IJARE

International Journal of Academic Research in Education (IJARE)
Volume 8, Issue 1, ss. 51-63, December 2022

Turkish JournalPark ACADEMIC

Investigation of relationship between intellectual risk taking in science learning and metacognitive awareness

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Abstract: *In this study, the relationship between intellectual risk taking in science learning and metacognitive awareness of sixth, seventh and eighth grade students was investigated by using the path analysis technique. This study is predictive research designed to determine the relationship between metacognitive awareness, grade level, gender, and students' intellectual risk taking. In the study, we examined a hypothesized model of relationships between variables. According to the hypothesized model, the endogenous variable of the study is intellectual risk taking (IRT) and exogenous variables are gender, grade level and metacognition. In this study, 418 students enrolled in ordinary formal secondary schools were involved. 191 were female while 227 were male. As data collection tools, two Likert type instruments; intellectual risk taking and metacognitive awareness scales, were used. The analysis of the data revealed that metacognitive awareness significantly predicted intellectual risk taking. In conclusion, there is a significant causal relationship between metacognitive awareness and intellectual risk taking. By increasing metacognitive awareness, we can increase intellectual risk taking and active participation to learning. It may be suggested to increase sample size and to use different higher-order thinking skills methods and measure metacognitive awareness and IRT.*

Keywords: *Metacognitive awareness, Intellectual risk taking, Science education, Secondary school students*

Suggested Citation: Fırat Açıkgül, E., Köksal, M.S. & Yılmaz, Y. (2022). Investigation of relationship between intellectual risk taking in science learning and metacognitive awareness. *International Journal of Academic Research in Education*, *8*(1), 51-63. DOI: 10.17985/ijare.1202400

Article History: Submitted 10 October 2022; Revised 22 December 2022; Accepted 26 December 2022

INTRODUCTION

Intellectual risk taking is a necessary behavior to participate actively in learning science. Taking intellectual risks such as asking questions and sharing thoughts in spite of uncertainties such as making a fool of one self and taking negative reactions, contributes to learning by active participation (Souza Fleith, 2000). Beghetto (2009) defined intellectual risk taking as behaviors including risks which aim to increase learning in a learning environment. Beghetto (2009), and Clifford and Chou (1991) summarized some kinds of intellectual risk-taking behavior as making explanations about the subjects, asking questions, giving answers to questions they do not know well, taking responsibilities, sharing ideas about the subject and trying untested solutions to the problems. All of these examples have different risks involving suspect about accuracy of ideas, trial of untested solutions and explanation with insufficient knowledge. Intellectual risk-taking behaviors increase active participation in learning, students' learning motivation and interest in learning (Beghetto, 2009). Beghetto (2009), in his study, found that intellectual

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risk-taking behavior is positively associated with self-efficacy and achievement. Similarly, Yaman and Köksal (2014) found that intellectual risk-taking behavior is positively associated with science achievement. Deveci and Aydin (2018) also reported that middle school students' intellectual risk taking and attitudes towards science are associated positively. Moreover, intellectual risk-taking behavior is a necessary factor for promotion of higher–order thinking (Souza Fleith, 2000; Tay et al., 2009), problem solving and decision making (Tay et al., 2009). In the literature above, the most important point is about association of intellectual risk taking with higher-order thinking since higher-order thinking is a desired outcome of 21st Century Skills Framework (Ananiadou & Claro, 2009; Scott, 2017) and of different curriculums across the World (Ministry of National Education (MoNe), 2018; South Australian Certificate of Education, 2012). Hence, promoting higher-order thinking is a needed step to make effective communication, collaboration and to solve problems effectively (Retnawati et al., 2018). Higher-order thinking involves understanding, transfer of knowledge, problem solving, critical thinking (Anderson & Krathwohl, 2001; Brookhart, 2010). Before the applying higher-order thinking, students should take intellectual risks in learning environment. In making decision about taking intellectual risks, students require evaluating alternatives before taking intellectual risks, monitor his/her risk-taking action and revise his/her behavior for next attempt. These processes are aspects of metacognitive awareness (Flavell et al., 2002). Metacognitive awareness involves one's awareness of cognitive processes and the ability to regulate, evaluate, and monitor thinking processes (Bonds et al., 1992).

