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Predictors of Mathematics Achievement in Pandemic: Academic Grit and Technology Attitude[1]

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Abstract

The purpose of this study is to determine the predictors of mathematics achievement of fourth grade students' during pandemic by considering academic grit and technology attitude variables. The participants of the study consisted of 246 fourth-grade students studying in public primary schools in Gaziantep province center, Oğuzeli and Şahinbey districts. "Academic Grit Scale", "Attitude Towards Technology Scale" and "Mathematics Achievement Test" were the tools used to collect data. The results indicated that gender was not the primary factor on mathematics achievement, academic grit and attitude towards technology scores. The academic grit and attitude towards technology are found to be the significant predictors of mathematics achievement and academic grit affects mathematics achievement positively whereas technology attitude affects negatively. In the light of the findings obtained in this study, it could be better to develop activities that support and increase students' academic grit and to focus on teacher and learner characteristics who integrate technology in their teaching and learning environment, respectively.

Keywords: *Academic Grit, Mathematics Achievement, Pandemic, Primary School, Attitude Towards Technology.*

Öz

Bu çalışmanın amacı, akademik azim ve teknolojiye yönelik tutum değişkenlerini göz önünde bulundurarak dördüncü sınıf öğrencilerinin pandemi döneminde matematik başarısını yordayan değişkenleri belirlemektir. Çalışmanın katılımcıları, Gaziantep ili merkez Oğuzeli ve Şahinbey ilçelerinde devlet ilköğretim okulunlarında öğrenim gören 246 dördüncü sınıf öğrencisinden oluşmaktadır. Veri toplama aracı olarak "Akademik Azim Ölçeği", "Teknolojiye Yönelik Tutum Ölçeği" ve "Matematik Başarı Testi" kullanılmıştır. Çalışmadan elde edilen bulgular, cinsiyetin matematik başarısı, akademik azim ve teknolojiye karşı tutum puanları üzerinde belirleyici bir rol oynamadığını göstermektedir. Mevcut pandemi döneminde yürütülen bu çalışmada, akademik azim ve teknolojiye yönelik tutumun matematik başarısının önemli yordayıcıları olduğu ve akademik azimin matematik başarısını olumlu, teknolojiye yönelik tutumun ise matematik başarısını olumsuz etkilediği belirlenmiştir. Çalışmadan elde edilen bulgular sonucunda, öğrencilerin akademik azimlerini destekleyen etkinliklerin geliştirilmesi ve sırasıyla teknolojiyi öğretme ve öğrenme ortamlarına entegre eden öğretmen ve öğrenen özelliklerine odaklanılması önerilmektedir.

Anahtar Kelimeler: *Akademik Azim, Matematik Başarısı, Pandemi, İlkokul, Teknolojiye Yönelik Tutum.*

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Introduction

The COVID-19 pandemic has changed our perspective on education and moreover, the way we interpret education, forcing all levels of educational institutions to work remotely and to implement emergency distance education (Al Lily et al., 2020; Bozkurt & Sharma, 2020; Gedik & Erol, 2022). The pandemic has turned students' lives upside down in different ways depending not only on their level and course, but also on the point they have reached in their programs, and is the biggest challenge faced by national education systems, which have made great progress in all respects in the last five decades (Daniel, 2020). It has been accepted that the way to maintain social distance is the distance education application, especially in all countries where the spread of the virus is intense, and it has become the most preferred channel by administrators and experts in education (Telli & Altun, 2020). Although many of the countries lack the necessary infrastructure opportunities, they quickly adapted to the distance education process and tried to minimize the effects of the epidemic on education.

