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ORIGINAL ARTICLE

Examination of Elementary School Students' Scientific Attitudes and Intellectual Risk-Taking Behaviors

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ABSTRACT

In this study, the relationship between scientific attitudes and intellectual risk-taking behaviors of fourth-grade students in elementary school in Turkey was examined. A total of 184 students participated in the study, which was conducted based on a survey model. For data collection, the "Scientific Attitude Inventory" and the "Intellectual Risk-Taking and Perceptions About Its Predictors Scale in Science Education" were utilized. Descriptive statistical analyses and t-test, ANOVA, simple linear regression, and multiple regression analyses were utilized for the analysis of the data. As a result of this data analysis, it was observed that these elementary school students have scientific attitudes at the "not sure" level and have intellectual risk-taking behaviors at the "mostly correct" level. Gender was not observed to have an effect on scientific attitude; however, it was effective on intellectual risk-taking behavior. In addition, the analysis results demonstrated that there is a meaningful difference between intellectual risk-taking behaviors of students and the educational levels of their fathers. Moreover, when the relations between other pairs of variables were examined, the variables of intellectual risk-taking, gender, educational level of the mother, and educational level of the father together had low-level but meaningful relations with the scientific attitudes of elementary school students. It was indicated that teachers will contribute to students' adoption of positive scientific attitudes by introducing the lives and studies of scientists, and it was suggested that the effect of changes in educational patterns in classroom environments be examined through experimental studies on intellectual risk-taking behaviors of students. With the results obtained from this study, more light can be shed on what should be done to support students' intellectual risk-taking behaviors.

KEY WORDS: elementary school students; intellectual risk-taking; scientific attitudes

INTRODUCTION

Science classes in elementary schools should seek to enable students to engage in scientific thinking, encourage them to perform work on basic sciences, and positively develop their attitudes toward science classes with a positive educational environment. Studies related to both the healthy construction of classroom environments and attitudes have a long history (Gardner, 1975; Ma and Bateson, 1999; Toma et al., 2019; Zhang and Campbell, 2011). Wang and Berlin (2010) indicated that attitudes toward science are effective factors in attaining goals of science education. In addition, they reported that these factors affect student motivation. According to Zhang and Campbell (2011), scientific attitudes of students also direct their interest in lessons and simultaneously affect their long-term success in courses. Attitude, as an affective domain of learning, is an element affecting learning outputs of students in science courses (Ministry of National Education, 2018). Accordingly, the importance of performing attitude studies emerges with regard to obtaining positive outputs on scientific attitude. Individuals with scientific attitudes have inquisitive and argumentative characteristics; therefore, they do not fall prey to preconceptions or dogmatic belief systems. Individuals with positive scientific attitudes are more willing to identify and solve the problems in their surroundings, as well as being willing to search for solutions. In addition, while scientific attitudes may help an individual to be successful, they also support his or her continual improvement by affecting his or her thinking (Demirbaş and Yağbasan, 2006). In this study, the effect of a different variable on attitude was examined by focusing on the relationship between scientific attitudes and intellectual risk-taking behaviors of elementary school students.

Theoretical Background

While an individual's attitude cannot always be observed precisely, it largely directs love, hate, and the ideas of the individual (Morgan, 2005). Munby (1980) examined scientific attitudes in four categories as attitudes toward school science, attitudes toward science careers, attitudes toward science itself, and attitudes toward specific issues in science. This examination, indeed, emphasizes the importance of attitudes in terms of long-term learning and indifference toward science or the development of deep understandings (Hong and Lin, 2011). Gardner (1975), however, divided such attitudes into two, as attitudes toward science and scientific attitudes. Moreover, the scientific attitudes included within the context of this study were expressed as a mixture of the will to know and understand, inquiring attitudes, data collection and sense-making, and evaluation and interpretation of results (Education

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Policies Commission, 1962). Therefore, the two concepts are quite different from each other and utilization of convenient scales is needed to decide which one can be measured and with which aim.