Both of the variables, intellectual risk taking and metacognitive awareness are also affected by two important demographics characteristics; gender and grade level (Beghetto, 2009; Byrnes et al., 1999; Spence et al., 1999; Aydın & Ubuz, 2010). Beghetto (2009) found negative relationship between intellectual risk taking and grade level, while Byrnes et al. (1999) reported less inclination of female students to take intellectual risks than males. Similarly, metacognitive awareness also differed across gender and grade level, Spence et al. (1999) compared metacognitive awareness of females and males and they found that females had better scores on metacognitive awareness scores than males. Carr et al. (1999) also found a significant difference between females and males in terms of metacognitive awareness in favor of females. For grade level comparison, Aydın and Ubuz (2010) found that tenth grade students were metacognitively more aware than seventh grade students. Based on the theoretical relationship, association between intellectual risk taking and metacognitive awareness might be represented by the Figure 1. According to this theoretical model based on the literature, it has been determined that gender and grade level are a predictor of IRT and metacognitive awareness. Also, IRT and metacognitive awareness have been included as predictors of higher-order thinking in the model, as studies have shown that they contribute to the development of higher order skills.

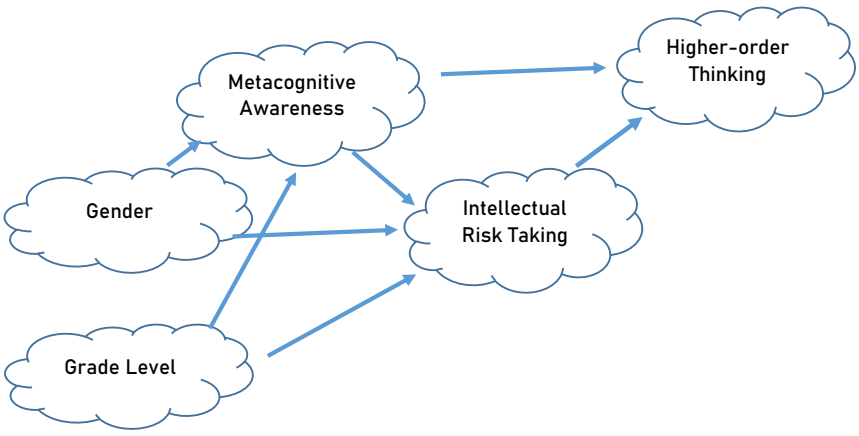

Figure 1. Theoretical model of association among gender, grade level, intellectual risk taking, metacognitive awareness and higher-order thinking.

In sum, the literature supported the relationship between meta-cognitive awareness and intellectual risk taking in promoting higher-order thinking of females and males in different grades. But the path of this association is not represented clearly to see mechanism of increasing higher-order thinking by taking intellectual risks since nearly all of the studies in the literature reported correlational associations rather than giving evidence to predictive relationship and amount of predictiveness power without including grade level and gender as variables. The purpose of this study is to investigate relationship between intellectual risk-taking behavior and metacognitive awareness of sixth, seventh and eighth grade students by using path analysis technique.

Intellectual Risk Taking, Metacognitive Awareness and Higher-order Thinking

To the best of our knowledge there is no study focusing on the relationship among intellectual risk taking, metacognitive awareness and higher-order thinking in the literature. However, there are some studies focusing on the relationship between intellectual risk taking and higher-order thinking and the relationship between metacognitive awareness and higher-order thinking, separately. Tay et al. (2009) investigated the relationship between intellectual risk taking and problem solving as higher-order thinking. Their sample involved 103 gifted 4-7th grade students and their findings showed that the relationship between intellectual risk taking and problem-solving skills was 0.60 as a value of Pearson correlation. Meyer et al. (1997) investigated challenge seekers' strategy use in project-based learning environments. In terms of intellectual risk takers (challenge seekers), their findings revealed that intellectual risk takers preferred deeper strategies than challenge avoiders in learning. Beghetto and Baxter (2012) developed a path model explaining the relationship between intellectual risk taking and science understanding as higher-order thinking and 207 elementary students participated into the study. Their model provided empirical evidence for the relationship between understanding and intellectual risk taking.