In distance education, the learner and the teacher are in physically separate environments. It is an interdisciplinary field that tries to eliminate the limitations between learning, teaching and learning resources, where students can participate either online or offline, offers the individual the opportunity to learn by themselves, uses existing technologies with a pragmatist approach without disturbing the integrity of education and according to the current historical period (Ad, 2020; Ağır, 2007; Akdemir, 2011; Bozkurt, 2017; Dinçer, 2006). First of all, distance education is a comprehensive learning process carried out in a planned manner and supported by new communication technologies (Kırık, 2014) and distance education provides opportunities to every learner (İşman, 2022). Although it is stated in the distance education literature that distance education is a priority opportunity for individuals who have difficulty in accessing educational opportunities in traditional education environments (Çoban, 2013), it seems that distance education did not find such an application area until the COVID-19

uncertainty (Fidan, 2020). During pandemic, there are also some research works focusing on the evaluation of distance education (e.g. Gökçe, Önal & Çalışkan, 2021; Krstic & Radulović, 2021). Moreover, the number of students experiencing distance education constitutes a great portion of all students (Allen & Seaman, 2016). In many parts of the world, the distance education applications, especially at primary school level, are almost non-existent until the COVID-19 pandemic. However, primary school is of great importance as it covers the childhood period of the individual (Türk, 1999). The experience and knowledge that the child gains in this period is very important in terms of their competence in education life (Kılıç & Gedik, 2020). In addition, the quality and efficiency of primary school education is very important in terms of forming the profile of citizens in a country (Küçüktepe, 2010). The primary schools' goal is to provide individuals with literacy and basic mathematics competencies and an understanding that they can make their own decisions throughout their lives. Considering this aspect, the foundation of mathematical skills that children will constantly need in their future lives is laid in primary school.

In today's world, people constantly encounter mathematical situations and have to make mathematical decisions in almost every field throughout their lives. Developing mathematical skills will help a person to solve many problems in daily life in a more systematic way (Yenilmez & Duman, 2008). Mathematics is a subject that should be emphasized from primary school age in order to enable a student to think logically, critically, systematically and creatively (Mutmainah & Indriayu, 2019).

In recent years, there have been significant changes in thought about what mathematics is and how it should be taught (Olkun & Uçar, 2018). Effective teachers maximize the potential of technology to improve their students' understanding, engage, and increase their proficiency in mathematics (Van De Walle, Karp & Bay-Williams, 2016). Technology is perceived as products containing high quality scientific knowledge and technical features (Gedik, 2021). Although we encounter it in this way in daily life, technology is a field that includes all social and

economic activities and organizations that envisage the realization of technical knowledge. When viewed with an optimistic definition, technology is the application of scientific principles and innovations to solve problems (Kol, 2012).

Nowadays, using technology has become a necessity rather than a privilege (Yılmaz, Ulucan & Pehlivan, 2010). Technological developments and information society's ways of reaching information are different (Alkan, 2005). Therefore, technology and especially information and communication technologies (ICT) are widely used in educational environments as in many fields and affect educational environments significantly (Gedik, Sönmez & Yeşiltaş, 2019; Kol, 2012; Örün et al., 2015). With technology integration in education, children can have the ability to slow down and revert to lessons and concepts (Arslan & Bilgin, 2020).

According to Papert (1980), the use of computers to investigate, discover and find mathematical concepts and relationships changed traditional mathematics teaching and learning environments. Tomorrow's classrooms would be different. The teachers would not be teaching like today and also students would not be learning like today (Baki, 2002). Based on the recent mathematics education philosophy, students should reach the information themselves (Altundal, 2013) and educational institutions should focus on gaining the practical skills that would enable them to produce solutions to mathematical problems (Stacey, 2006). It can be said that academic success is directly or indirectly related to many factors (Kenar & Balcı, 2013) and there are many factors that may have an impact on students' mathematics achievement (Üredi & Üredi, 2005). Therefore, many features such as students' interests, learning styles, self-concepts, experiences and mathematical abilities are very effective in the teaching of this course (Açıkgöz, 1996). At this point, it is thought that the academic grit of the students who are faced with distance education during the pandemic process is important because they carry out educational activities at home without the support of teachers.

Children with a high level of tolerance as a personal characteristic, optimistic, open to sociability, willpower, cheerful, determined, and not giving up easily are more successful in the later stages of their lives (Tough, 2012). Children who are the same in ability and capacity may differ in grit. For this reason, it is stated that children should struggle against difficulties without giving up (Duckworth et al., 2007).

