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THE EFFECT OF NON-TRADITIONAL TEACHING METHODS USED IN SCIENCE LESSONS ON INTELLECTUAL RISK-TAKING BEHAVIORS: A META-ANALYSIS STUDY

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ABSTRACT

This study aimed to synthesize and statistically combine the results of studies examining the effect of non-traditional teaching methods on intellectual risk-taking behavior in science courses in the context of Turkey. In this regard, the meta-analysis method was utilized in the study, and the overall effect size of the effect of non-traditional teaching methods used in the science course on intellectual risk-taking behavior was calculated. The literature review required for this study was conducted through the Higher Education Council of Turkey (YÖK) Thesis Center, and only thesis studies were included. The literature review used the keywords determined by the literature research. After the inclusion and exclusion criteria of the obtained studies were established, the necessary elimination was made. Within the scope of the study's literature search and selection criteria, nine theses studies were identified, and the essential analyses were made. The number of observations, arithmetic averages, and standard deviation measurements based on experimental control groups regarding the pre-test and post-test measurements of nine different theses included in the research were discussed. Within the scope of meta-analysis, standardized mean difference (SMD) values, known as Cohen-d in the literature, were used as the type of effect size based on the number of observations and descriptive statistics of reference studies. In line with the analysis, based on the results of the random effect type in the post-test context, the overall effect size of the scale score averages between the experimental and control groups for the post-test applications was found to be statistically significant ($p<0.05$). However, within the scope of the standardized mean difference (SMD) value known as Cohen-d, the overall effect size for the mean differences between the experimental and control groups for the post-test applications was low ($SMD=0.20<0.424<0.50$).

Keywords: Non-traditional teaching methods, intellectual risk-taking behaviors, meta-analysis.

INTRODUCTION

Risk-taking behavior corresponds to behavior that has no expectations about the consequences and may even create some dangerous situations, as well as positive behaviors such as gaining new experiences and finding new solutions to problems (Alexander et al., 1990; Çiftçi, 2006). Intellectual risk-taking behaviors can be mentioned as a positive dimension of risk-taking behaviors. Intellectual risk-taking behavior is a set of risky behaviors that students take for learning in learning environments (Beghetto, 2009). Intellectual risk-taking behaviors, which we define as risky with this dimension, support students' learning processes in learning environments (Akkaya & Köksal, 2022). In the literature, risky behaviors in learning environments include behaviors such as exhibiting a new psychomotor behavior, criticizing, discussing, presenting non-routine evaluations, bringing original explanations to a topic, sharing different ideas with other stakeholders in learning environments, undertaking a non-routine task, and self-criticism (Beghetto, 2009; Clifford, 1991; Robinson, 2011; Skaar, 2009; Taylor, 2010). In this case, increasing the frequency of intellectual risk-taking behaviors in learning environments contributes positively to student learning. The positive relationship between intellectual risk-taking behavior and academic achievement is supported by studies in the literature (Akkaya & Köksal, 2022; Beghetto, 2009; Çakır & Yaman, 2015; Tay et al., 2009). Considering academic success as an indicator of achieving the desired goals in the learning environment, increasing the frequency of intellectual risk-taking behaviors in learning environments can be expressed as a desirable situation.

