

Relationship between students' tendencies toward academic risk-taking and their attitudes to science

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The purpose of this study was to examine the relationship between fifth to eighth grade students' tendencies toward academic risk-taking and their attitudes to science. A total of 680 students participated in this study which used a relational survey model. The "Science Attitude Scale" and "Academic Risk-taking Scale" scales were used to collect data. Simple linear regression, stepwise multiple regression, t tests, and ANOVA statistics were used to analyse the data. It was concluded that there is a statistically significant positive correlation at a moderate level between students' tendency to take academic risks and their attitudes to science. For the academic risk sub-factors, there was a low positive correlation between the tendency to have negative feelings after failure and attitudes to science. Similarly, there was a low positive correlation between the tendency not to do any homework and attitudes to science. There is a statistically significant difference between students' attitudes to science and their tendency to take academic risks based on gender (female), grade level (low) and academic success (high). In addition, the students' tendency to take academic risks significantly predicted attitudes to science. Whether students' tendencies to take academic risks predicts their creativity, and their critical, analytical and innovative thinking skills can be examined using these results.

Introduction

Recently, the concept of entrepreneurship has gained importance and is notable in national and international school science curricula (Ministry of Education, 2013; 2017; European Commission, 2015). When looking at entrepreneurship as a competence, entrepreneurship is defined as the capacity to act upon opportunities and ideas in order to create value in society (McCallum, Weicht, McMullan & Price, 2018). Entrepreneurship, in addition, is expressed as a personal skill that allows putting ideas into practice (European Commission, 2011). The concept of entrepreneurship is now one of the life skills in the 2013 and 2017 science curriculum in Turkey, which includes 'risk-taking' as one of the most important characteristics of entrepreneurship (Antoncic, 2003).

Risk is the likelihood of losing, and reflects on how people behave in the context of losing and uncertainty (Assailly, 2013). According to Young (1991), risk-taking is the desire to get into the unknown. Risk attitude reflects the tendency of a person to take or avoid risk in a decision-making process (Pannell et al., 2006). Risk-taking behaviours include intellectual risk-taking or academic risk-taking, which refer to the decisions related to these options and the possibility of failure (Badger, 2009). The concept of 'academic risk-taking' has been used to provide conceptual consistency in this research. Academic risk-taking is an instructional decision that involves uncertainty when providing instructions and supporting the learning of students (Grisham, Berg, Jacobs & Mathison, 2002). This kind of risk-taking in teaching often forces students to follow rules beyond what is comfortable or routine for them (Grisham, Berg, Jacobs & Mathison, 2002). Academic risk-taking is

important in education because it affects the learning process and outputs (Tan, Lim & Manalo, 2017). Streitmatter (1997) reported that taking academic risks helps shape the academic identity of students and encourages academic success. Besides, Sünkür, İlhan, Kinay and Kiliç (2013) have found a positive relationship between positive perfectionism and academic risk-taking. So it can be said that the tendency to take academic risk in the learning environment has a very important role to play.

It is possible to encounter too much risk-taking in everyday life, but risks are part of life. Sometimes they entertain us and sometimes they make us uncomfortable (Sharma, 2015). The nature of learning requires us to take risks such as when solving problems, developing a new product, and discovering new concepts (Osman, Hamid & Hassan, 2009). A risk-taking tendency helps students to overcome the mental difficulties they experience during a problem-solving process (Gupta, Kavita & Pasrija, 2016). Turkey's 2017 science curriculum uses an inquiry-based teaching approach, and the "taking initiative and entrepreneurial perception" dimension included in the "basic skills" aspect of the 2017 science curriculum emphasises the risk-taking characteristics of the students (Ministry of Education, 2017). The science curriculum offers students significant opportunities to improve their risk-taking tendencies and there is a strong correlation between individuals' willingness to participate in discussions and risk-taking in science education. There is also a strong correlation between individuals' willingness to solve open-ended problems and risk-taking (Hills, Stroup & Wilensky, 2005). In addition, there is a positive relationship between students' risk-taking tendencies and their interest in science courses (Beghetto, 2009). In the learning environment, risk-taking requires deep thinking about a subject or problem, considering different points of view, listening to criticism, and creating solutions by sharing experiences gained and being willing to participate in this (Osman, Hamid & Hassan, 2009), and there are an increasing number of controversial socio-scientific issues that require students to take such risks (Christensen, 2009). For example, nuclear power plants, genetically modified organisms, cloning technology, stem cell therapy, organ transplantation are some of such socio-scientific issues. On the other hand, science experiments involve risk-taking involving trial and error processes, and when considering the possibility of failure (*NEA Arts Magazine*, 2014) and there are many open-ended problems that require risk-taking (Hills, Stroup & Wilensky, 2005). Therefore, risk-taking is important in science education, so it is essential that teachers encourage students to take risks when solving problems (Gupta & Pasrija, 2016).