Studies conducted on scientific attitudes of students indicate the effects of different variables. While these variables were categorized as gender, age, and cultural history by Toma et al. (2019), socio-economic level and effect of school were included in the variables studied by Gardner (1975). However, in studies on scientific attitude, which is examined with quite a wide scope, it is observed that science is found to be considerably unappealing and boring, and it is accepted that out-of-school science is more enjoyable than the science performed at school (Bennett and Hogarth, 2009). Barmby et al. (2008), in a large-scale study, emphasized that female students generally develop more positive attitudes toward medical applications or biological sciences, while male students have positive attitudes in physics courses and mostly in information technology fields. Chetcuti and Kioko (2012) based this differentiation in attitudes on the fact that girls and women are more focused on adopting a balance between careers in science fields and family life. According to Osborne et al. (2003), attitudes toward science generally begin to decrease at the age of eleven years, with a sharp fall between the ages of 11 and 14 years. Barmby et al. (2008), who examined the changes in scientific attitudes of children aged 7–9 years, indicated that the attitude level of the students decreased as they approached middle school. Moreover, this decrease was more clear among female students, and they suggested necessary measures to be taken for the current situation. Chetcuti and Kioko (2012), who examined the differentiation of attitudes based on gender, reached the conclusion that scientific attitudes of female Kenyan students changed based on attitudes toward science courses and their perceptions of the convenience of science courses. Moreover, Hong and Lin (2011), as a result of a study conducted in Taiwan, indicated that attitudes toward science change based on gender, age, and school type. However, Zhang and Campbell (2011) focused on the success of connecting science with daily life and the effects of a student's academic success and the environment for learning science on scientific attitude. According to Hong (2010), positive attitudes toward science affect students' positive attachment to science and their life-long interest and learning enthusiasm. Therefore, it is possible to say that more than one variable is effective on scientific attitude and that the relations of many variables with attitude have not been completely revealed. Among these variables, intellectual risk-taking behaviors are a category worth examining.

Risk-taking behavior is an individual's willingness to take risks under conditions in which he or she cannot forecast the consequences, for actions not previously performed and for which the possible alternatives are unknown (Çakır and Yaman, 2016). Neihart (1999) divided risk-taking behaviors into the categories of intellectual, social, emotional, physical, and sentimental risk-taking. However, Akdağ et al. (2017) addressed risk-taking behaviors within five groups as risk-taking behaviors pertaining to traffic, to sexuality, to drug use, to extreme sports, and to academic or intellectual risks. Intellectual risk-taking behavior is a specific category of risk-taking pertaining to education. Beghetto (2009. p. 211) expressed intellectual risk-taking behavior as "*an adaptive form of risk taking*" and stated that this behavior is affected by interest in science (IS), creative self-efficacy (CSE), and the perception of teacher contributions. Clifford (1991), who studied intellectual risk-taking behavior within the context of education, mentioned educational environments that will enable students to take more risks in educational activities. Similarly, Allmond et al. (2016) demonstrated intellectual risk-taking behaviors to be among 21st century skills and emphasized that it is necessary to support students in adopting such behaviors. Radloff et al. (2019) also observed that the benefits of risk-taking included increased student participation in science courses, increased self-confidence in teachers about teaching science, and increased collaborative teacher relations. Studies conducted at middle school level have demonstrated that there is a low-level relation between test anxiety and intellectual risk-taking behavior (Bal-İncebacak et al., 2019). However, in the literature, many studies relating intellectual risk-taking behavior with scientific success have concluded that students with high tendencies of taking risks when starting new subjects or projects are academically more successful (Meyer et al., 1997; Tay et al., 2009). Moreover, in other studies that examined the relations of intellectual risk-taking with different variables, similar relations were determined regarding motivation, interest, and self-efficacy and academic success (Akdağ et al., 2017; Beghetto, 2006; 2009).

Rationale for the Study

Within the framework of studies on scientific attitudes, many relations have been previously examined in the literature. Hong and Lin (2011) examined whether scientific attitudes changed based on class level, gender, and school type among 2876 students in Taiwan. In studies conducted at elementary school level, examinations of the relationship between attitude toward science and academic success (Uyanık, 2017), the relationship between attitude toward science at the middle school level and test anxiety (Akman et al., 2010), and scientific attitudes based on demographic variables (Mıhladız and Duran, 2010) have been performed.

At the high school level, the relationship between attitude toward science and attitude toward the environment (Ma and Bateson, 1999), the relationship between attitude toward science and family income (Çibir and Özden, 2017), and the relationship between attitudes toward science and epistemological beliefs (Ocak and Erbasan, 2017) have been examined. Camcı-Erdogan (2015) examined the relation between scientific attitudes of prospective teachers and levels of self-efficacy in science, Bartan (2019) examined the relation between basic scientific literacy levels of teacher candidates and their scientific attitudes, and Toma et al. (2019) examined the relation between attitude toward science and the

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nature of science. However, in these studies, attitudes toward science were examined most intensely and, furthermore, the examination of attitudes toward science courses was regarded as fundamental. In this study, in contrast to the context of attitude toward science, an examination of "scientific attitude" has been undertaken. According to Uyanık (2017), taking cognitive and affective dimensions into consideration and planning education in accordance with them for the development of scientific attitudes at the elementary school level will improve the efficiency of the provided education.