For another relationship which is in the focus of this study, Hassan and Rahman (2017) provided evidence showing the relationship between metacognitive awareness and problem solving as a higher-order thinking. Similarly, Sümen and Çalışıcı (2016) studied on the relationship between metacognitive awareness and problem solving with 171 prospective teachers. They made regression analysis for investigating the relationship. Their findings revealed that metacognitive awareness explained 15% of the observed variation in problem solving scores of the participants. According to Corliss (2005), metacognitive awareness helps students make adjustments in their planning and strategy use when they think critically. Kuhn and Dean (2004) revealed that critical thinking as a higher-order thinking involves awareness of thinking process and reflection on the thinking so that effective critical thinking is experienced. In a path analysis study, Akbay et al. (2018) reported that there was a direct relationship between metacognitive awareness and critical thinking of college students. Similarly, Magno (2010) also showed positive relationship between critical thinking and metacognitive awareness of college students by using path analysis method.

As seen in the literature represented above, the relationship between intellectual risk taking and higher-order thinking and the relationship between metacognitive awareness and higher-order thinking are well-established separately. However, there is a need to investigate direct relationship between IRT and metacognitive awareness by more advanced statistical technique than correlational studies. Based on these studies, it can be said that there is a need to test path model regarding the direct relationship between intellectual risk taking and metacognitive awareness by considering grade level and gender.

Intellectual Risk Taking and Metacognitive Awareness

Intellectual risk taking is expressed when uncertainty about the outcome of attempts to learn something (Atkins et al., 1991). During the process of making decision on taking an intellectual risk, the uncertainty led students to evaluate, monitor and change their ideas and next actions. These situations require being metacognitively aware about cognitive sources and processes in making a decision (Qiu et al., 2018). Relationship between metacognitive

awareness and intellectual risk taking is well-established in theoretical manner. However, there is a need to investigate for empirical evidence of this relationship. Some of the studies investigated the relationship by using correlational ways of analysis. Ugras (2018) provided indirect correlational evidence for the relationship between intellectual risk-taking skills and metacognitive awareness. In his study, 207 eighth grade students were involved and relationship between their self-efficacy in science, metacognitive awareness and achievement. His correlational finding showed that there was a moderate relationship between metacognitive awareness and two predictors of intellectual risk taking (Beghetto, 2009); achievement and self-efficacy in science. In another study, Landine and Stewart (1998) studied with 108 high school students to investigate the correlational relationship, however they also focused on the relationship between metacognitive awareness and predictors of intellectual risk taking; achievement and self-efficacy. They also showed that there was a significant correlation between metacognitive awareness and, academic achievement and self-efficacy. In another study, 629 undergraduate students were involved (Coutinho & Neuman, 2008). The purpose of the study was to model association between self-efficacy, goal orientation, metacognitive awareness and learning style. The findings of the study also provided a correlational support for the relationship between metacognitive awareness and self-efficacy (predictor of intellectual risk taking).

By using a comprehensive method of data analysis; path analysis, Özcan and Gümüş (2019) investigated the relationship between metacognitive awareness and problem-solving performance through metacognitive awareness, self-efficacy, motivation, and anxiety. Their findings provided two important evidences that metacognitive awareness and problem solving as a higher-order thinking was associated significantly and metacognitive awareness was associated with self-efficacy in mathematics as predictor of intellectual risk taking. This study has importance for our study since they contributed to existent literature on the relationship between metacognitive awareness and intellectual risk taking by providing more comprehensive evidence than correlational studies. However, this study also gave indirect correlational evidence for the relationship between metacognitive awareness and intellectual risk taking. In the literature, to the best of our knowledge, there is only one study investigating the relationship between intellectual risk-taking and metacognitive awareness, direct evidence was provided by Çakır and Yaman (2015). They studied the relationship with 208 middle school students by using correlational analysis. Their findings revealed that there was a moderate positive relationship between the students' intellectual risk-taking skills and metacognitive awareness levels.

Purpose of the study

In this study provided evidence is coming from correlational analysis, but understanding the nature of the relationship requires more comprehensive evidence by using other analysis methods such as path analysis. Hence the purpose of this study is investigating the relationship between intellectual risk-taking behavior and metacognitive awareness across gender and grade level by using path analysis technique. For this purpose, following model was tested to explain the relationship between intellectual risk-taking behavior and metacognitive awareness of middle school students.