Learning environments can be modified for different disciplines to achieve learning objectives. These modifications aim to facilitate student achievement of the objectives as well as to increase the retention of learning. The arrangements made in the learning environment vary according to learning disciplines. When designing the learning environment of science as a learning discipline, a number of factors, such as course content, learning objectives, and students' characteristics, are considered. These arrangements include using different teaching methods in the teaching process. The teaching methods chosen in science courses help students to reach their learning objectives. The academic success of the student can evaluate the effectiveness of the chosen method. In this regard, it can be stated that there is a positive relationship between the effectiveness of the learning method and academic achievement. The choice of teaching methods has taken a different path, especially with the integration of constructivism philosophy into education. Within the teaching process, a teaching environment has been constructed in which the student is at the center. The learning methods used in this direction have evolved into methods in which the student actively directs the learning process. Among these evolving methods are cooperative learning, problem-solving-based learning, project-based learning, extracurricular learning, etc., where students can actively participate in the learning process. Numerous studies in the literature indicate that these methods increase students' achievement (Ayaz & Söylemez,2015; Chen & Yang, 2019; Donker et al., 2014; Ileri et al., 2020; Lei et al., 2022; Orhan, 2019; Orhan & Durak Men, 2018; Ören, 2020; Yokuş & Ayçiçek, 2019). In this respect, a study evaluating the approaches used in a constructivist learning environment was conducted by Ayaz and Şekerci (2015). In Ayaz and Şekerci's (2015) meta-analysis of 53 studies, the constructivist learning approach was compared with traditional teaching methods, and they stated that constructivist learning approaches positively affected students' academic achievement. Besides students' achievement, these methods used in a constructivist learning environment are also effective on other factors affecting learning (such as motivation, attitude, and perception) (Dilbaz et al., 2016; Orhan & Durak Men, 2018; Şahin &Yılmaz, 2020; Yavuz Topaloğlu & Balçın, 2021).

Examining student-centered teaching methods, it is observed that many intellectual risk-taking behaviors are integrated into the teaching process. Since it is known that there is risk-taking behavior in the nature of learning, it is expressed as a desired situation that these behaviors exist in the learning environment. These methods can be considered as methods that include intellectual risk-taking behaviors such as discussion, criticism, coming up with a new idea, and making non-routine evaluations. In parallel with this case, some experimental studies show that these methods change the frequency of intellectual risk-taking behaviors (Akkaya & Köksal, 2022; Öner et al., 2020).

The objective of this study is to determine the effect of using non-traditional teaching methods and techniques in science courses on students' mental risk-taking behaviors. Considering that intellectual risk-taking behaviors positively affect student achievement (Akkaya & Köksal, 2022) and predict it (Akdağ & Köksal, 2022; Özbay & Köksal, 2021), it is necessary to include practices to identify and increase these behaviors. Clifford (1991) argued that competence rewards and skill development rewards are associated with intellectual risk-taking behavior, while extrinsic rewards are associated with reduced risk-taking. Bransford and Donovan (2005) argued that providing students with a wide range of ideas and encouraging diverse thinking and disagreement can foster a classroom environment in which both teachers and students value intellectual risk-taking. Akkaya and Köksal (2022) stated that the use of animations with role model content in the teaching process in the science course in the classroom positively affected students' intellectual risk-taking behaviors. Soutter and Clark (2023) used the Harkness method to make intellectual risk-taking behavior a culture in the classroom. In this case, it would not be inaccurate to refer to intellectual risk-taking behavior as a type of behavior affected by the strategies and methods adopted in the learning process. In this sense, our study reveals to what extent the teaching methods, which we call non-traditional methods, discussed in the studies in the literature, affect intellectual risk-taking behaviors (the effect size) by meta-analysis method.

METHOD

In this study, meta-analysis was used to combine the results of independent experimental studies. Meta-analysis is a technique for synthesizing research that aggregates the findings of primary quantitative investigations in a specific field, chosen using defined standards (Kanadlı, 2021). Differing effect sizes and methodological differences are among the reasons why the meta-analysis method was preferred in the study (Demir & Başol, 2014). Meta-analysis is a statistical method that synthesizes and then reinterprets the findings obtained from different individual studies (Bayraktar, 2020; Card, 2012; Wolf, 1986).