The concept of academic grit is defined as a feature or skill that includes being focused, resilient and determined in reaching the long-term challenging goals that individuals set in their education life in line with their own wishes (Clark, 2017). Grit is a character trait that ensures people's commitment to their goals and desires, works towards these goals and contributes to them (Bashant, 2014). Also, grit is the inexhaustible interest in facing the challenges that come our way and even if there are unsuccessful results despite our efforts (Pappano, 2013). Grit will enable individuals to move forward without giving up despite the difficulties they face (Ergüner Tekinalp & Işık, 2021). Academic grit is the power of endurance and patience that makes people achieve success by overcoming obstacles in all conditions and places (Rojas et al., 2012). Family environment, school, classroom climate and social activities are very important in the beginning of academic determination (Gorman, 2015).

One of the main factors in shaping the success of students in a certain field or the design of a curriculum is the "attitude" towards related learning products (Yurdugül & Aşkar, 2008). Students were left alone at home without teacher support and peer interaction during the pandemic process. In such a case, the main motivation of this research is to determine whether the individual academic determination of the students or their attitude towards technology that they are frequently exposed to during the distance education process have an impact on their academic success.

In this study, the relationships among mathematics achievement, academic grit and attitude towards technology of fourth grade students during the pandemic was investigated.

Within the scope of the research, answers to the following questions were sought.

RQ1. What is the level of students' mathematics achievement, academic grits and technology attitudes?

RQ2. Do students' mathematics achievements, academic grits and technology attitudes differ according to gender?

RQ3. What is the relationship among mathematics achievement, academic grit and technology attitude variables?

RQ4. Do academic grit and technology attitudes predict mathematics achievement?

Method

This section covers information regarding the research design, participants, data collection tools and data analysis.

Research Design: This quantitative study was designed to determine the predictors of fourth grade students' mathematics achievement with academic grit and technology attitude variables in pandemic. Therefore, the correlational survey model was used in this study since we examined the relationships among variables and investigated whether there was a difference between the groups in which two or more variables exist and depending on the independent variable, in terms of dependent variable (Cemaloğlu & Erdemoğlu Şahin, 2007; Creswell, 2017; Karasar, 2013).

Participants: The participants consists of 246 fourth grade students studying in public primary schools in Gaziantep, Turkey in the 2020-2021 academic year. Moreover, 55.3% of the students are female (136 pupils) and 44.7% are male (110 pupils).

Data Collection Tools: "Academic Grit Scale", "Attitude Towards Technology Scale" and "Mathematics Achievement Test" were the tools that were used to collect the data.

Mathematics Achievement Test: It is a test consisting of 22 multiple-choice items, developed by Balcı (2019) by making validity and reliability analyzes to determine the mathematics achievement of fourth grade students. Balcı determined the KR-20 reliability coefficient of the achievement test as .84. Based on this value, it can be said that the test reliability is at a good level.

Academic Grit Scale: The scale developed by Rojas et al. (2012) in order to determine the academic grit levels of primary and secondary school students was adapted into Turkish by Bozgun and Başgül (2018). The scale is in 5-point Likert type and consists of 10 items within one dimension. The Cronbach alpha internal consistency coefficient calculated for the original version of the scale was .85, and Turkish adapted version of the scale. was 84. In this study, the Cronbach's Alpha reliability coefficient for the academic grit scale was calculated as .85. Based on this value, it can be said that the reliability of the scale is at a good level.

Technology Attitude Scale: This scale was developed by Edge and Balcı (2013) and measured the attitude towards technology. It is a 5-point Likert type and consists of 20 items. The Cronbach alpha coefficient was found to be .80 which was at a good level.

Data Analysis

SPSS statistical package program was used in the analysis. In this direction, descriptive statistics were used to reveal the current situation in the mathematics achievement, academic grit and attitudes towards technology. Normality assumptions were tested to compare students' mathematics achievement, academic grit and attitudes towards technology according to the gender variable by parametric tests. In the comparisons, independent sample t-test was used for comparing gender differences. Pearson moments product correlation coefficient was calculated to determine the relationships between mathematics achievement, academic grit and attitudes towards technology. Finally, linear regression analysis was used to predict mathematics achievement with academic grit and attitudes towards technology.