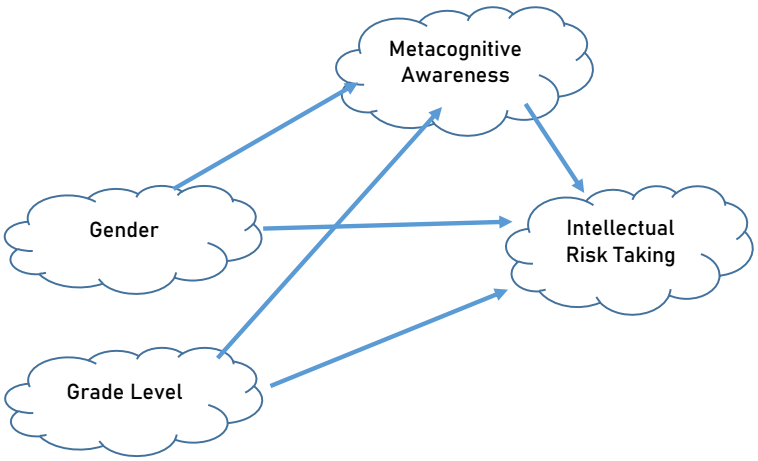

Figure 2. Theoretical model for association between intellectual risk taking and metacognitive awareness

METHOD

Research Design

This study is a predictive study conducted to determine the relationship between intellectual risk-taking skills (IRT) and metacognition awareness of 6th, 7th, and 8th grade students. In the study, path analysis, one of the structural equation modeling, was used to determine the relationship between the variables (Fraenkel et al., 2012; Tabachnick & Fidell, 2012). In path analysis, diagrams help clarify a researcher's ideas about the relationships between variables and can be directly translated into the equations needed for analysis (Tabachnick & Fidell, 2012). According to the model as in Figure 2, the endogenous variable of the study is IRT and exogenous variables are gender, grade level and metacognition. To examine the relationships determined in the theoretical model the following hypotheses are proposed:

1. Hypothesis 1: Grade level and gender significantly predict IRT both directly and indirectly through metacognitive awareness.
2. Hypothesis 2: Grade level, gender, and metacognitive awareness significantly predict IRT directly.
3. Hypothesis 3: The metacognitive awareness significantly predicts IRT.

Participants

Participants were 418 students from sixth, seventh, and eighth grade classrooms in a small-scale city in south east of Turkey during the 2018–2019 school year. Convenience sampling method was used to determine the participants (Fraenkel et al., 2012). The distribution of the participants by gender and grade level is as Table 1.

Table 1. The distribution of the participants by gender and grade level

		n	%
Grade level	6. grade	94	22.5
	7. grade	198	47.4
	8. grade	126	30.1
	Total	418	100.0
Gender	Female	191	45.7
	Male	227	54.3
	Total	418	100

Data Collection Tools

Metacognitive Awareness Inventory for Children (Jr. MAI) - B form), Intellectual Risk-Taking Scale, and demographic information questionnaire (gender and grade level) were used to collect data in the study. The Metacognitive Awareness Inventory for Children (Jr. MAI) - B Form was developed by Sperling et al. (2002) to measure metacognitive skills of 3-9 grade students. The scale was adapted to Turkish by Karakelle and Saraç (2007). Form B of the scale developed for 6th, 7th, 8th and 9th grade students and it consists of 18 items. In A and B forms, half of the items were related to cognitive knowledge (e.g., item 5) and the other half was related to regulation of cognition (e.g., item 16). A five-point Likert-type scale (never, rarely, sometimes, often, always) was used for each item in form B. The score from the scale is calculated by summing the item scores. A high total score from the scale indicates that metacognitive skills are also high at that level.

The Intellectual Risk-Taking Scale used in the study was developed by Beghetto (2009) and adapted to Turkish by Yaman & Köksal (2014). The scale consists of 18 items and four factors (Intellectual risk taking, self-efficacy in scientific creativity, interest in science, and teacher support). In this study, one factor (intellectual risk taking; 6 items) was used after the confirmatory factor analysis was performed, the scale was evaluated as one-dimensional and the total score average was analyzed.