Literature review

When looked at from a grade level perspective, Young (1991) stated that children take more risks during early childhood. There is a decrease in risk-taking tendencies as the grade level increases (Avcı & Özenir, 2016; Akça, 2017; Daşcı & Yaman, 2014). For example, some studies have found that as students progress in grade level, the tendency to engage in academic risk-taking decreases (Avcı & Özenir, 2016; Akça, 2017; Beghetto, 2009; Daşcı & Yaman, 2014). So it can be said that it is necessary to examine how tendencies to academic risk-taking change during middle school levels (grades 5-8). From an academic success perspective, there may be a significant relationship between academic

risk-taking and problem solving ability (Tay, Özkan & Tay, 2009), and a significant relationship between students' academic risk-taking tendency and metacognitive awareness (Çakır & Yaman, 2015). These results indicated a positive relationship between academic risk-taking and academic achievement level. For example, the tendency of students to take academic risks positively and strongly predicts their success in science (Özbay, 2016). Also found is a moderately positive relationship between the tendency towards academic risk-taking and achievement in science (Çakır & Yaman, 2015), and a meaningful and positive relationship between students' positive perfectionism traits and their tendency towards academic risk-taking (Sünkür, İlhan, Kinay & Kiliç, 2013). Avcı & Özenir (2016) found that as students' mathematics achievement scores increased, their mathematics-oriented academic risk-taking behaviours also increased significantly.

Viewing academic risk-taking from a gender perspective, the relevant literature has little focus on gender differences in risk-taking. For example, some researchers have not found gender differences in the tendency to take academic risks on the part of primary and middle school students (Avcı & Özenir, 2016; Clifford, 1988; Clifford, Lan, Chou & Qi, 1989). Besides, it is possible to see that female students' tendencies to take academic risks are higher than that of male students (Abdullah & Osman, 2010). On the other hand, there are research findings that show that male students are more likely to take academic risks than females (Byrnes, Miller & Schafer, 1999). As some quite different results have been obtained concerning gender, further research is needed to determine the relationship between gender and academic risk-taking.

In addition, there is some experimental research in the literature. For example, Çınar (2007) examined the effects of a problem-based learning approach on academic risk-taking and concluded that this approach positively reflects on the tendency of students towards academic risk-taking, whereas Çelik (2010), stated that a problem-based learning approach is not a significant influence on the tendency of students towards academic risk-taking. Korkmaz (2002) investigated the effect of project-based learning on the tendency of students to take academic risks, and found that it has a positive effect.

Some studies conducted with gifted middle school students have found a significant positive correlation at a high level between gifted students' attitudes to academic risk-taking and their problem solving competence (Tay, Özkan & Tay, 2009). Akdağ and Köksal (2017) found no significant differences between gifted students and their peers in terms of the academic risk-taking tendency. There is a statistically significant and negative relationship between the tendency of gifted students towards academic risk-taking and their achievement in science (Akdağ, Köksal & Ertekin, 2017). The gifted eighth grade students have a statistically lower tendency toward academic risk-taking in science learning than other grades (Akdağ, Köksal & Ertekin, 2017).