Intellectual risk-taking is a research area that must be handled together with scientific attitude in terms of focusing on tasks, developing alternative strategies to be productive, and achieving active participation. Furthermore, in the related literature, attitudes toward science among students having different socio-economic characteristics have been examined (Gardner, 1975; Toma et al., 2019). However, the relationship between parental educational levels and students' scientific attitude and intellectual risk-taking behaviors was not examined. As reported by Toma et al. (2019), only 13% of the experimental studies on scientific attitude were conducted with elementary school students. Therefore, the present study addresses the question of whether there is a meaningful difference between female and male students of elementary school age in terms of scientific attitudes and intellectual risk-taking behaviors.

Ma and Bateson (1999) reported that attitudes may change with some interventions. As a result of a 20-week collaborative science intervention performed by Hong (2010) with 37 successful students receiving education in the eighth grade, it was observed that an intervention with innovative teaching strategies applied to the study group was effective. Both quantitative and qualitative findings of that study revealed the relation between the attitudes and anxieties of the students. For this reason, outputs to be gained through studies conducted on attitude will help direct researchers and practitioners with regard to performing the necessary interventions. In addition, the determination of which variables affect intellectual risk-taking behaviors in which directions and at which levels may shed light on what should be done to better support the intellectual risk-taking behaviors of students (Avcı and Özenir, 2016). With these aims, in the present study, five fundamental research questions were pursued:

RQ_1: Is there a meaningful difference between the scientific attitudes of female and male elementary school students?

RQ_2: Is there a meaningful difference in the scientific attitudes of elementary school students based on the educational levels of their parents?

RQ_3: Is there a meaningful difference between the intellectual risk-taking behaviors of female and male elementary school students?

RQ_4: Is there a meaningful difference in the intellectual risk-taking behaviors of elementary school students based on the educational levels of their parents?

RQ_5: Is there a meaningful relation between the scientific attitudes and intellectual risk-taking behaviors of elementary school students?

METHODS

This study, with survey value, aimed to determine whether there is a meaningful relation between the scientific attitudes and intellectual risk-taking behaviors of fourth grade students in elementary school in terms of various variables. In this research, which was conducted based on a correlational survey model; efforts were made to interpret whether there is a relation between the variables and the place, power, and direction of the relation by using numerical values (Fraenkel et al., 2012). In accordance with the creation of quantitative research, scales for measuring scientific attitudes and intellectual risk-taking behaviors of a specific number of participants were utilized in this study.

Participants of the Study

Participants of this study were fourth grade students (11 age) receiving education in the 2018–2019 academic year in a large city in terms of population density in the Central Anatolia Region of Turkey. Data were collected from 184 elementary school students receiving education at five different public schools, and students of both low and high levels in socio-economic terms were selected to provide diversity and enable generalization. Data were collected from only fourth grade students in elementary school by utilization of the purposive sampling method. With the application of this sampling type, only elementary school students were targeted and efforts were made to measure the effects of parental educational levels on the scientific attitudes and intellectual risk-taking behaviors of the students. Ninety-six (52.2%) female students and 88 (47.8%) male students participated in the study. When the educational levels of the students' parents were examined, it was found that, of the mothers, 6% were illiterate, 27.2% had an elementary school education, 20.1% had a middle school education, 22.3% had a high school education, and 24.5% had studied at undergraduate, graduate, or postgraduate levels. When the educational levels of the fathers were examined, it was observed that 3.8% were illiterate, 20.7% had an elementary school education, 16.8% had a middle school education, 24.5% had a high school education, and 34.2% had studied at undergraduate, graduate, or postgraduate levels. However, since parametric analyses cannot be performed when the number of data in a category is less than 15 (Büyüköztürk, 2011), the educational levels of the mothers and fathers were re-classified into the levels of elementary school or below, middle school, high school, and undergraduate/graduate/postgraduate.

Instruments

Personal information form

This form was developed by the researcher to collect demographic data about the participants. It included the variables of the student's gender and the educational levels of the mother and father.

Scientific attitude inventory (SAI II)

To measure the scientific attitudes of elementary school students, the SAI II, developed by Moore and Foy (1997),

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was utilized in this study. The Turkish translation of this measurement tool was done by Demirbaş and Yağbasan (2006). It has 40-items scored on a 5-point Likert-type scale and comprises six dimensions: Structure of the laws and theories of science (first dimension), structure of science of science and it us way of approaching events (second dimension), exhibiting scientific behavior (third dimension), structure and aim of naturel sciences (fourth dimension), the place and importance of natural sciences in the society (fifth dimension), and willingness to conduct scientific studies (sixth dimension). Individuals' levels of agreeing with the items are classified as "strongly agree," "mildly agree," "neutral/undecided," "mildly disagree," and "strongly disagree." Of the items on this scale, 20 items are positive and 20 items are negative. A scoring pattern of 5, 4, 3, 2, and 1 is applied for positive items and a scoring pattern of 1, 2, 3, 4, and 5 is applied for negative items. As a result of the validity and reliability analyses performed for this tool by Demirbaş and Yağbasan (2006) with a total of 300 elementary school students, the Cronbach alpha value was calculated as 0.76 for the total scale. Moreover, the Spearman-Brown split-half test correlation was calculated as 0.84. The Cronbach alpha was calculated as 0.53 for the first dimension, 0.54 for the second dimension, 0.53 for the third dimension, 0.52 for the four dimension, 0.61 for the fifth dimension, and 0.59 for the sixth dimension in the present study.