Literature Review Process

National thesis studies examining the effect of non-traditional teaching methods on intellectual risk-taking behavior in science courses were evaluated, and the Higher Education Council of Turkey (YÖK) Thesis Center was used to identify these studies. The studies presented here cover all relevant studies uploaded until April 2022. In this database, keywords such as "intellectual risk-taking", "academic risk-taking", "academic risk-taking and science education", "intellectual risk-taking and science education", "science, academic achievement, and risk-taking," and combinations of these words were entered as keywords. The studies were evaluated one by one, and a total of nine theses published between 2007 and 2021 that met the inclusion and exclusion criteria for the problem situation were identified.

Inclusion and Exclusion Criteria of the Studies Obtained

The phase in which inclusion and exclusion criteria are determined is the most important phase in meta-analysis studies. The criteria determined are critical for the successful conduct of the study and for other researchers to reach similar results by using the same criteria (Card, 2012). Inclusion criteria of the study:
Time: No time limit was set for the studies included in the research.
Type of publication: The studies included in the research consist of national master's and doctoral theses.
Research methodology: The studies included in the research include experimental and quasi-experimental studies that aim to evaluate intellectual risk-taking behavior and academic achievement in science courses.
Statistical data: The studies included in the research include arithmetic mean (X), standard deviation (SD), sample size (N), T and P values or data that can reach these values to calculate effect sizes.

Not all studies were evaluated in the screening conducted through the Higher Education Council of Turkey (YÖK) Thesis Center. In other words, exclusion criteria were set for this study. Exclusion criteria of the study:

- Studies on science courses in which mental or academic risk-taking behavior was not examined were not included in the meta-analysis.
- Studies that did not use a scale in intellectual risk-taking behavior were not included in the meta-analysis.
- Studies that did not contain statistical data for meta-analysis were not included in the study.
- Non-experimental studies were not included in the study.

Codification of The Studies

A literature review was conducted several times at different times, and a meta-analysis was performed with nine studies that met the exclusion and inclusion criteria. A coding form was developed to identify these studies. The coding form should be general enough to include all studies and specific enough to reveal study differences (Demir & Başol, 2014). In the meta-analysis coding form of the study, "*study number, study title, author's name and surname, year of the study, sample group and scale used, sample size, method of the study, arithmetic mean and standard deviation values of the experimental and control groups*" are included.

Data Analysis and Statistical Model Selection

In the statistical analysis phase of the study, meta-analysis was implemented to compare the means of independent groups. The number of observations, arithmetic averages, and standard deviation measurements on the basis of experimental control groups for the pre-test and post-test measurements of 9 different theses included in the study were discussed. Within the scope of the meta-analysis, the effect size type was based on the standardized mean difference (SMD) values, known as Cohen-d in the literature, based on the number of observations and descriptive statistics of the reference studies.

When evaluating the SMD effect size, it is concluded that there is a low effect if this value is in the range of [0.20, 0.50), a medium effect if it is in the range of [0.50-0.80), and a high effect if it is 0.80 and above. (Cohen, 1988: p.1992; Söner, 2021). In order to choose between fixed and random effects, a heterogeneity test was applied I^2 and the Q statistic was used in the test context (Higgins & Thompson, 2002; Higgins et al., 2003). In the context of meta-analysis, the overall SMD value was calculated over the data obtained from the reference studies and tested with the significance test. The Egger test (Egger et al., 1997) and the Begg and Mazumdar rank correlation test (Begg & Mazumdar, 1994) were applied to test for publication bias. A funnel plot and a forest plot were created to visualize the meta-analysis results. The meta package (Balduzzi et al., 2019) in the R-Project (R Core Team, 2022) program was used to obtain all statistical findings for meta-analysis.

FINDINGS

In this section of the study, the heterogeneity test of the studies included in the meta-analysis study, the findings on the effect sizes of whether they show publication bias, and the forest plots are presented.

Meta-Analysis Results for Pre-Test Data

Table 1 shows the heterogeneity test results obtained for the meta-analysis findings for the pre-test application studies.