Academic risk-taking and attitude to science have been investigated in a small number of studies. One study found that students who have high anxiety levels on science courses have a lower tendency to take academic risks (Akça, 2017), and another found a positive relationship between science ability and the tendency to take academic risks (Beghetto, 2009). When examining the academic risk-taking studies in the related literature, it is

found that a relational survey model has not been conducted to examine the relationship between the tendency of middle school students toward academic risk-taking and their attitudes to science (Akça, 2017; Avcı & Özenir, 2016; Beghetto, 2009; Çınar, 2007; Daşcı & Yaman, 2014; Korkmaz, 2002). The purpose of this study is to examine the relationship between the tendency of the students towards academic risk-taking and their attitudes to science. So, the central problem is what is the relationship between the tendency of middle school students toward academic risk-taking and their attitudes to science? The sub-problems are given below:

- Is there a meaningful relationship between the tendency of middle school students toward academic risk-taking and their attitudes to science?
- Does the tendency of middle school students to academic risk-taking and their attitudes to science show any meaningful differences in terms of gender, grade level and academic achievement level?
- Is the tendency of middle school students toward academic risk-taking a significant predictor of their attitudes to science?

Method

This research used a relational survey model, a quantitative method appropriate for this research. Using this model, we investigated whether or not there is a relationship between the variables in the research and, where there is a relationship, its strength and direction is interpreted using numerical values (Lodico, Spaulding & Voegtler, 2010). This research has not focused on individual perceptions and experiences regarding the attitudes of each participant to academic risk-taking tendencies and attitudes to science. Instead, the researchers focused on the answers that the many participants gave to structured questions related to their academic risk-taking tendency and attitude to science. In this sense, the researchers intended to interpret the relationship between academic risk-taking and attitude to science, making use of the statistical data. Therefore, it was decided that the relational survey model was appropriate for this. Using this model, the relationship between variables such as academic risk-taking, attitudes to science, gender, grade level, and academic achievement level, are examined.

Participants

In the 2016-2017 education year, three schools in the city of Kahramanmaraş in Turkey were selected from 17 middle schools using simple random sampling. Schools where the researchers lived were included, so the researchers could more readily attend to the data collection process. A total of 680 middle school students participated in the research. Table 1 contains demographic information for the participants.

Table 1: Demographics

Academic achievement level		Grade level		Gender	
	n		n		n
0-44	14	5th grade	206	Female	360
45-54	31	6th grade	156	Male	320
55-69	107	7th grade	181	Total	680
70-84	212	8th grade	137		
85-100	316	Total	680		
Total	680				

Data collection tools

Science Attitude Scale

This scale was developed by Çavaş (2004) to determine the attitudes of middle school students towards science. It consists of 40 items in a 1-4 Likert-type response scale, always=4, sometimes=3, very little=2, never=1. Positive and negative items are included in the scale. Scoring high on the scale indicates a positive attitude towards science courses when negative items are reversed. In the original study, the reliability coefficient was found to be .91. The scale items consist of statements aimed at determining students' attitudes towards science. Some of the expressions in the scale tool are 'I like science courses very much'; 'I enjoy studying science lessons in my free time'; 'I enjoy reading books and magazines about science'; 'I feel comfortable on science courses'. The Cronbach reliability coefficient for the current study was calculated as .86.

Academic Risk-taking Scale

This scale was developed by Clifford (1991) to measure students' courage and willingness to cope with learning situations and difficulties and it was adapted into Turkish by Korkmaz (2002). The version developed by Clifford (1991) consists of 36 items scored on a 1–5 Likert-type response scale. The factors contained in the scale are the tendency to have negative feelings after failure, the tendency to prefer hard tasks, the tendency to recover after failure and the tendency to have negative feelings after failure. From the results of the adaptation study carried out by Korkmaz (2002) the four factors that emerged are the tendency to have negative feelings after failure, the tendency to prefer hard tasks, the tendency to recover after failure, and the tendency not to do any homework. The tendency to have negative feelings after failure is assessed by twelve items (2, 4, 7, 9, 12, 13, 16, 18, 20, 24, 31, 34), the tendency to prefer hard tasks by ten items (1, 5, 8, 10, 14, 17, 28, 30, 32, 35), the tendency to recover after failure by eleven items (3, 6, 11, 15, 23, 25, 26, 27, 29, 33, 36), and the tendency not to do any homework by three items (12, 19, 22). In this adaptation study, Korkmaz (2002) calculated the reliability coefficient as .90. Some of the items on the scale are as follows: 'I feel bad when I make a mistake in school'; 'If I cannot succeed in a new job at school, I will give up immediately'; 'If I make a mistake in a topic I try to learn, my courage is broken'; 'I always learn something from mistakes I make in school'. The reliability coefficient for the current study was calculated as .79.