Intellectual risk-taking and perceptions about its predictors scale in science education (IRT - S scale)

With the aim of measuring the intellectual risk-taking behaviors of elementary school students, the IRT-S Scale, developed by Beghetto (2009), was utilized in this study. The original version of the scale was applied to 585 elementary school students. It is composed of four dimensions: IRT, IS, CSE, and perceptions of teacher support (PTS). In his related study, Beghetto (2009) reported that the reliability coefficients of the scale were 0.80, 0.77, 0.83, and 0.77. A study of the scale's adaptation to Turkish was conducted by Yaman and Köksal (2014) with a total of 864 students. Among the 18 items of the scale, constructed as a 5-point Likert-type scale, there are no negative sentence structures. Individuals' levels of agreement with the items are ranked from 1 (not true) to 5 (very true). The scores from the scale are between 1.00 and 5.00; as scores get closer to 5.00, students' levels of agreeing with the items are accepted as being high, and as scores get closer to 1.00, students' levels of agreeing with the items are accepted as low. Reliability levels of the scale's dimensions were determined by Yaman and Köksal (2014) as 0.80 for IRT, 0.77 for IS, 0.83 for CSE, and 0.77 for PTS. The Cronbach alpha was calculated as 0.64 for IRT, 0.69 for IS, 0.74 for CSE, and 0.75 for PTS in the present study. Sample items from the scale are found in Table 1.

DATA ANALYSIS

Before the data collected with these scales were analyzed, missing data were checked, and extreme values were examined. Afterward, calculations were performed to determine whether the data met normal distribution hypothesis values. Due to the fact that the sampling size was ≥50, Kolmogorov–Smirnov test results were first examined (Büyüköztürk, 2011). This obtained value was not observed to be meaningful ($\rho > 0.05$). The normal distribution curve was then followed by examining histogram tables, and then skewness and kurtosis values were examined. The skewness value was found to be +0.381 and the kurtosis value was −0.083; thus, the data were confirmed to conform to normal distribution (Hair et al., 2013). Hence, parametric tests were utilized in the data analysis of this study. Data were transferred to the SPSS 20 program and tests of frequency, percentage, mean, standard deviation, and independent sample t-test and analyses of one-way ANOVA, simple linear regression, and multiple linear regressions were conducted. Before conducting multiple linear regression analysis, the categorical variables of gender and education level were turned into artificial variables referred to as "dummy variables." The aim in utilizing dummy variables in this way is to examine the effect of independent variables such as gender, educational level, occupation, race, or religion on dependent variables in regression analysis (Büyüköztürk, 2011). Dummy variables were equivalent to the category number minus one (C - 1). While the scores gained from the IRT-S Scale were included unchanged in multiple regression analysis, the educational statuses of the mother and father were included as dummy variables. In accordance with this, the "male" category

Table 1: Sample scale items

Scale	Factor	Sample item
SAI II	Structure of the laws and theories of science	Scientific laws have been proven beyond all possible doubt.
	Structure of science of science and it usage way of approaching events	Some questions cannot be answered by science
	Exhibiting scientific behavior	Good scientists are willing to change their ideas.
	Structure and aim of natural sciences	Ideas are the important result of science.
	The place and importance of natural sciences in the society	Every citizen should understand science
	Willingness to conduct scientific studies	Scientists have to study too much
IRT-S	Intellectual risk-taking (IRT)	During science, I try to find new ways of doing things even if they might not work out.
	Interest in science (IS)	I like what we do in science.
	Creative self-efficacy (CSE)	I am good at coming up with new ways of finding solutions to science problems.
	Perceptions of teacher support (PTS)	My teachers really listen to my ideas.

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of gender was coded as "0" and turned into a dummy variable. "High school education level" among the educational levels of mothers and fathers was also coded as "0."

In influence quantity calculations, intervals of <0.20 (trivial), 0.20–0.59 (small), 0.60–1.19 (moderate), 1.20–1.99 (large), 2.0–3.9 (very large), and >4.0 (extremely large) were taken into consideration as Cohen d values (Hopkins et al., 2009). The gap widths of the utilized 5-point Likert-type scales were calculated with the formula of sequence gap/number of groups created (Tekin, 1993) and mean gaps based on evaluations of the research findings were determined as follows: 1.00–1.80, strongly disagree/not true; 1.81–2.60, mildly disagree/frequently; 2.61–3.40, neutral/undecided; 3.41–4.20, mildly agree/mostly true; and 4.21–5.00, strongly disagree/very true.