Table 1. Heterogeneity Test for Pre-Test Application Studies

I^2	95%-CI	Q	sd	p
67.3%	[34%; 83.8%]	24.450	8	0.002

CI: Confidence interval

For the pretest studies included in the meta-analysis presented in Table 1, heterogeneity was found to be moderate (I^2=67.3) and statistically significant ($p<0.05$). Following the heterogeneity test, effect-type analyses were conducted for the pretest applications. Table 2 shows the meta-analysis effect type results for the pre-test applications.

Table 2. Effect-Type Analyses for Pre-Test Application Studies

Effect type	SMD	95%-CI	z	p
Fixed effect	0.069	[-0.088; 0.226]	0.860	0.391
Random effect	0.028	[-0.286; 0.342]	0.170	0.863

CI: Confidence interval

The effect-type analyses presented in Table 2 are based on the random effect-type results since heterogeneity is significant in the context of pre-test studies. Based on the results of the random effect type, the overall effect size of the mean scale scores between the experimental and control groups for the pre-test applications was not statistically significant (p>0.05). Within the scope of SMD value, the overall effect size for the mean differences between the experimental and control groups for the pre-test applications was low (SMD=0.028<0.20). Along with the heterogeneity test and the analyses to determine the type of effect for the pretest applications, the forest plot for the size of the random effect type is examined in Figure 1.

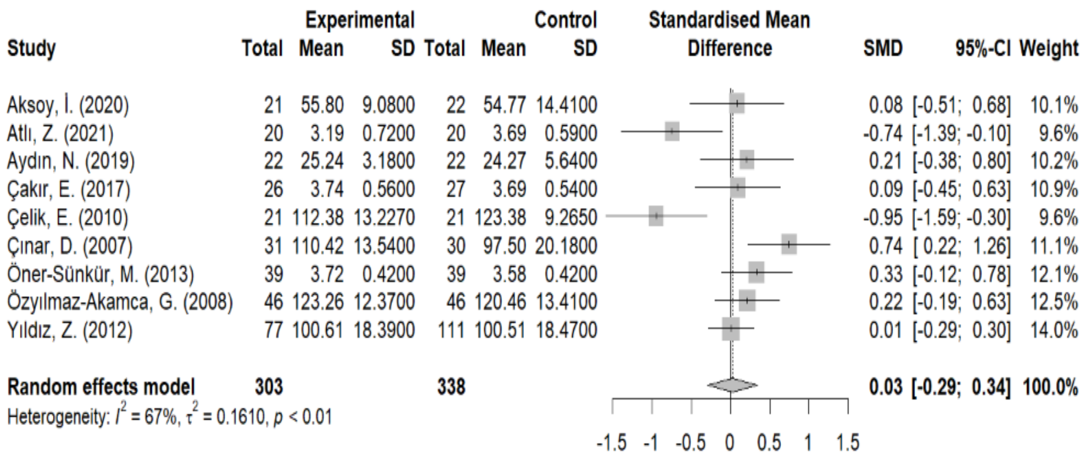

Figure 1. Forest Plot for Random Effect Type Findings in Pre-Test Application Studies.

Figure 1 shows the forest plot for the random effect type analysis in the pre-test application studies. The forest plot shows the SMD and weight statistics of all reference studies in the context of the pre-test treatments for the random effect type results. According to the forest plot, the effect size of six studies in the pre-test applications was positive, and the effect size of two studies was negative. For the scale score averages between the experimental and control scores, the SMD average of the pre-test applications is also very close to zero (SMD=0.03). In line with the findings obtained, the funnel plot for the pretest applications is shown in Figure 2.

