender. It was determined that the psychological resilience levels showed a statistically significant difference according to the gender variable and the psychological resilience of male students was higher. It was observed that the levels of psychological resilience and academic grit did not differ according to grade levels. It was determined that there was a positive and moderate relationship between the mathematics course achievement of secondary school students and their levels of resilience and academic grit, and a positive and moderate relationship between their levels of resilience and academic grit.

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To cite this article:

Demir, B. (2023). Investigation of the effects of secondary school students' psychological resilience and academic grit levels on mathematics achievement. *Journal for the Education of Gifted Young Scientists*, 11(3), 369-380. DOI: <http://dx.doi.org/10.17478/jegys.1346129>

Introduction

It is very important to examine the factors affecting academic performance and achievement in school, which are considered to be an indicator of the quality of the education system and student goals. Academic achievement is an important criterion for determining the level of knowledge and skills acquired by students and is evaluated by various exams and applications at different educational levels from elementary school to university. Academic achievement, students, as well as their families, educators, managers, etc. It is an issue that is also cared about by. It is known that academic achievement is a determining factor on personal and professional development (Ateş, 2016; Ateş & Sağar,

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2021). Research provides information about self-concept, self-efficacy, motivation and study habits, intelligence, ability, personality and familial qualities, characteristics of school, study habits, exam anxiety, difficulty of lessons, teacher attitude, friend effect and other factors affecting academic achievement (Afemike, 1985; Al-Qaisy, 2011; Ateş, 2016; Chen et al., 1997; Goodman et al., 2011; Khan et al., 2012; Owoyele, 2009; Sharma & Sharma, 2018; Tabbodi et al., 2015; Taşlıyan, Hırlak & Harbaroğlu, 2015; Umoinyang, 1999; Yıldırım & Ergene, 2003). These factors are important factors that affect the academic achievement of students.

The problem of low achievement among students in mathematics, one of the core subjects of education, has become a growing concern among parents, teachers, researchers and society in general. According to research, many secondary schools report the same low math performance year after year. The measure of achievement or failure in mathematics is usually based on cognitive variables evaluated with intelligence (Umoinyang, 1999). Studies have shown that students' behavior, especially in science and especially in mathematics, is also greatly influenced by certain psychological or non-cognitive factors (Eduwem, Umoinyang & Otu, 2017). Afemike (1985) and Umoinyang (1999) found that psychological factors such as self-concept, attitude towards mathematics, gender-based stereotypes, study habits, confidence, test anxiety, motivation, interest in school, and problem-solving habits are associated with students' achievement. showed.

One of the reasons that enable students to be achievement both academically and socially in the school environment is psychological power factors. Psychological power factors gain more importance in academic research as they reveal the possibilities of coping with stress in individuals. An incompatible coping with stress emerges with a low level of psychological resilience, which causes dysfunctional work attitudes in individuals (Stainton et al., 2019). For this reason, it is thought that it is important to determine the psychological resilience and grit levels of the students.

Masten (2001) defines psychological resilience as seeing positive and positive results in the adaptation and development of the individual despite the serious negativities and great dangers that occur in his life. Rutter (2006), who defines psychological resilience as having a relatively good psychological outcome despite risk experiences that are expected to bring serious dangers, defines this situation as a feature that develops throughout life, emerges suddenly and becomes more evident in different periods of life, rather than a feature possessed by the individual considers it. Individuals with high psychological resilience have features such as producing alternative solutions to cope with difficulties, coping with stress, managing negative emotions, setting life goals, and establishing relationships that include social bonds. These features can increase students' interest and motivation in mathematics lessons and contribute to better learning results and academic achievement. Although psychological resilience depends on the individual's own characteristics, today and family should be evaluated together with the holistic situation that it constitutes (Dent & Cameron, 2003; Prince-Embury, 2010; Chen, Cheung, Fan & Wu, 2017).