Data Analysis

After the data collection phase, the data were examined and the data with missing values were not included in the research. In the analysis phase, first of all the items 'scores were converted to standard z-scores and z-scores less than - 3.0 or higher than + 3.0 were considered as outliers (Çokluk et al., 2010). In order to use path analysis, the assumptions were checked first and multivariate kurtosis coefficient was calculated to determine the multivariate normality assumption of the data and it was found that it was 3.64. Since this value is less than 5, the data provides the assumption of multivariate normality (Bentler, 2006). Then, the correlation coefficients between the variables were calculated first. The model was modified for path analysis by considering the correlation coefficients. Hypothesized model was tested using Maximum Likelihood method because data showed a multivariate normal distribution (Kline, 2010). The fit indices were calculated during the evaluation of model fit (χ2/sd, GFI, AGFI, RFI, NFI, NNFI, IFI, CFI, RMSEA, RMR and SRMR) and the model was evaluated in terms of criteria for fit indices (Schermelleh-Engel et al., 2003).

In this research, path diagram was created by drawing paths by considering indirect and direct relationships between variables in the theoretical model. Then, the model was tested with path analysis as a structural equation modeling by AMOS 23 program. Structural equation modeling (SEM) is a set of statistical techniques that allows the study of a set of relationships between one or more continuous or discrete variables (Tabachnick & Fidell, 2012). System of variables can be statistically tested by concurrent analysis to determine how consistent the

hypothesized model is with the data in SEM (Byrne, 2016). Three components were tested using path analysis. In the first component, it was tested that gender and grade level significantly predicted IRT through metacognitive awareness directly or indirectly. In the second component, the gender, grade level, and metacognitive awareness significantly predicted IRT directly. In the third component, the metacognitive awareness significantly predicted IRT directly.

FINDINGS

In this section, findings are represented in two parts: Preliminary analysis and findings for fit of the model.

Preliminary Analyses

Confirmatory Factor Analysis Results on Intellectual Risk-Taking Scale

Confirmatory factor analysis is a required step in path analysis to provide valid scores for further analysis. The goodness of fit statistics values for IRT scale were calculated. The fit indices obtained are represented in the Table 2.

Table 2. *Fit indices of IRT*

	Good Fit Values	Acceptable Fit Values	Model	Model Fit
χ2/df	$0 \leq x^2/df \leq 2$	$2 \leq x^2/df \leq 3$	1.59	Good
RMSEA	0 ≤ RMSEA ≤ .05	.05 ≤ RMSEA ≤ .08	0.038	Good
RMR	0 ≤ RMR ≤ .05	.05 ≤ RMR ≤ .08	0.047	Good
SRMR	0 ≤ SRMR ≤ .05	.05 ≤ SRMR ≤ .08	0.036	Good
RFI	.95 ≤ RFI ≤ 1	.90 ≤ RFI ≤ .95	0.96	Good
NFI	.95 ≤ NFI ≤ 1	.90 ≤ NFI ≤ .95	0.98	Good
NNFI	.97 ≤ NNFI ≤ 1	.95 ≤ NNFI ≤ .97	0.99	Good
IFI	.95 ≤ IFI ≤ 1	.90 ≤ IFI ≤ .95	0.99	Good
CFI	.97 ≤ CFI ≤ 1	.95 ≤ CFI ≤ .97	0.99	Good
GFI	.95 ≤ GFI ≤ 1	.90 ≤ GFI ≤ .95	0.96	Good
AGFI	.90 ≤ AGFI ≤ 1	.85 ≤ AGFI ≤ .90	0.93	Good

When Table 2 is examined, it is seen that the value of χ2 / df value is 1.59. This value indicates little difference between expected and observed model (Suhr, 2006). The standardized factor loadings of the scale ranged from 0.32 to 0.69 and t values ranged from 6.34 to 14.94. When the fit index values are examined, it is seen that all values are in the "Good Fit Values" range (Schermelleh-Engel et al., 2003). Therefore, it was determined that one-dimensional structure of IRT scale was confirmed by CFA.

Confirmatory Factor Analysis Results on Metacognitive Awareness Scale

The goodness of fit statistics of metacognitive awareness scale were calculated and considering the fit indices are represented in the Table 3. The fit indices were evaluated by Schermelleh-Engel et al. (2003).