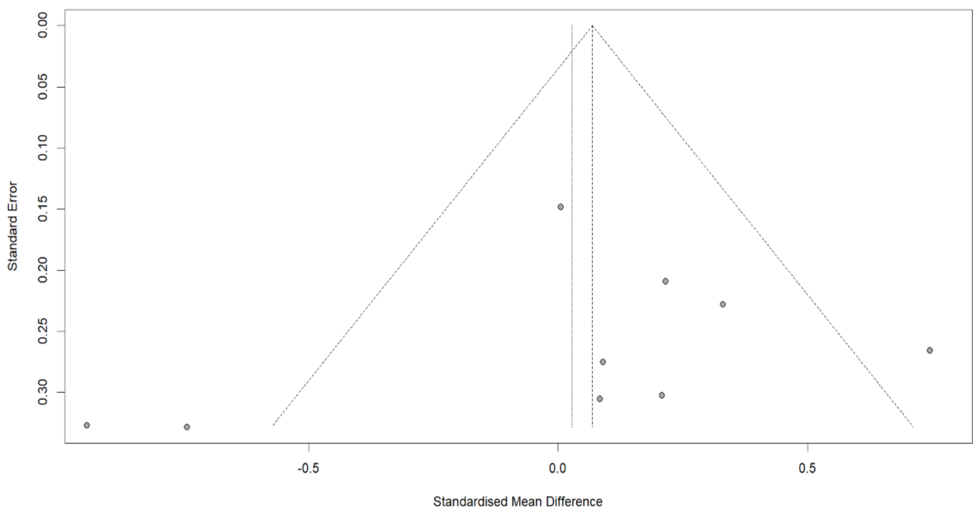

Figure 2. Funnel Plot for Pre-Test Application Studies.

According to the funnel plot given in Figure 2, the SMD values of the pre-test application studies exhibit an approximately symmetrical distribution, and this result supports the conclusion that there is no publication bias. Finally, the publication bias tests presented in Table '3' were conducted for the pre-test applications.

Table 3. Tests of Publication Bias for Pre-Test Application Studies

Egger test					Begg and Mazumdar test		
Constant term	B	t	sd	p	Tau	z	p
0.435	-1.579	-0.710	7	0.503	0.401	-1.460	0.144

B: Beta coefficient, sd: Degrees of freedom, Tau: Kendall-Tau correlation

Table 3 shows the results of the Egger test and Begg and Mazumdar test for the pre-test application studies. According to the results of both publication bias tests, there was no publication bias in the comparisons for the pre-test applications ($p>0.05$). Following the analyses conducted for the pre-test applications, similar analyses were conducted for the post-test applications. First, the heterogeneity test results obtained for the meta-analysis findings for the post-test applications studies are analyzed in Table 4.

Meta-Analysis Results for Post-Test Data

Table 4 shows the heterogeneity test results obtained for the meta-analysis findings for the post-test application studies.

Table 4. Heterogeneity Test for Post-Test Application Studies

I^2	95%-CI	Q	sd	p
65%	[28.6%; 82.8%]	22.850	8	0.036

CI: Confidence interval

In line with the data obtained from Table 4, heterogeneity for the post-test studies included in the meta-analysis was found to be moderate (I^2=65%) and statistically significant ($p<0.05$). Table 5 shows the meta-analysis effect type results for the post-test applications.

Table 5. Effect Type Analyses for Post-Test Application Studies

Effect type	SMD	95%-CI	z	p
Fixed effect	0.448	[0.289; 0.607]	5.520	<0.001
Random effect	0.424	[0.138; 0.710]	2.900	0.004

CI: Confidence interval

Table 5 shows the meta-analysis effect type results for the post-test applications. Since heterogeneity is significant in the context of post-test studies, the random effect type results will be taken as a basis. According to the random effect type results, the overall effect size of the scale score averages between the experimental and control groups for the post-test applications was found statistically significant ($p<0.05$). However, within the scope of SMD value, it was seen that the overall effect size for the mean differences between the experimental and control groups for the post-test applications was at a low level (SMD=0.20<0.424<0.50). Along with the heterogeneity test and the analyses to determine the type of effect for the post-test applications, the forest plot for the size of the random effect type is examined in Figure 3.