The importance of grit is emphasized behind achievement in all other areas of life, from education to art, from politics to economy (Duckworth, 2006; Sarıçam, Çelik & Oğuz, 2016). Grit has been defined as the passion, effort and interest shown to achieve a long-term goal (Duckworth, 2006). Duckworth, Peterson, Matthews, and Kelly (2007) argue that grit is more important for the individual's academic, social, and professional achievement as well as their well-being than features such as cognitive ability, creativity, intelligence, charisma, and self-confidence. In recent years, studies aimed at measuring and examining academic grit rather than general grit have attracted attention. Academic grit can be defined as the ability of students to struggle with the difficulties they encounter in every environment and condition for achievement in education life, patience, endurance, and grit (Duckworth & Quinn, 2009). Academic grit can also be expressed as the desire and effort of students to reach their goals (Clark & Malecki, 2019). Since academic grit is defined as the power to overcome obstacles and difficulties, it is stated that it overlaps with the concept of resilience and even forms the basis of psychological resilience (Luthans, Luthans & Chaffin, 2019).

It is supported by research that the level of psychological resilience and academic grit levels have a positive effect on academic achievement. Psychological resilience has been associated with academic achievement and many studies have examined this relationship (Ateş & Sağar, 2022; Demir, 2023). These studies have shown that psychological resilience positively affects academic achievement. When the literature is examined, the variables of grit have a positive direction

with variables such as academic performance and academic achievement (Credé, Tynan & Harms, 2017; Çelik & Sarıçam, 2018; Hwang, Lim & Ha, 2018) have been found to be related. In a small number of studies conducted on adolescents as a concept of academic grit, it has also been concluded that academic grit significantly affects achievement (Clark & Malecki, 2019; Işıkçı & Çoklar, 2022).

Secondary school development periods are a period in which rapid developments are experienced in the field of physical, emotional, and interpersonal relations. During these periods, difficulties may be experienced in academic performance and social relations. At this level, the child's psychological resilience and academic grit can affect both academic and social achievement in the school environment. Due to its importance in determining mathematics achievement, the identification of students at risk of failure in the second level of primary education will contribute to teachers in terms of development and preventive studies. When the literature is examined, studies focus on studies examining the levels of resilience on teachers and university students (Ateş & Sağar, 2022; Demir, 2023; Credé, Tynan & Harms, 2017; Hwang, Lim & Ha, 2018). More research is needed to determine the effect of students' levels of psychological resilience and academic grit on their mathematics achievement. However, it is seen in the literature that the studies on secondary school students for mathematics lessons are limited. Therefore, this study is considered valuable and important in terms of the field. This type of study can help us better understand the effects of students' levels of psychological resilience and academic grit on their mathematics achievement. In addition, it is thought that determining the relationship between academic grit, which is stated to be the basis for psychological resilience in the literature, and the concept of psychological resilience will contribute to the field. The aim of this research is to examine the mathematics course achievement of secondary school students within the framework of their psychological resilience and academic grit levels. In this context, answers to the following questions were sought:

- What is the level of psychological resilience of secondary school students?
- What is the academic grit of secondary school students?
- Do the psychological resilience and academic grit levels of secondary school students differ according to the mathematics course achievement, gender, and grade variables?
- Is there a relationship between the psychological resilience, mathematics course achievement and academic grit levels of secondary school students?

Method

Research Model

In this study, descriptive survey model, one of the quantitative research methods, was used. Descriptive survey is a type of research that is carried out in the form of describing the situation of the living, existing ones, and experiences. Descriptive surveys are studies conducted on large groups, in which the opinions, competences and attitudes of individuals in the group about a phenomenon and event are taken, and the phenomena and events are tried to be described (Karakaya, 2012).