Data analysis

Using regression analysis, the dependent variable is the predicted variable(s), and the independent variable is the predictor(s) variables (Büyüköztürk, 2012). In this study, for regression analysis the predicted variable is the 'attitude towards science', and the predictor variables are academic risk-taking and its sub-dimensions. Some assumptions must be made to perform regression analysis, and firstly, the data is formed on an equal interval scale, using continuous variables and then examined for missing values. It has been indicated that it is appropriate not to include the analysis when the missing values are less than 5% (Çokluk, Şekercioğlu & Büyüköztürk, 2010), so in this study, missing values below 5% and 25 scales were not included. It was determined that the dataset did not show a normal distribution by looking at the values of kurtosis and skewness in the first stage, so it excluded 90 scales of extreme values to approximate normal distribution to the dataset. Thus, it has also been proven that both dependent and independent variables have a normal distribution. In the last case, the values of skewness and skewness on N=680 data were found to be between -1 and +1 (Table 2), and these values were accepted as evidence that the dataset has a normal distribution (Huck, 2012). The Durbin-Watson statistic was used to examine auto-correlation between independent variables, and these values are between 1.569 and 1.590. In this sense, the Durbin-Watson values were acceptable values close to 2 (Field, 2005). Therefore, it was determined that there was no auto-correlation among the independent variables within the scope of this study. After satisfying the assumptions of regression analysis, simple linear regression, stepwise multiple-regression analysis, *t*-test, and ANOVA statistics were used in the analysis processes. Findings from mean, standard deviation and correlation calculations are also included.

Table 2: Values of kurtosis and skewness of variables

	Variables	Skewness	Kurtosis
The dependent variable	Attitude to science	-.518	-.500
General independent variable	Risk-taking	-.003	-.210
Independent variables (sub-factors)	Tendency to have negative feelings after failure	-.127	-.232
	Tendency to prefer hard tasks	.016	-.446
	Tendency to recover after failure	-.514	-.317
	Tendency not to do any homework	.031	.181

Findings

Findings are included in this section and are displayed separately according to sub-problems.

Findings related to the first sub-problem

In this sub-problem, the correlation coefficients between the tendency of the middle school students towards academic risk-taking and their attitudes to science were included.

Descriptive values related to the tendency to academic risk-taking and attitudes to science are given in Table 3.

Table 3: Descriptive statistics of dependent and independent variables

Variables		N	Mean	SD
Attitude to science	Attitude towards science	680	3.18	.0512
Academic risk-taking	Academic risk-taking	680	3.44	.44573
Academic risk-taking (sub-factors)	Tendency to negative feelings after failure	680	2.81	.62404
	Tendency to prefer hard tasks	680	3.61	.64121
	Recovery tendency after failure	680	3.98	.60710
	Tendency not to do any homework	680	3.17	.73235

Examining the descriptive values of the variables in Table 3, the average of the attitude to science using the 4-point Likert-type scales is 3.18, showing in general that students have a positive attitude. Using the 5-point Likert-type academic risk-taking scale, the average was 3.44, indicating that students overall have an tendency towards taking academic risks. The fact that the means of the sub factor items varied from 2.81 to 3.98 shows that there is a tendency to have negative feelings after failure, prefer hard tasks, recover after failure and not to do any homework. The Pearson correlation coefficients between the variables are shown in Table 4.

Table 4: Pearson correlation coefficients between variables

Variables	Attitude towards science	Academic risk-taking	Tendency to negative feelings after failure	Tendency to prefer hard tasks	Recovery tendency after failure	Tendency not to do homework
Attitude towards science	1	.45**	.15**	.39**	.47**	.16**
Academic risk-taking	.45**	1	.61**	.78**	.81**	.48**
Tendency to negative feelings after failure	.15**	.61**	1	.15**	.22**	.27**
Tendency to prefer hard tasks	.39**	.78**	.15**	1	.62**	.30**
Recovery tendency after failure	.47**	.81**	.22**	.62**	1	.28**
Tendency not to do homework	.16**	.48**	.27**	.30**	.28**	1

**p < .01

The Pearson correlation coefficients of the variables in Table 4 show a moderately positive correlation between the tendency towards academic risk-taking and the attitude to science ($r=.45$; $p<.01$). For the sub factors, there is a low positive correlation between the tendency to have negative feelings after failure and attitudes to science ($r=.15$; $p<.01$), and between the tendency not to do any homework and the attitudes to science ($r=.16$;

$p < .01$). There is a moderately positive correlation between the tendency to prefer hard tasks and attitudes to science ($r = .39$; $p < .01$), and between the tendency to recover after failure and attitudes to science ($r = .47$; $p < .01$).