Table 3. *Fit indices of metacognitive awareness scale*

	Good Fit Values	Acceptable Fit Values	Model	Model Fit
χ2/df	$0 \leq x^2/df \leq 2$	$2 \leq x^2/df \leq 3$	1.45	Good
RMSEA	0 ≤ RMSEA ≤ .05	.05 ≤ RMSEA ≤ .08	0.03	Good
RMR	0 ≤ RMR ≤ .05	.05 ≤ RMR ≤ .08	0.05	Good
SRMR	0 ≤ SRMR ≤ .05	.05 ≤ SRMR ≤ .08	0.04	Good
RFI	.95 ≤ RFI ≤ 1	.90 ≤ RFI ≤ .95	0.94	Acceptable
NFI	.95 ≤ NFI ≤ 1	.90 ≤ NFI ≤ .95	0.95	Good
NNFI	.97 ≤ NNFI ≤ 1	.95 ≤ NNFI ≤ .97	0.98	Good
IFI	.95 ≤ IFI ≤ 1	.90 ≤ IFI ≤ .95	0.98	Good
CFI	.97 ≤ CFI ≤ 1	.95 ≤ CFI ≤ .97	0.98	Good
GFI	.95 ≤ GFI ≤ 1	.90 ≤ GFI ≤ .95	0.96	Good
AGFI	.90 ≤ AGFI ≤ 1	.85 ≤ AGFI ≤ .90	0.94	Good

Table 3 shows that χ2/df value is 1.45. The standardized factor loadings of the scale ranged from 0.32 to 0.55, while t values ranged from 5.96 to 11.21. Also, all of the goodness of fit values is in the "good fit values" range (Schermelleh-Engel et al., 2003). According to the findings, it can be said that the one-dimensional structure of metacognitive awareness scale was confirmed.

Descriptive Analysis Results

Descriptive analysis before path analysis was done to see general distribution and normality in variables. The results of the descriptive analysis of the variables in the study are given in Table 4.

Table 4. *Descriptive values for variables of the study*

			Frequency	Percent	IRT	Metacognitive awareness
Gender	Female		191	45.7	3.77	69.50
	Male		227	54.3	3.81	67.92
Grade level	6. grade		94	22.5	3.97	70.44
	7. grade		198	47.4	3.79	67.40
	8. grade		126	30.1	3.67	69.26
	Mean	SS	Minimum	Maximum	Skewness	Kurtosis
IRT	3.7966	.66291	1,19	5.00	-.376	.090
Metacognitive awareness	68.6496	10.55762	33.35	90.00	-.243	-.154

According to the findings, the mean test score on the IRT scale was 3.79 and the mean score on the metacognitive awareness scale was 68.64. Furthermore, Table 4 indicated that mean scores of IRT for 6th, 7th, and 8th grades were 3.97, 3.79 and 3.67, respectively, so students' IRT scores decreases as the grade level increases. When the data were analyzed in terms of gender, the mean score of boys on IRT was higher than girls, the mean score of girls on the metacognitive awareness scale, is higher than boys. When the correlation coefficient values between the variables were examined, it is seen that there is a statistically significant relationship between and metacognition and IRT.

Findings for Testing the Hypothesized Model

In the study, the structural model was tested and it was concluded that all the paths were significant as shown in Table 5. The modified path diagram of the model is given in Figure 5.