Participants

The research group is the 7th and 8th grades of secondary schools in Görükle district of Bursa province in the spring term of the 2022-2023 academic year. It consists of a total of 204 students, who are studying in their classes and who voluntarily participated in the research. In this context, the purposeful sampling method, which is one of the non-random sampling methods, was used in the research. Purposeful sampling method is a sampling method that enables the selection of rich situations related to the subject and collecting in-depth information in accordance with the purpose of the research (Fraenkel, Wallen & Hyun, 2012). In Table 1, descriptive data of the students are given.

Table 1. Demographic Information of Students

Variables	Groups	n	%
Gender	Female	112	54,9
	Male	92	45,1
Grade Level	7th grades	50	24,5
	8th grades	154	75,5
Mathematics Achievement Grade	Grade between 0-50	40	19,6
	Grade between 51-75	62	30,4
	Grade between 76-100	102	50,0
Total		204	100

According to Table 1, 112(54.9%) of the students participating in the research were female and 92 (45.1%) were male. When the distribution by grades is examined, it is seen that 50 (24.5%) students from 7th grades and 154 (75.5%) students from 8th grades participated in the research. For mathematics course achievement, 40(19.6%) of the students are academically achievement between 0-50, 62 (30.4%) between 51-75, 102 (50.0%) between 76-100.

Data Collection Tools

Two different measurement tools were used to collect data in the study. These measurement tools are short psychological resilience scale and academic grit scale, respectively. In addition, information about the sub-objectives of the research was obtained with a personal information form. In this study, the academic achievement of the students was determined based on the achievement of the mathematics course at the end of the semester.

Brief Psychological Resilience Scale (BRS)

In the study, the Brief Psychological Resilience Scale (BRS), developed by Smith, Dalen, Wiggins, Tooley, Christopher and Jennifer Bernard (2008) and adapted by Doğan (2015), was used to measure the resilience levels of students. The scale consists of one dimension and 6 items. Items 2, 4, and 6 on the scale are coded in reverse. The internal consistency coefficient for BRS was reported as 0.83. The expressions in the scale were used as "1= Not appropriate at all" and "5= Completely appropriate" and a 5-point Likert type scale.

Academic Grit Scale (AGS)

For academic grit, it was developed by Clark and Malecki (2019) and Sağkal and Özdemir (2020) "Academic Grit Scale" adapted into Turkish was used. The scale has a single factor structure and consists of 10 items. The Cronbach's Alpha coefficient for the reliability of the scale was expressed as .92, and the test-retest reliability as .90.

Analysis of Data

The data collected from the participants were analyzed with descriptive and inferential statistical methods. While calculating statistics such as mean and standard deviation as descriptive statistics, descriptive statistical methods were used to calculate skewness and kurtosis values for normality analyses. While analysis of variance (ANOVA) and t-test were used for group comparisons as inferential statistical methods, correlation analysis was used to determine the relationships between variables. All data analyzes were performed using the SPSS 23 statistical software program. As a result of the analysis, the ranges used when interpreting the average score obtained from the scales were determined as 1.00-1.80 "Very low", 1.81-2.60 "Low", 2.61-3.40 "Medium", 3.41-4.20 "High", 4.20-5.00 "Very high".

Results

Descriptive Statistics for the Variables of the Research

In order to determine whether the variables have a normal distribution, skewness and kurtosis values, mean and standard deviation values were calculated.

Table 2. Definitional statistics of scores from scales

Variable	N	Cronbach	Min	Max	X	Ss	Skewness		Kurtosis	
							Value	Std.	Value	Std.
Psychological Resilience	204	,818	1,00	5,00	2,94	,968	-,021	,239	-,495	,474
Academic Grit	204	,866	1,00	5,00	3,40	,648	-,202	,239	,244	,474
Mathematics Achievement Grade	204		32,5	100	71,9	20,0	-,304	,239	-1,264	,474

Table2 when examined, it is seen that the skewness values of the variables are between -0.304 and - 0.021, and the kurtosis values are between -1.264 and 0.244. For the variables to have a normal distribution, the skewness and flatness values must be between +2 and -2 (George & Mallery, 2010). It was observed that the calculated values were included in the specified range, the assumption of normal distribution was met. The Cronbach alpha reliability values of the scales were calculated as 0.818 for the Brief Resilience Scale and 0.866 for the Academic Grit Scale these results show us that the scales used in the research are reliable.