RESULTS

The results obtained in this study are listed below based on the respective research questions.

Examination of the Difference Between Scientific Attitudes of Female and Male Elementary School Students

Values obtained from the SAI II and IRT- S Scale were examined based on the variable of gender and the obtained results are presented in Table 2.

According to Table 2, the overall SAI II values demonstrate no difference in scientific attitudes between female and male students. However, for the third dimension of the scale, a statistically meaningful difference was detected. According to this, male students were observed to have higher scores for the scale's third dimension of "exhibiting scientific behavior" ($M = 3.32$, $t_{(182)} = -2.16$, $\rho < 0.05$). The η^2 value calculated in this regard was 0.02. In line with this, approximately 0.2% of the variance observed in SAI II scores was based on gender. This finding can be interpreted as reflecting the trivial effect size of gender on scientific attitude (Hopkins et al., 2009). In addition, when the scores achieved at item level are examined, it is observed that some "undecided" replies were given with regard to scientific attitude. The values obtained from the overall IRT-S Scale further demonstrate that male students exhibited more intellectual risk-taking behaviors ($M = 4.18$, $t_{(182)} = -2.02$, $\rho < 0.05$). A statistically meaningful difference was also detected for the IS and CSE dimensions of the scale (35). However, the η^2 value calculated for the IS and CSE dimensions and for the overall scale was at the 0.02 (trivial) level. Moreover, when students' replies to the IRT-S Scale were examined at item level, it was observed that most scores are at the level of "mostly true."

Table 2: The t-test results for the SAI II and IRT- S scale

Variables	Category	N	Mean	S	df	t	ρ*
First dimension	Female	96	3.10	0.40	182	−0.17	0.86
	Male	88	3.11	0.44			
Second dimension	Female	96	3.80	0.63	182	−0.87	0.38
	Male	88	3.88	0.63			
Third dimension	Female	96	3.16	0.48	182	−2.16	0.03
	Male	88	3.32	0.52			
Fourth dimension	Female	96	3.09	0.40	182	−0.47	0.63
	Male	88	3.12	0.38			
Fifth dimension	Female	96	3.29	0.49	182	−0.06	0.94
	Male	88	3.33	0.56			
Sixth dimension	Female	96	3.41	0.44	182	−0.83	0.40
	Male	88	3.47	0.54			
Total	Female	96	3.28	0.23	182	−1.33	0.18
	Male	88	3.33	0.30			
IRT	Female	96	4.17	0.59	182	−0.70	0.48
	Male	88	4.24	0.61			
IS	Female	96	4.23	0.77	182	−2.08	0.03
	Male	88	4.44	0.54			
CSE	Female	96	3.83	0.74	182	−1.99	0.04
	Male	88	4.05	0.73			
PTS	Female	96	3.78	0.86	182	−1.35	0.17
	Male	88	3.96	0.94			
Total	Female	96	4.02	0.52	182	−2.02	0.04
	Male	88	4.18	0.53			

*ρ<0.05

Examination of the Difference in the Scientific Attitudes of Elementary School Students Based on the Educational Levels of their Parents

ANOVA and descriptive statistical analyses were utilized to examine the relation of the SAI II and IRT-S Scale scores of the elementary school students with the educational levels of their parents (Table 3).

The analysis results (Table 3) demonstrate that there was not a meaningful difference between the educational levels of the students' parents and the students' scientific attitudes ($F_{(3,180)} = 2.201$ and $F_{(3,180)} = 1.953$, $\rho > 0.05$). However, there was a meaningful difference between students' intellectual risk-taking behaviors and the educational levels of fathers ($F_{(3,180)} = 3.008$, $\rho < 0.05$). According to the results of the Scheffe test, which was performed to determine the sources of the differences by educational levels of fathers, scores were higher for those with fathers who had received high school education (C) ($M = 4.22$) compared to those with fathers having elementary education or below (A) ($M = 3.98$) and middle school education ($M = 3.94$). In other words, intellectual risk-taking behaviors were more common among students whose fathers had a high school level of education compared to students whose fathers had a middle school level of education or below.

Examination of the Relation Between the Scientific Attitudes and Intellectual Risk-Taking Behaviors of Elementary School Students

Simple linear regression analysis was utilized to determine whether the intellectual risk-taking behaviors of the elementary school students were an important predictor of scientific attitude (Table 4).