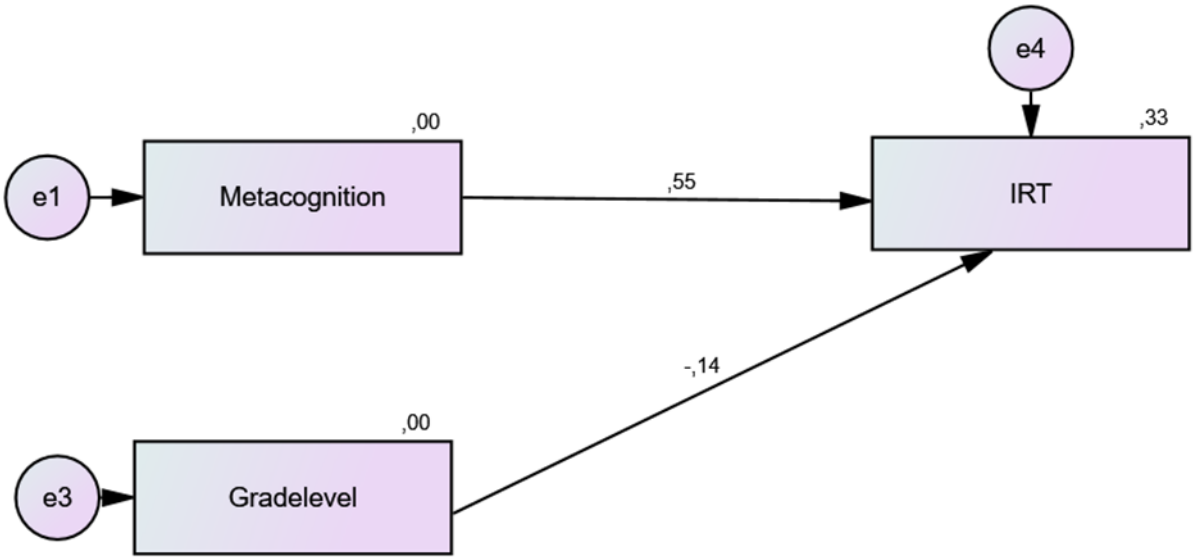

Figure 5. Modified model for the relationship between metacognitive awareness and IRT

The values related to the standardized regression coefficients and the significance of the regression coefficients are given in Table 5.

Table 5. *Reliability coefficients of the variables and standardized factor loadings of the items*

	B	β (Direct Effect)	S.E	C.R (t)	p
IRT <--- Metacognition	-.131	.554	.037	-3.573	***
IRT <--- Gradelevel	.035	-.143	.003	13.804	***

The findings of the analysis showed that metacognitive awareness appeared to be positively associated with IRT (β=0.55, c.r.=3.573, p<.01). Moreover, the results also revealed that grade level significantly predict IRT (β=-0.14, c.r.=13.804, p<.01) in negative direction. Cohen (1988) stated that if the effect size value is less than .2, is observed a small effect, when the effect value is between .3 and .5, medium effect and in cases where the effect value is .8 and above, a large effect is observed. Thus, it can be said that relationship between metacognitive awareness and IRT has a medium effect in practice, and grade level has a small effect on IRT. According to the findings, none of the indirect effects are statistically significant. In addition, when the variance ratios were analyzed, it was seen that metacognition awareness and grade level together explained 33% of the variance of IRT. The fit indices of the hypothesized model values calculated to determine the fit of the model are given in Table 6.

Table 6. *Fit indices of the hypothesized model*

	Good Fit Values	Acceptable Fit Values	Model	Model Fit
χ2/df	$0 \le x^2/df \le 2$	$2 \le x^2/df \le 3$	1.44	Good
p			0.22	
RMSEA	0 ≤ RMSEA ≤ .05	.05 ≤ RMSEA ≤ .08	0.03	Good
RFI	.95 ≤ RFI ≤ 1	.90 ≤ RFI ≤ .95	0.95	Good
NFI	.95 ≤ NFI ≤ 1	.90 ≤ NFI ≤ .95	0.97	Good
NNFI/TLI	.97 ≤ NNFI ≤ 1	.95 ≤ NNFI ≤ .97	0.98	Good
IFI	.95 ≤ IFI ≤ 1	.90 ≤ IFI ≤ .95	0.99	Good
CFI	.97 ≤ CFI ≤ 1	.95 ≤ CFI ≤ .97	0.99	Good
GFI	.95 ≤ GFI ≤ 1	.90 ≤ GFI ≤ .95	0.99	Good
AGFI	.90 ≤ AGFI ≤ 1	.85 ≤ AGFI ≤ .90	0.98	Good

When Table 6 is examined, the model is accepted as the fit indices of the model are within the range of "good fit values" (Schermelleh-Engel et al., 2003).

Discussion and Conclusion

This study is predictive research designed to determine the relationship of metacognitive awareness, grade level, gender, and students' intellectual risk taking. In the study, we examined a hypothesized model of relationships between variables. The hypothesized model established in the research was tested by path analysis. In the study, confirmatory factor analyzes of IRT and metacognition scales were conducted and one-dimensional structures of both scales were confirmed. In addition, correlation coefficients were calculated between the variables before the path analysis, and it was found that there was a significant relationship between IRT and metacognition variables. Based on preliminary analysis, the theoretical model was modified and path analysis was started. As a result of testing the modified model with path analysis, all paths were found to be significant. When the fit index values of the model were examined, it was found that all values were in the “Good Fit Values” ranges and the model was verified. (Çokluk et al., 2010; Hooper et al., 2008; Hu & Bentler, 1999; Kline, 2010; Schermelleh-Engel et al., 2003; Suhr, 2006; Tabachnick & Fidell, 2012).