Psychological Resilience

The first research question of the study, " What is the level of psychological resilience of secondary school students?". The findings regarding the sub-problem are given in Tables 3.

Table 3. Means and standard deviations of psychological resilience scale items

Items	\bar{X}	S.D
I can recover quickly after difficult times.	2,97	1,315
I have difficulty coping with stressful events.	2,96	1,392
It doesn't take long for me to recover after stressful situations.	3,08	1,335
When something bad happens, it's hard for me to get over it.	2,97	1,374
I get through tough times with very little hassle.	2,69	1,288
It takes a long time for me to recover from the effects of negativity in my life	3,00	1,323
Total	2,94	0,968

When Table 2 is examined, it is seen that the psychological resilience levels of secondary school students are at a moderate level ($\bar{x}=2.94$). When the environments are examined, the highest mean ($\bar{x}=3.08$) is "It doesn't take long for me to recover after stressful situations." and the lowest mean ($\bar{x}=2.69$) is "I get through tough times with very little hassle." was found to be.

Academic Grit

The second research question of the study, " What is the academic grit of secondary school students?". The findings due to the sub-problem are given in Tables 4.

Table 4. Means and Standard Deviations of Academic Grit Scale Items

Items	\bar{X}	S.D
I push myself at school to do my best.	3,47	,852
I will continue to work towards achieving my academic goals no matter how long it takes	3,42	,894
I try as hard as I can with my studies, even when I can do something more fun.	2,77	1,057
I complete my homework no matter how hard it is.	3,86	1,005
I try to do my best for my lessons.	3,81	,805
When I set a school-related goal, I try to overcome the difficulties that will arise.	3,56	,906
I can find a balance between making time for my hobbies and interests and studying hard.	2,93	1,171
Even if I have difficulties in school, I will continue to do my best.	3,44	1,000
I always try to do my best when it comes to finishing school work.	3,53	,908
I work hard at school to achieve difficult goals.	3,20	,968
Total	3,40	,648

When Table4 is examined, it is seen that the academic perseverance levels of secondary school students are at a high level ($\bar{x}=3,40$). When the environments are examined, the highest average ($\bar{x}=3.86$) is "I complete my homework no

matter how hard it is.” and the lowest mean ($\bar{x} = 2.77$) is “I try as hard as I can with my studies, even when I can do something more fun.” was found to be.

Differentiation of Psychological Resilience and Academic Grit

The third research question of the study, " Do the psychological resilience and academic grit levels of secondary school students differ according to the mathematics course achievement, gender and grade variables?". The findings regarding the sub-problem are given in Tables 5, Table 6 and Table 7.

Table 5. Independent sample t-test analysis of secondary school students' superior psychological resilience and academic grit scores in relation to gender variable

		\bar{X}	S.D	t	p
Academic grit	Female	3,39	,652	-0,81	0,936
	Male	3,40	,649		
Psychological Resilience	Female	2,75	,944	-2,234	0,028*
	Male	3,18	,955		

*p<0,05

When Table 5 is examined, it is seen that the academic grit scores of secondary school students do not differ statistically significantly according to the gender variable ($p=0,936>0,05$). In the analysis of psychological resilience levels according to gender variable, it was determined that there was a statistically significant difference in favor of male students($p=0,936>0,05$).

Table 6. Independent sample t-test analysis of secondary school students' superior psychological resilience and academic grit scores in relation to grade level variable

		\bar{X}	S.D	t	p
Academic grit	7th grade	3,37	,662	0,238	0,810
	8th grade	3,41	,647		
Psychological Resilience	7th grade	2,92	,936	-0,648	0,458
	8th grade	3,02	1,077		

*p<0,05

When the total mean scores were examined, it was seen that there was no statistically significant difference between the academic perseverance and psychological resilience levels of secondary school students and the grade level variable. ($ag-p=0,810>0,05$ / $pr-p=0,458>0,05$). When the averages are examined in detail, it is seen that as the grade level increases, academic grit and psychological resilience levels increase.