It was observed that intellectual risk-taking and the variables of gender and educational levels of the mother and father

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Table 3: Results of descriptive statistical analysis for the parents of the students (SAI II and IRT- S scale)

Variables	Parent's educational status	n	Mean	S	Source	Sum of squares	df	Mean of square	F	ρ	Sig.
Mother education status											
Scientific attitude	Primary and lower education level (A)	61	3.24	0.24	Between group	0.469	3	0.156	2.201	0.09	---
	Secondary school graduate (B)	37	3.29	0.24	Within group	12.784	180	0.071			
	High school graduate (C)	41	3.35	0.30	Total	13.253	183				
	University and graduate (D)	45	3.36	0.26							
	Total	184	3.30	0.26							
Father education status											
Scientific attitude	Primary and lower education level (A)	45	3.27	0.25	Between group		3	0.139	1.953	0.12	--
	Secondary school graduate (B)	31	3.23	0.25	Within group		180	0.071			
	High school graduate (C)	45	3.37	0.26	Total		183	1.223			
	University and graduate (D)	63	3.32	0.28							
	Total	184	3.30	0.26							
Mother education status											
IRT-S	Primary and lower education level (A)	61	3.93	0.44	Between group		3	0.271	4.510	0.13	--
	Secondary school graduate (B)	37	4.06	0.55	Within group		180				
	High school graduate (C)	41	4.23	0.61	Total		183				
	University and graduate (D)	45	4.26	0.49							
	Total	184	4.01	0.53							
Father education status											
IRT-S	Primary and lower education level (A)	45	3.98	0.40	Between group		3	0.835	3.008	0.03	C-A, C-B
	Secondary school graduate (B)	31	3.94	0.51	Within group		180	278			
	High school graduate (C)	45	4.22	0.63	Total		183				
	University and graduate (D)	63	4.18	0.52							
	Total	184	4.10	0.53							

"A" signifies elementary school education level or below, "B" middle school, "C" high school, and "D" undergraduate/graduate/postgraduate. These symbols are used for abbreviation

Table 4: Simple linear regression analysis results regarding prediction of scientific attitude

	B	Std.Error	β	t	ρ*
Constant	2.403	0.473	0.259	5.079	0.001
IRT-S	0.514	0.142		3.610	

*ρ<0.05

Table 5: Multiple linear regression analysis results regarding prediction of scientific attitude

Variable	B	Std. Error	β	t	ρ*
Constant	2.813	0.152		18.458	0.001
Father education status	−0.063	0.054	−0.088	−1.181	0.239
Mather education status	0.004	0.050	0.007	0.090	0.928
IRT- S	0.120	0.037	0.239	3.266	0.001
Gender	0.029	0.039	0.054	0.738	0.462

R=0.279, R2=0.078, F (4179=3.781, ρ=0.001. *ρ<0.05

together have a low-level but meaningful relation with the scientific attitudes of elementary school students (R = 0.279, $R^2 = 0.078$, $p < 0.05$). With these four mentioned variables, 8% of the total variance in scientific attitude was explained. Based on the standardized regression coefficient (β), the predictive variables' relative order of importance for scientific attitude is as follows: Intellectual risk-taking, educational level of the father, gender, and educational level of the mother. Moreover, when t-test results on the meaningfulness of the regression coefficients are examined, it is observed that only intellectual risk-taking behavior is a meaningful predictor of scientific attitude (Table 5). According to the results of regression analysis, the regression equation model for prediction of scientific attitude is as follows:

Scientific attitude = 2.813 - 0.063 × father's educational level + 0.004 × mother's educational level + 0.120 × IRT + 0.029 × gender

DISCUSSION AND CONCLUSION

In this study, in which the relations of scientific attitudes of elementary school students were examined in terms of intellectual risk-taking and other variables, the SAI II was utilized and the obtained results demonstrated that there is not a meaningful difference between female and male students in terms of scientific attitudes. In studies conducted on scientific education with different age groups, researchers have argued that the variable of gender has an effect on scientific attitude as educational level increases (Barmby et al., 2008; Bartan, 2019; Hong and Lin, 2011; Mıhladız and Duran, 2010; Osborne et al., 2003; Toma et al., 2019). In accordance with this, positive scientific attitudes are determined at younger ages, but at older ages, these attitudes become more negative. According

to Hong and Lin (2011), this is due to the fact that elementary school students receive education in a more collaborative environment supported by both parents and teachers. However, as the grade level increases, students focus more on individual success in a more competitive environment. By constructing feelings of responsibility in students, this situation causes them to think more about exams and thus causes them to see scientific studies only in an exam-focused way. In a similar study conducted by Camcı-Erdogan (2015) with teacher candidates, it was observed that scientific attitude did not differ based on gender. It was also determined that scientific attitudes of teachers did not affect educational performance but did direct the scientific attitudes of the students. Accordingly, it is possible to say that the scientific attitude of the teacher is effective on students' scientific attitudes at the elementary school level. In addition, parents' levels of interest are also effective on students' development of positive scientific attitudes. In the related literature, additional variables such as the scientific attitudes of classmates, achievement motivation, perceptions of success, cultural history, test anxiety, and science perceptions of students are also observed to have determinant effects (Akman et al., 2010; Mıhladız and Duran, 2010; Toma et al., 2019; Uyanık, 2017). Moreover, Osborne et al. (2003) explored the factors that are effective on these attitudes within the following categories:

> The perception of the science teacher, anxiety toward science, the value of science, self-esteem at science, motivation towards science, enjoyment of science, attitudes of peers and friends toward science, attitudes of parents towards science, the nature of the classroom environment, achievement in science, and fear of (failing a) course (p. 1054).