According to the results of the study, metacognition and grade level variables in the model together explain 33% of the variance in IRT. Path analysis showed that metacognition awareness positivity significantly predicted IRT. Çakır and Yaman (2015) also revealed that there was a moderate positive relationship between the students' intellectual risk-taking skills and metacognitive awareness levels. Ugras (2018) likewise concluded that there was a moderate relationship between metacognitive awareness and two predictors of intellectual risk taking (Beghetto, 2009). Furthermore, Landine and Stewart (1998)’s study’s findings also provided a correlational support for the relationship between metacognitive awareness and self-efficacy (predictor of intellectual risk taking). By supporting these findings, the nature of the moderate positive relationship was determined with this study. Furthermore, it was found that increased metacognition awareness will increase IRT, contributing to the results in the literature. This result shows that increasing metacognitive awareness of students plays a moderate role in increasing intellectual risk-taking skills. Therefore, in addition to the studies in the literature (Akbay et al., 2018; Beghetto & Baxter, 2012; Hassan & Rahman, 2017; Magno, 2010; Sümen & Çalışıcı, 2016) that metacognitive awareness and IRT skills develop higher-order thinking skills, it can be argued that there is a path for the relationship. Dachner et al. (2017) also argued in their studies that IRT will increase in individuals who engage in metacognitive behaviors. This was explained by the fact that when students perceived autonomy regarding their working methods and high expectations from themselves, they acted more metacognitively and therefore took more intellectual risks (Dachner et al., 2017). Based on the findings, it is seen that development of students' metacognitive awareness may contribute to the increase in IRTs and thus increase of higher-order thinking. The

results of Özcan and Gümüş (2019)'s research, metacognitive awareness and problem solving as a result of a higher-order thinking is associated with a metacognitive awareness of self-efficacy in mathematics as predictor of intellectual risk taking, also reinforces this claim.

Another problem investigated in this study is to determine the relationship among gender, grade level, intellectual risk taking, and metacognitive awareness. According to the results of the study, unlike other studies (Açıkgül & Şahin, 2019; Aydın & Ubuz, 2010; Byrnes et al., 1999; Carr et al., 1999; Spence et al., 1999), there was no significant relationship between gender and intellectual risk taking and, gender and metacognitive awareness. Therefore, the gender was not included in the hypothesized model because there was no significant relationship between gender and other variables. This indicates that gender is not an indirect and/or direct predictor on IRT. When the results were examined in terms of grade level, it was determined that grade level was a direct negative predictor of IRT (2%). This result shows that the students' IRTs decrease as the class level increases. Beghetto (2009) also stated that as students' class levels increased their IRT skills decreased. However, students' metacognitive awareness levels differ from IRT. According to the results, grade level is not a significant predictor of metacognitive awareness, but students' metacognition awareness increases as grade level increases. Aydın and Ubuz (2010) also found that tenth grade students were metacognitively more aware than seventh grade students. Çakır and Yaman (2015) argued that, at the middle school level, the relationship between IRT and metacognition skills of the students could be seen at the highest level. The reason for this claim was explained by the increase in metacognition skills, while the level of IRT decreases as the students' class level increases. Therefore, in this study, due to the limited participation of participants in the middle school level, the strength, direction and form of the relationship between grade level and metacognitive awareness, and IRT can be investigated at primary and high school level and clear evidence can be established for the relationship between metacognitive awareness and IRT. In addition, in this study, it was determined that metacognitive awareness was the predictor of students' IRTs. In another study, using structural equation modeling, it may be suggested to investigate the direct or indirect effects of metacognitive awareness and IRT on higher order thinking by one kind of higher-order thinking. It is also possible to determine whether demographics variables other than gender and grade level predict IRT. This study may be limited to the sample size, so it may be suggested to increase sample size and to use different higher-order thinking skills methods and measure metacognitive awareness and IRT.

Declarations on Ethical Standards

Conflicts of interest The authors declare that they have no conflict of interest.

Informed Consent The authors acknowledge that informed consent has been obtained from legal guardians.

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