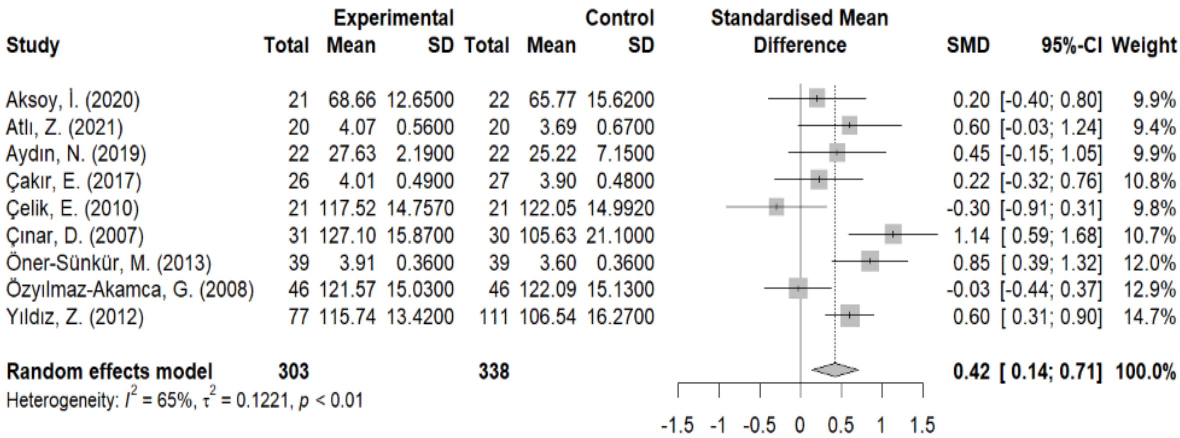

Figure 3. Forest Plot for Random Effect Type Findings in Post-Test Application Studies.

Figure 3 shows the forest plot for the random effect type analysis in the post-test application studies. The forest plot presents the SMD and weight statistics of all reference studies in the context of post-test treatments for the random effect type results. According to the forest plot in the post-test applications, the effect size of six studies was positive, and the effect size of two studies was negative. For the scale score averages between the experimental and control scores of the post-test applications, the SMD average was also found to be far from zero (SMD=0.42). In line with the findings obtained, the funnel plot for the post-test applications is analyzed in Figure 4.

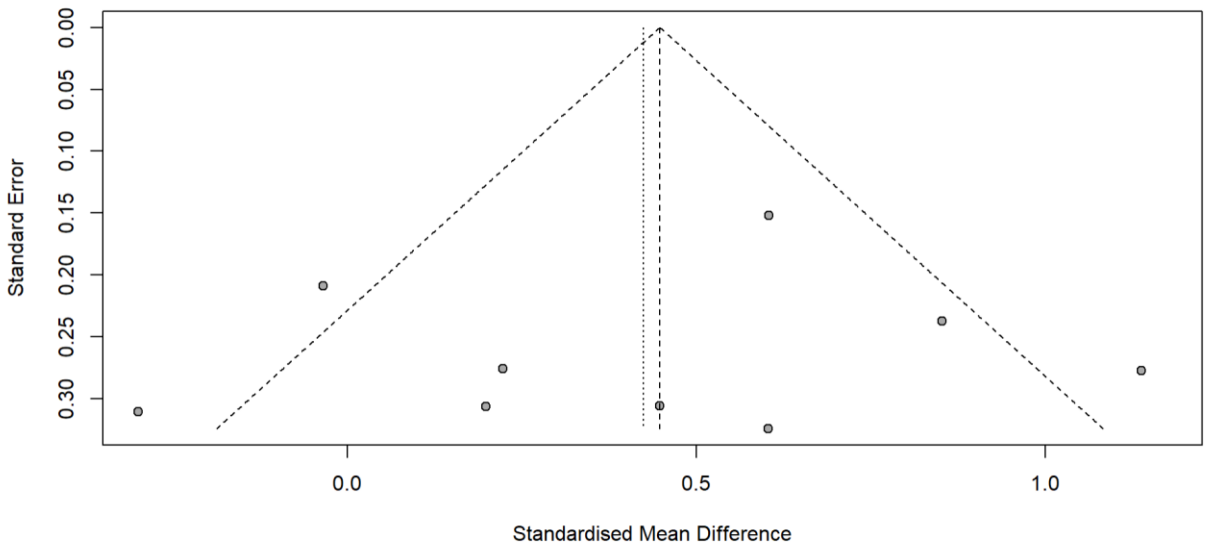

Figure 4. Funnel Plot for Post-Test Application Studies.