Results

The findings are discussed in the context of research questions. To begin with, the descriptive statistics for mathematics achievement, academic grit and technology attitude variables are found as in Table 1.

Table 1. Descriptive statistics for mathematics achievement, academic grit and attitudes towards technology variables

Varibles	Mean	Std. Dev.	Min-Max
Mathematics achievement	10.50	3.67	0-22
Academic grit	40.31	7.31	5-50
Attitudes towards technology	46.43	7.48	5-100

Table 1 presents descriptive statistics for mathematics achievement, academic grit and attitudes towards technology. Firstly, the mean raw score of mathematics achievement test was obtined as10.50 (out of 22) and the standard deviation was 3.67. Secondly, the mean academic grit scale score was calculated as 40.31 (out of 50) and standard deviation was 7.31. Thirdly, mean score for attitude towards technology scale was found to be 46.43 (out of 100) and standard deviation was 7.48. Based on these values, it can be said that the participants' mathematics achievement levels are below medium, their academic grits are high and their technology attitudes are moderate.

In the second research question, mathematics achievement test, academic grit scale and technology attitude scale scores were compared according to gender with independent t-test. The results are figured out in Table 2.

Table 2. Gender comparison of mathematics achievement test, academic grit scale and attitudes towards technology scale scores

Variables	Gender	f	Mean	Std. Dev.	T	p
Mathematics achievement	Female	136	10.33	3.66	-.78	.43
	Male	110	10.70	3.68		
Academic grit	Female	136	40.69	7.30	.89	.37
	Male	110	39.85	7.32		
Attitude towards technology	Female	136	46.40	6.97	-.05	.95
	Male	110	46.46	7.99		

In this analysis, independent samples t-test was conducted to investigate whether male and female students' mathematics achievement test, academic grit and attitudes towards technology scores differ sigificantly. Accordingly, it was determined that there was no significant gender difference in either mathematics achievement, academic grit and attitudes towards technology scores (p>.05).

The third research question investigates the relationships among mathematics achievement, academic grit and attitude towards technology variables. Results of Pearson Product Moments correlation coefficients are given in Table 3.

Table 3. Pearson Product Moments correlation coefficients between mathematics achievement, academic grit and attitudes towards technology

	Academic grit	Attitude towards technology
Mathematics achievement	.306**	-.158**

$**p < .01$

Due to the Pearson Moments Product correlation coefficients given in Table 3, there is a positive (.306) and significant relationship between students' mathematics achievement test scores and academic grit scale scores. However, there is a negative (-.158) and significant relationship between mathematics achievement test scores and attitudes towards technology scale scores (p<.01). Based on this finding, it can be said that as students' academic grit scale scores increase, their mathematics achievement test scores also increase. On the other hand, as primary school students' attitudes towards technology increase, their mathematics achievement decreases.

The fourth research question focuses on the variables (i.e. academic grit and attitude toward technology) predicting mathematics achievement. Linear regression analysis are conducted and the results are given in Table 4.

Table 4. Linear regression analysis results conducted to predict mathematics achievement

Dependent variable	Independent variable	Unstandardized β	Standardized Std. Error	β	t	p
Mathematics achievement	Constant	7.860	1.862		4.221	.000
	Academic grit	.156	.031	.309	5.120	.000
	Attitude towards technology	-.079	.030	-.160	-2.650	.009

$R=.347$ $R^2=.113$ $F_{(2.242)}=16.534$ p=.000 Durbin Watson=1.736

According to Table 4, the regression model is determined as "mathematics achievement = 7.860

+ 0.156*(academic grit) – 0.079*(attitude towards technology)". When all other values of the remaining variables are kept as constant, 1 point increase on the academic grit scale score ends up with .156 point increase on mathematics achievement test score. Conversely, when all other values of the remaining variables are kept as constant, 1 point increase on the attitude toward technology scale score turns out to be .079 point decrease on mathematics achievement test scores. When the model explanatory coefficient is examined, it is seen that 11% of the mathematics achievement score is explained by academic grit and attitude towards technology variables. According to the results of linear regression analysis, it can be said that academic grit has a more significant effect on mathematics achievement than attitude towards technology. In addition, the Durbin-Watson value calculated for the model is 1.736, which indicates that there is no autocorrelation problem in the model.