Table 7. Analysis of variance of secondary school students' superior psychological resilience and academic grit scores according to mathematics course achievement variable

		\bar{X}	S.D	F	p
Academic grit	Grade between 0-50	3,26	,557	0,868	0,423
	Grade between 51-75	3,37	,732		
	Grade between 76-100	3,47	,627		
Psychological Resilience	Grade between 0-50	2,68	1,083	2,198	0,116
	Grade between 51-75	2,87	1,053		
	Grade between 76-100	3,13	,829		

*p<0,05

When the results in Table 6 are examined, it is seen that there is no statistically significant difference between the academic perseverance and psychological resilience levels of secondary school students and the mathematics course achievement variable ($ag-p=0,810>0,05$ / $pr-p=0,458>0,05$). When the averages are examined in detail, it is seen that as mathematics course achievement increases, academic grit and psychological resilience levels also increase.

Relationship between the Psychological Resilience, Mathematics Course Achievement and Academic Grit

The fourth research question of the study, " Is there a relationship between the psychological resilience, mathematics

course achievement and academic grit levels of secondary school students?". The findings regarding the sub-problem are given in Tables 7.

Table 7. Correlation results of secondary school students between academic grit, mathematics course achievement and psychological resilience

		Academic grit	Psychological resilience	Mathematics course achievement
Academic grit	r	1	0,308**	0,289**
	p	-	0,002	0,012
Psychological resilience	r	0,308**	1	0,394**
	p	0,002	-	0,000
Mathematics course achievement	r	0,289**	0,394**	1
	p	0,012	0,000	-

** $p < 0,01$

According to the results in Table 7, there is a positive and moderate relationship between secondary school students' achievement in mathematics course and their levels of psychological resilience and academic grit ($r = 0.394^{**}$, $r = 0.289^{**}$). In addition, statistically significant relationship was seen between students' psychological resilience and academic grit at a positive moderate level ($r = 0.308^{**}$). In other words, as the self-efficacy scores increase, their academic grit also increase positively.

Conclusion and Discussion

In this study, the effects of secondary school students' levels of psychological resilience and academic grit on their mathematics achievement were examined. According to the results obtained, it was seen that the psychological resilience levels of the students were moderate and their academic grit levels were high. When the field is examined, it has been concluded that the psychological resilience levels are at a moderate level (Dikici, 2023; Erkoç & Daniş, 2020; Hoşoğlu et al., 2018; Aslan, 2018; Çolak Sarı, 2018) in studies conducted at different levels and occupational groups. These results support the findings of our study. Studies with high (good) level of psychological resilience were also found (Ulukan, 2020; Güngörmüş et al., 2015; Yılmaz et al., 2008). A limited number of studies have been found in the literature on the emergence of academic grit levels. Soysal Işıkçı and Çoklar (2022), in their research examining the academic levels of high school students, reported a high level in parallel with the findings of our study.

As a result of the research, it was determined that the psychological resilience levels of secondary school students showed a statistically significant difference according to the gender variable, and the psychological resilience of male students was higher. It has been seen in the literature that there are studies supporting these research results (Bahadır, 2009; Sezgin, 2016; Hoşoğlu et al., 2018; Açıkgöz, 2016; Ernas, 2017; Güngörmüş et al., 2015; Önder & Gülay, 2008; Oktan, 2008; Cole et al., 2004). There are also studies in the literature in which the level of resilience does not differ according to gender (Aydın & Egemberdiyeva, 2018; Özer, 2013; Topçu, 2017; Varıcıer, 2019; Ulukan, 2020). In the findings of our study, it was determined that the academic levels of secondary school students did not show a statistically significant difference according to the gender variable. These results showed similarities with some studies in the literature (Gamel, 2014, Wallace, 2015; Ekinçi & Hamarta, 2020; Kwon, 2018). It is seen in the literature that there are studies in which the level of academic grit differs according to gender (Soysal Işıkçı & Çoklar, 2022; Farroll, 2016; Clark & Malecki, 2019; Christensen & Knezek, 2014; Eskreis-Winkler et al., 2014; Oriol et al., 2017; Sağkal et al., 2020).