Based on the total scores obtained from the overall SAI II, it was determined that gender is not a determinant factor for scientific attitude, but for the "exhibiting scientific behavior" dimension of the scale, there is meaningful differentiation in favor of male students. Mıhladız and Duran (2010) stated that boys have a tendency to have more positive attitudes toward science in elementary school, but this situation is reversed as the grade level increases. It was observed at the elementary school level in some studies that female students (Chetcuti and Kioko, 2012; Çibir and Özden, 2017; Ocak and Erbasan, 2017) and in some studies that male students have positive scientific attitudes (Toma et al., 2019). In the studies that Hong and Lin (2011) conducted at elementary and middle school levels, it was observed that the scientific attitudes of female students were more positive. These findings demonstrate that there is not a consensus in the related literature on the issue of gender as a determinant factor on scientific attitude. There may be many reasons for this lack of consensus. For example, the sociocultural environments in which students find themselves and the effects of teachers can both be mentioned. In particular, the reasons why the SAI II revealed male students to display meaningful differences in "exhibiting scientific behavior" needs to be explored. Osborne et al. (2003) suggested that the opinion of science being more suitable for boys is dominant in many countries, while Jones et al. (2000) indicated that girls, in a different way from boys, followed classroom directives more collaboratively in classroom environments and generally refrained from competitiveness. Accordingly, the boys had more advantages in terms of exhibiting scientific behavior. Toma et al. (2019) proposed teacher attitudes as the source of this advantage. To prevent such gender-based differences, they underlined that teachers need to provide inclusive education without gender discrimination, avoid transferring unconscious messages, and undertake classroom planning carefully. In the experimental study that Hong (2011) conducted with high school students, it was observed that 20-week collaborative learning studies made a positive contribution to the scientific attitudes of the students. Wang and Berlin (2010) reported that, in developed countries other than Israel, boys have more positive scientific attitudes and the reason for that must be a cultural explanation.

The other result obtained from this Likert-type scale was that the reply of "undecided" was often given for the items. This means that students have theoretical information about science but they are lagging in performance and application (Camcı-Erdogan, 2015). According to Uyanık (2017), attitudes are adopted at early ages and they do not change easily, unless the individual undergoes very important experiences or practices. Therefore, students who have positive scientific attitudes in elementary school years will be advantaged in the following years, as that positive attitude will likely be sustained. Therefore, positive attitudes toward science should be instilled early in life by relating scientific activities in elementary school to daily life, replying to individual needs, and performing the necessary interventions to evoke excitement and curiosity in students about science. According to Koch (1990), teachers who attach importance to science tend to inspire their students to develop similar positive attitudes. However, Wang and Berlin (2010) focused on the geographical locations in which studies of scientific attitudes were conducted and concluded that educational strategies for specific locations need to be taken into consideration. Bennett and Hogarth (2009) reported that students exhibit more positive attitudes toward science when they come to believe that scientists do good things for the world. This indicates that teachers can help students adopt positive attitudes toward science by introducing the lives and works of scientists in school.

In this study, it was observed that there was not a meaningful relation between the educational levels of the parents and the scientific attitudes of the students. In contrast, Ocak and Erbasan (2017) found that the educational levels of both the mother and the father were effective on scientific attitude. Moreover, in the study of Çibir and Özden (2017), conducted with elementary school students, it was observed that as the economic status and educational attainment of the parents increased, the scientific attitudes of the students increased, as well. Mıhladız and Duran (2010) reported similar results. Thus, the effect of the educational level of parents on the scientific attitudes of their children is seen to vary in the literature. It is,

therefore, necessary that other factors effective on students' scientific attitudes be taken into consideration for the causes of these attitudes to be revealed. Mordi (1991) demonstrated that socio-economic status had 1% effect, student characteristics had 16% effect, school characteristics had 11% effect, and learning and educational approaches had 41% effect on the scientific attitudes of students. Even though the educational level of the parents is not the sole variable effective on the scientific attitudes of students, it does seem possible that it has a collective effect together with the other mentioned factors.