Findings related to the second sub-problem

This section reflects on the findings regarding whether there is a statistically significant difference in terms of gender, grade level and academic achievement level and the tendency of middle school students towards academic risk-taking and attitudes to science. The descriptive values for gender are displayed in Table 5.

Table 5: Descriptive values in terms of gender

Variables	Gender	N	Mean	SD
Academic risk-taking	Female	360	3.5277	.43581
	Male	320	3.3550	.43966
	Total	680		
Attitude to science	Female	360	3.2144	.40198
	Male	320	3.1398	.40563
	Total	680		

The descriptive values in Table 5 show that the mean of the item scores for female students' tendency towards academic risk-taking, as well as their attitude to science, is higher than that for male students. Table 6 gives the results of the *t*-test by gender for students' tendency towards academic risk-taking and attitudes to science.

Table 6: *t*-test results for students' tendency towards academic risk-taking and attitudes to science

Variables	Category	N	Mean	SD	df	<i>t</i>	<i>p</i>
Academic risk-taking	Female	360	3.5277	.43581	678	5.135	.000
	Male	320	3.3550	.43966			
Attitude towards science	Female	360	3.2144	.40198	678	2.405	.016
	Male	320	3.1398	.40563			

According to the *t*-test results in Table 6, there was a statistically significant difference between students' tendency towards academic risk-taking [$t(678) = 5.135$] and attitudes to science [$t(678) = 2.405$]. Female students' tendency towards academic risk-taking (mean = 3.52) and attitudes to science (mean = 3.21) was found to be higher than that of male students.

Table 7 shows the descriptive values of students' tendency towards academic risk-taking and their attitudes to science according to grade levels. The fifth and sixth grade students' item averages were found to be higher than the seventh and eighth grade students, for both the tendency towards academic risk-taking and their attitudes to science.

Table 7: Descriptive values for grade levels

Variables	Category	N	Mean	SD
Academic risk-taking	5th grade	206	3.4916	.41864
	6th grade	156	3.5018	.48270
	7th grade	181	3.4162	.45710
	8th grade	137	3.3554	.41168
	Total	680	3.4464	.44573
Attitude to science	5th grade	206	3.3191	.35074
	6th grade	156	3.2090	.37116
	7th grade	181	3.0591	.44019
	8th grade	137	3.0943	.40427
	Total	680	3.1793	.40512

Table 8 shows the ANOVA test results according to the grade level category of students' tendency towards academic risk-taking and attitudes to science.

Table 8: ANOVA test results for students' tendency towards academic risk-taking and attitudes to science

Variables	Source	Sum of squares	df	Mean square	F	p	Significant differences among grade levels
Academic risk-taking	Between groups	2.199	3	.733	3.734	.011	5>8
	Within groups	132.702	676	.96			6>8
	Total	134.901	679				
Attitude to science	Between groups	7.764	3	2.588	16.875	.000	5>6, 5>7, 5>8
	Within groups	103.676	676	.153			6>7
	Total	111.440	679				

Table 8 shows a statistically significant difference in the students' tendency towards academic risk-taking based on their grade levels [$F(3;676) = 3.73, p < .05$]. The Tukey test was conducted to determine in which grade levels the differences were found and it was discovered that the fifth-grade students' (mean = 3.49, Table 7) and sixth grade students' (mean = 3.50) tendencies towards academic risk-taking was statistically higher than that of the eighth-grade students (mean = 3.35). It was also found that the students' attitudes to science were significantly different according to their grade level [$F(3;676) = 16.87, p < .05$]. According to the results of the Tukey test it was found that the fifth-grade students (mean = 3.31) had more positive attitudes towards science than the sixth-grade students (mean = 3.20), seventh grade (mean = 3.05) and eighth grade students (mean = 3.09). It was also found that sixth grade students (mean = 3.20) had more positive attitudes to science than seventh grade students (mean = 3.05).