Discussion, Conclusion and Recommendation

The purpose of this study is to determine the predictors of mathematics achievement of fourth grade students' during pandemic by considering academic grit and technology attitude variables. According to the results, it was determined that the mathematics achievement levels of the students were below medium. This result is inline with the results of the study conducted by Tümer & Güler (2017). According to these researchers, although Turkey showed slight increases in Trends in International Mathematics and Science Study (TIMSS) assessments, it remained below the international average in each exam. In addition, there are different research results in the related literature that support this finding (Aktan, 2012; Peker & Mirasyedioğlu; Yılmaz, 2021; Yücel & Koç, 2011). It was determined that the academic grit of the fourth grade students was high and their attitude towards technology were moderate. Research results on academic grit and attitude towards technology (Çetin, Çalışkan, & Menzi, 2012; Dargut & Çelik, 2014; Erten, 2019; Şahin & Arslan Namlı, 2019) also support this finding.

It was determined that there was no significant difference in the mathematics achievement, academic grit and attitudes towards technology of fourth grade students according to gender comparison. Studies showing that gender is not a factor on students' mathematics achievement (Akhan & Bindak, 2017; Bozkurt, 2012; Herbert & Stipek, 2005; Hyde, Fennema & Lamon, 1990; Leahey & Guo, 2001; McGraw, Lubienski & Struchens, 2006; Sarı & Ekici, 2018; Tanrıverdi, 2021; Yılmaz, 2021; Yücel & Koç, 2011) also support this finding. In addition, Yenilmez and Duman (2008) stated that according to student opinions, and Dursun & Dede (2004) according to teachers' opinions, gender is not a significant factor in students' mathematics achievement. In addition, research results on academic grit (Ekinci & Hamarta, 2020) and attitude towards technology (Bakioğlu, et al., 2015; Karasakaloğlu, Saracaloğlu & Uça, 2012) support this finding by revealing that gender is not a factor on these variables. However, it is possible to come across research results in the related literature that academic grit (Bozgün, 2021) and attitude towards technology (Dargut & Çelik, 2014; Şahin & Arslan Namlı, 2019) differ according to gender.

It has been determined that there is a positive relationship between mathematics achievement and academic grit of fourth grade students, and a negative significant relationship between their mathematics achievement and their attitudes towards technology. Based on this finding, it can be said that as students' academic grit increases as their mathematics achievement increases, and as their attitude towards technology increases, their mathematics achievement decreases. In addition, it was determined that students' academic grit and attitude towards technology were significant predictors of their mathematics achievement, and that 11% of mathematics achievement was explained by these two variables, and the model obtained was significant. While students' academic grit affects their mathematics achievement positively, their technology attitudes negatively affect their mathematics achievement. Finally, it was concluded that academic grit has a more significant effect on mathematics achievement than technology attitude. Research

results on the positive effect of academic grit on achievement (Bowman, et al., 2015; Duckworth, et al., 2007; Robertson-Kraft & Duckworth 2014; Yoncalık, 2018;) support this finding. According to Datu, Valdez and King (2016), the positive effect of grit on academic engagement means that students who are determined and passionate about achieving long-term goals tend to feel good about participating actively in classroom activities and taking part in academic studies. The use of technology increases scientific skills, helps to learn the subjects, likes it to be used in lessons, and wants it to be used more often in lessons. From this, it can be concluded that as the attitude towards technology is positive, the level of using technology also increases (Arslan & Bilgin, 2020). However, it is an important situation that should not be overlooked that students with a high technology attitude can use technology for different purposes. Especially during the pandemic process, students have been very much intertwined with technology and may have chosen to use technological opportunities for different purposes in many cases where they need to focus on their lessons. Such a situation may have resulted in students moving away from their courses and academic studies and negatively affecting their academic achievement.

In the light of the findings obtained in this study, it could be better to develop activities that support and increase students' academic grit and to focus on teacher and learner characteristics who integrate technology in their teaching and learning environment, respectively.

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