In this study, an attempt was also made to measure the relationship between scientific attitudes and intellectual risk-taking. First, the intellectual risk-taking behaviors of elementary school students were examined. Item-level analysis of the students' replies to the IRT- S Scale demonstrated that the "mostly true" level of scoring was usually preferred. Tay et al. (2009) reported similar results in a study examining the relationship between intellectual risk-taking behaviors and problem-solving skills among gifted students and they determined that the intellectual risk-taking behaviors of those students were high. Clifford (1991) explained that intellectual risk-taking is a strong resource for education, enabling the development of motivation, and necessary skills. Accordingly, the results gained in this study suggest that when students take risks in educational environments, they are engaging in deep thinking on a problem or subject, they share that thinking with others, and they try to improve their experiences with new solutions. Tay et al. (2009) similarly stated that students who are able to take intellectual risks can handle the responsibilities of their successes or failures. In the study conducted by Allmond et al. (2016), it was observed that positive classroom cultures contribute to students' intellectual risk-taking behaviors. Radloff et al. (2019), also in a study that included elementary school students, concluded that risk-taking and the teacher's contributions both serve to increase students' participation in science courses and help develop their course-specific self-confidence.

The analysis performed in the present study also revealed that risk-taking behaviors are more prevalent in male students than female students. Among the limited examinations of intellectual risk-taking according to gender performed in Turkey (Akdağ et al., 2017; Avcı and Özenir, 2016; Çakır and Yaman, 2016), it was generally concluded that intellectual risk-taking behaviors do not change based on gender. Atkins et al. (1991) claimed that there are important differences between boys and girls in risk-taking behavior that cannot be clearly defined with the standard utilized scales because the determination of differences based on gender through one single analysis will not be reliable. However, Fesser et al. (2010) determined that male students are better in terms of intellectual risk-taking and they explained adult women's behaviors of avoidance of risk-taking to be due to attitudes dating back to the previous educationalsse years. When the present study is considered in the Turkish context, intellectual risk-taking behaviors being more prevalent in male students than female students can be regarded as normal. In this specific context, the cultural history, the importance parents attach to the education of girls, and other structural factors are effective on this result.

Scores obtained from the IRT-S Scale demonstrated that intellectual risk-taking behaviors were more prevalent among the students whose fathers had received high school educations. Avcı and Özenir (2016) determined a relation between educational levels of parents and the education of children. In this study, the effect of the educational level of the father on intellectual risk-taking is particularly worth considering. It could also be related to the fact that intellectual risk-taking behaviors were found to be more common among boys in the present study. Fathers being more supportive of these children may contribute to increased confidence and levels of responsibility, in turn increasing levels of intellectual risk-taking behavior.

As a result of the analyses performed in this study, it was determined that intellectual risk-taking behavior is a meaningful predictor of scientific attitude. Sünkür et al. (2013) and Bal-İncebacak et al. (2019), in research examining the relation of risk-taking behavior with different variables, determined that this skill displays a negative relation with such characteristics as low self-esteem, test anxiety, and fear of lessons but has a positive relation with variables including metacognitive skills such as permanence, self-efficacy, and enjoyment of and engagement in lessons. Beghetto (2009), through the IRT- S Scale, determined a positive relation between skills related to science. These results show that intellectual risk-taking behavior has a positive relation with the expected skills. The fact that intellectual risk-taking behavior is also affected by cognitive factors explains why it is a meaningful predictor of scientific attitude.

It was determined that the variables of intellectual risk-taking, gender, educational level of the mother, and educational level of the father, when taken together, have a low-level but meaningful relationship with the scientific attitudes of elementary school students. This finding, which was also confirmed in previous analyses, demonstrates that these variables are also effective on scientific attitudes. The fact that both scientific attitudes and intellectual risk-taking behaviors of students together with other factors may be affected by the scientific attitudes and educational patterns has been addressed in the related literature (Mıhladız and Duran, 2010). Therefore, the effect of intellectual risk-taking variable can be examined in further studies on scientific attitudes. By comparing the results of this study with the results of future studies performed with larger numbers of participants, the level of generalizability will be increased because, as the sample size increases in screening-type studies, the generalizability level also increases (Çakır and Yaman, 2016). Finally, the effect of changes in educational patterns in classroom environments on students' intellectual risk-taking behaviors should be examined in experimental studies.

Limitations

In this study, although valuable results have been contributed to the literature, there are some limitations. The values obtained

from the SAI II revealed that male students had higher scores for the scale's third dimension, "exhibiting scientific behavior." The influence quantity value (η^2) calculated for this was 0.02. This demonstrates that approximately 2% of the variance observed in SAI II scores is related to gender and this value is considerably low. At the same time, in the analyses performed for the IRT-S Scale, the same value was calculated for the dimensions of IS and CSE and for the overall scale.

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