Table 9 shows the descriptive values of students' tendency to academic risk-taking and attitudes science according to the academic achievement level. Students who have high levels of academic achievement take more academic risks, and their attitude to science is more positive.

Table 9: Descriptive values for academic achievement levels

Variables	Academic achievement level	N	M	SD
Academic risk-taking	0-44	14	3.1845	.35399
	45-54	31	3.0260	.37829
	55-69	107	3.1947	.34788
	70-84	212	3.3804	.37733
	85-100	316	3.6289	.44167
	Total	680		
Attitude to science	0-44	14	2.9232	.42961
	45-54	31	3.0097	.30507
	55-69	107	3.0759	.33932
	70-84	212	3.1297	.41800
	85-100	316	3.2756	.40147
	Total	680		

Table 10 shows the results of the ANOVA test and whether there is a significant difference between students' tendency towards academic risk-taking and attitudes to science based on their levels of academic achievement.

Table 10: ANOVA test results of students' tendency towards academic risk-taking and their attitudes to science based on their levels of academic achievement

Variables	Source	Sum of squares	df	Mean square	F	p	Significant diffs among achievement levels (a)
Academic risk-taking	Between groups	24.663	4	6.166	37.754	.000	5>1, 5>2, 5>3, 5>4
	Within groups	110.238	675	.163			
	Total	134.901	679				
Attitude to science	Between groups	6.407	4	1.602	10.294	.000	5>1, 5>2, 5>3, 5>4
	Within groups	105.033	675	.156			
	Total	111.440	679				

(a) Academic achievement levels:1=0-44, 2=45-54, 3=55-69, 4=70-84, 5=85-100

According to the values in Table 10, students' tendency towards academic risk-taking shows a statistically significant difference between academic achievement levels [$F(4;675) = 37.75, p < .05$]. The results of the Tukey test determine that students' tendency towards academic risk-taking in the range of 85-100 (mean = 3.62) is higher than 0-44 (mean = 3.18), 45-54 (mean = 3.02), 55-69 (mean = 3.38). In addition, students in the range of 70-84 (mean = 3.38) have a higher tendency towards academic risk-taking than those in the range of 45-54 (mean = 3.02) and 55-69 (mean = 3.19). The research also found that based on the different academic achievement levels there is a statistically significant difference in students' attitudes to science [$F(4;675) = 10.294, p < .05$]. The results of the Tukey test show that students in the range of 85-100 (mean = 3.62) have more positive attitudes towards science than those in the range of 0-44 (mean = 3.18), 45-54 (mean = 3.02) and 55-69 (mean = 3.38).

Findings related to the third sub-problem

The findings from the regression analysis to examine whether students' tendency towards academic risk-taking can predict their attitudes to science are presented in this section. Table 11 shows the results of the simple linear regression analysis.

Table 11: Simple linear regression analysis results

	B	Std. error	t	R	R ²	β	Adjusted R square	F**	Durbin-Watson
Constant	1.772	.108	16.353	.45	.202	.449	.201	171.403	1.569
Academic risk-taking	.408	.031	13.092						

** $p < .001$

Dependent variable: Attitudes to science

Table 11 shows it is statistically significant that students' tendency towards academic risk-taking can predict their attitudes to science [$R=.45$, $R^2=.20$, $F(1;678) = 171.403$, $p < .001$]. It is seen that 20% of the total variance is explained by the students' tendency towards academic risk-taking.

Table 12 shows the results of the stepwise multiple regression analysis regarding whether the sub-dimensions of the tendency towards academic risk-taking can predict attitudes towards science.

Table 12: Results of the stepwise multiple regression analysis

Mod	Independent variables	B	t	Standard. coeffs β	F**	R	R ²	R square change	Durbin-Watson
1	Constant	1.932	21.148	.469	190.980**	.47	.22	.220	1.590
	Recovery tendency after failure	.313	13.820						
2	Constant	1.829	19.396		104.727**	.48	.24	.017	
	Recovery tendency after failure	.245	8.535	.366					
	Tendency to prefer hard tasks	.104	3.825	.164					

** $p < .001$, dependent variable: Attitudes to science

The results in Table 12 for model one show that the tendency to recover after failure helps to explain students attitudes to science and contributes 22% to the variance for attitudes to science which is statistically significant ($R^2=.220$, $F=190.980$, $p < .001$). For model two, another predictor variable is the tendency to prefer hard tasks which also contributes to attitudes to science. The tendency to prefer hard tasks predicted 2% of the total variance in explaining students' attitudes to science, which is statistically significant ($R^2=.24$, $F=104.727$, $p < .001$). These results indicate that the recovery tendency after failure and the tendency to prefer hard tasks, together explained approximately 24% of the

total variance in attitudes to science. There is no statistically significant contribution from the other sub-dimensions (i.e. the tendency to have negative feelings after failure and the tendency not to do homework).