It was observed that the levels of psychological resilience and academic grit did not differ according to grade levels.

In the study of Seçim (2020) and Gündaş (2015), a result in parallel with our study finding was found in terms of resilience levels according to grade levels. In Turgut's (2015) study, it was observed that levels of resilience differed significantly according to grade levels. Contrary to our study, it has been observed in the literature that the academic grit levels of the students differ significantly according to their grade levels (Işıkcı & Çoklar, 2022; Sağkal et al., 2020).

Although there was no statistically significant difference in the evaluations made in the context of mathematics course success, it was observed that the success of the course increased as the levels of psychological resilience and academic grit increased. When the literature was examined, it was found that the variable of perseverance was positively related to variables such as academic performance and academic success (Credé, Tynan & Harms, 2017; Çelik & Sarıçam, 2018; Hwang, Lim & Ha, 2018). A small number of studies on the concept of academic perseverance on adolescents have also concluded that academic grit significantly affects success (Clark & Malecki, 2019; Işıkcı & Çoklar, 2022).

In this study, it was determined that there was a positive, moderate relationship between mathematics course success, psychological resilience and academic grit levels. These results showed that resilience and academic grit positively affect academic achievement in mathematics. Studies examining the relationship between resilience and success in mathematics, either directly or indirectly, found similar results (Reis et al., 2004; Oktan, 2008; Allan, 2014; Ayyash-Abdo et al., 2016; Durmuş, 2016; Kaya et al., 2016; Bacchi & Licinio, 2017; Allan et al., 2014; Borman & Overman, 2004; Novotny & Kremenkova, 2016; Sakız & Aftab, 2019; Ateş & Sağar, 2022; Demir, 2023). In addition, Demir (2023) examined the psychological resilience of secondary school students and their academic resilience towards mathematics and concluded that psychological resilience positively and significantly affects students' academic resilience in mathematics. Contrary to these results, Yalçın (2020) reported that there is no significant relationship between psychological resilience and science and mathematics achievement grades in his study.

As a result, studies show that academic perseverance and resilience positively affect academic achievement. Students with high levels of psychological resilience and academic grit may exhibit better academic performance. For this reason, it is important for teachers and school administrators to use various strategies to support students' academic perseverance and psychological resilience. At the secondary school level, the psychological resilience and academic grit of the child can affect both academic and social success in the school environment. Due to its importance in determining mathematics achievement, it is necessary to identify students who are at risk of failure in the second level of primary education, and to carry out developmental and preventive studies for teachers. Educators can evaluate students' psychological resilience and academic grit levels by conducting one-on-one interviews with students and using scientific approaches. They can develop educational programs and strategies to increase students' resilience and academic grit. These approaches can be seen as an important turning point in increasing the academic success of students.

In addition to quantitative studies on different psychological factors in addition to the psychological resilience and academic perseverance variables of secondary school students, qualitative studies can also be conducted.

Limitations of Study

The research was carried out with a limited sample of 204 students studying in the 7th and 8th grades of secondary schools in the district of Görükle in Bursa. Repeating this study with more participants and examining different variables will increase generalizability. The study was carried out using purely quantitative data.

Acknowledgment

This research was found ethically appropriate with the decision of Kocaeli University Social and Human Sciences Scientific Research Ethics Committee, dated 03/04/2023 and numbered 2023/58.

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