Discussion and conclusion

In this research, the degree and direction of the relationship between students' tendency towards academic risk-taking and their attitudes to science were examined to discover whether these tendencies and attitudes differ significantly by gender, grade level and academic achievement level. Whether students' tendency towards academic risk-taking could also predict their attitudes to science was also investigated. It was determined that there is a moderate positive correlation between students' tendencies towards academic risk-taking and their attitudes to science. In addition, when we examined the relationship between the sub-dimensions of academic risk-taking and attitudes to science, it was found that attitudes to science have a low positive correlation with the tendency to have negative feelings after failure and the tendency to do no homework. Moreover, it was determined that attitudes to science have a moderate positive correlation with tendencies to prefer hard tasks and recovery tendencies after failure. It was also found that as middle school students' attitudes to science increase, their tendency towards academic risk-taking also increases.

When students' tendencies towards academic risk-taking are examined by gender, female students show higher tendencies than male students. Similarly, Abdullah and Osman (2010) found that fifth grade girls have a higher risk-taking tendency than male students. However, Avcı and Özenir (2016) found no significant differences between the risk-taking tendencies of male and female middle school mathematics students. These differences in findings could be due to the research conducted by Avcı and Özenir (2016) being oriented towards mathematics. Examining attitudes of middle school students to science by gender shows that females have more positive attitudes than male students. Interestingly, there are no gender differences in the attitudes of middle school students to science found in some previous research (Çakır, Şenler & Taşkin, 2007; Kaya & Büyük, 2011). Yenice, Saydam & Telli (2012) found no gender differences in the motivations of students to learn science. This difference between the current research and other research findings may be due to demographic characteristics such as sample differences, data collection tools, and the years in which the investigations were conducted. The results from this research indicate that both the tendency towards academic risk-taking and positive attitudes to science are higher in middle school female students than in male students.

When the tendencies of middle school students to academic risk-taking are examined according to their grade level, fifth and sixth grade students have a significantly higher tendency towards academic risk-taking than eighth grade students. This shows that as grade levels increase, the tendency of students towards academic risk-taking decreases. Similarly, Avcı and Özenir (2016) found that as grade levels increase, middle school students' tendency towards mathematics-focused academic risk-taking decreased. Akça (2017) also found that the tendency of fifth grade students towards academic risk-taking is

significantly higher than sixth, seventh and eighth grade students. Dağcı and Yaman (2014) found that academic risk-taking skills of middle school students in science courses decreased as their grade levels increased. Gifted eighth grade students in science were found by Akdağ, Köksal & Ertekin (2017) to have a lower risk-taking behaviour than in other academic grade levels. These results support the findings from the current research. Therefore, it can be said that at middle school levels, the tendency of students towards academic risk-taking decreases as their grade levels increase.

Examination of middle school students' attitudes to science grade levels finds that fifth-grade students' attitudes to science are more positive than for sixth, seventh and eighth grade students. Also, sixth-grade students' attitudes to science are more positive than the attitudes of seventh grade students. It can be said that as the grade level increases, middle school students' attitudes to science decreases. Consistent with this result, the attitudes of fifth grade students to science courses were significantly higher than those of sixth-grade students (Ural & Aydın, 2017). Çakır, Şenler and Taşkın (2007) found that sixth-grade students' attitudes to science courses were significantly more positive than those of seventh and eighth grade students. In addition, it was found that sixth grade students' motivation for science learning is significantly higher than that of seventh and eighth grade students (Yenice, Saydam & Telli, 2012). These results support the findings of the current research. Differently, Kaya and Büyük (2011) concluded that the attitudes to science of eighth-grade middle school students were significantly more positive than those in other grade levels, though generally it can be said that in middle school students there is a decrease in positive attitudes to science courses as grade levels increase.

Investigating students' tendencies towards academic risk-taking according to academic achievement levels shows that those with an average of 85-100 grade points have a statistically higher tendency towards academic risk-taking than those with average points of 0-44, 45-54, 55-69 and 70-84. Moreover, students with an average of 70-84 grade points have a statistically higher tendency towards academic risk-taking than students who averaged 45-54 and 55-69 grade points. These results indicate that high academic achieving students may have higher tendencies towards academic risk-taking. Streitmatter (1997) noted that academic risk-taking helps shape the academic identity of students and encourages academic success, and current research results help to support this claim. On the other hand, students with an average of 85-100 grade points had statistically higher positive attitudes to science than those with an average of 0-44, 45-54, 55-69 and 70-84 grade points. These findings show that students who have high academic success may have a more positive attitude to science than those who are less successful. Çakır, Şenler and Taşkın (2007) found that students who perceive themselves as successful have more positive attitudes to science. Therefore, it can be said that students with high academic achievement level tend to have more positive attitudes to science and a higher tendency towards academic risk-taking.

The results show that students' tendency towards academic risk-taking significantly predicted their attitude to science. Middle school students' tendency towards academic risk-taking explained 20% of the total variance in their attitudes to science. In terms of the sub-dimensions of academic risk-taking, the tendency to recovery after failure and to

prefer hard tasks contributed to explaining attitudes to science, but the tendencies to have negative feelings after failure and not to do any homework did not contribute to explaining attitudes to science. The ambiguity in the scientific inquiry process requires a willingness to take risks (Beghetto, 2009). It could be possible to say that in every experiment made in science courses, students may fail. In this sense, Bransford and Donovan (2005) stated that students' tendency towards academic risk has been improved with the introduction of scientific inquiry processes which involve exchanging idea, asking questions, trying new methods and strategies, proving or refuting the ideas put forward. Bransford and Donovan's (2005) allegations support the results of the current research, which can be regarded as normal, given that there are a number of components with regard to improving students' tendencies towards academic risk-taking in science courses.

There was a significant though low level correlation between students' tendencies towards academic risk-taking and their attitudes to science. Middle school female students tend more towards academic risk-taking and positive attitudes to science than male students. Students with high academic achievement level have more tendency towards academic risk-taking and positive attitudes to science compared with low achieving students, and students in lower-grade levels tend to have a higher tendency towards academic risk-taking and positive attitudes to science than in higher grade levels. The results from this study show there is a positive relationship between students' tendency towards academic risk-taking and positive attitudes to science. It can be said therefore, that students' tendencies towards academic risk-taking and their positive attitudes to science show a change in parallel with their academic achievement level. In this study, it was also determined that as grade levels increase, students' tendencies towards academic risk-taking and their positive attitudes to science decrease. Similarly, Bursal (2013) determined that seventh and eighth grade students' science achievement scores were significantly lower than those of students at other grade levels. So, as grade levels increase, the falls in success rates can be interpreted as a tendency to reduce academic risk and a positive attitude to science. It was seen that students' tendency towards academic risk-taking positively predicted their attitudes to science. The variables that affect attitudes to science and the tendency towards academic risk-taking are positively related to each other. Beghetto's (2009) findings support the results of the current study, as he found that students' tendencies towards academic risk-taking and their interest in science courses are positively related. In addition, Hills, Stroup and Wilensky (2005) found a strong correlation between students' willingness to participate in discussions on science courses and in open-ended risky academic behaviours. Therefore, a positive relationship between students' tendencies towards academic risk-taking and their attitudes to science appears to exist, and both variables affect each other.

Recommendations

Female students' attitudes to science and their tendencies towards academic risk-taking was found to be higher than that of male students, so this difference could be examined in future studies. It was also determined that as grade levels increase, students' tendencies to take academic risks and their attitudes to science decreases, which could also be examined. High academic achieving students were shown to be more likely to take academic risks

and had a more positive attitude to science, so empirical research could be conducted to find ways to improve the tendencies and attitudes of low-achieving science students. Lastly, it was found that students' tendencies towards academic risk-taking significantly predicted their attitude to science. So, the influence of science experiments on students' tendencies towards academic risk-taking can be proven by empirical studies in future studies.

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