In the funnel plot given in Figure 4, the SMD values of the post-test implementation studies exhibit an approximately symmetrical distribution, indicating that there is no publication bias. Finally, the publication bias tests presented in Table 6 were conducted for the post-test applications.

Table 6. Publication Bias Tests for Post-Test Application Studies.

Egger test					Begg and Mazumdar test		
Constant term	B	t	sd	p	Tau	z	p
0.697	-1.058	-0.460	7	0.066	0.349	-0.210	0.835

B: Beta coefficient, sd: Degrees of freedom, Tau: Kendall-Tau correlation

Table 6 shows the results of the Egger, Begg and Mazumdar tests applied for the post-test application studies. Based on the results of both publication bias tests for the post-test applications, it was observed that there was no significant publication bias in the experimental-control comparisons (p>0.05).

CONCLUSION and DISCUSSION

In conclusion, a meta-analysis of the effects of traditional and non-traditional teaching methods on intellectual risk-taking behaviors showed that the overall effect size for the mean differences between the experimental and control groups had an effect size in favor of non-traditional methods, albeit at a low level (SMD=0.20<0.424<0.50). There are not many studies on intellectual risk-taking in the literature. Nonetheless, in the meta-analysis study of Brynes et al. (1999), including 150 studies, it was stated that intellectual risk-taking differed in terms of gender.

In the literature, meta-analyses on non-traditional teaching approaches have generally focused on the concept of academic achievement. It is acknowledged that there is a positive relationship between intellectual risk-taking behavior and academic achievement (Akkaya & Köksal, 2022; Beghetto, 2009; Çakır & Yaman, 2015; Tay et al., 2009), and intellectual risk-taking behaviors predict academic achievement (Akdağ & Köksal, 2022; Özbay & Köksal, 2021). In this regard, meta-analysis studies examining the effect of non-traditional approaches on academic achievement can be analyzed. Accordingly, Orhan (2019) conducted a meta-analysis study to compare the effect of academic achievement and flipped learning on academic achievement with the effect of learning with traditional methods on academic achievement and stated that the effect of reversed teaching method on academic achievement was 0.744 with an error of 0.80 according to the fixed effects model. This effect size is moderate (Cohen et al., 2007). In their meta-analysis study on the effectiveness of teaching learning strategies on academic achievement, Donker et al. (2014) analyzed 58 articles, including 95 strategy interventions. Nine of the articles they examined were within the scope of science, and according to the results of their meta-analysis, the effect of teaching learning strategies on achievement in science courses was determined as .73. Ayaz and Söylemez (2015) conducted a meta-analysis study on the effect of a project-based learning approach on academic achievement in science courses. The results of this study show that the project-based learning approach positively affects student academic achievement in science courses compared to traditional teaching methods. In their meta-analysis study to evaluate students' academic achievement of project-based learning, Cheng and Young (2019) reported that the overall average weighted effect size for students indicated that project-based learning had a moderate to significant positive effect on students' academic achievement compared to traditional teaching. In their study, Ileri et al. (2020) examined the effect of a cooperative learning approach on academic achievement in science education with a meta-analysis method. According to the results obtained from the study, it was stated that the cooperative learning approach had a positive and strong effect on student's academic achievement. Yokuş and Ayçiçek (2019) conducted a meta-analysis study to determine the effect of concept cartoons on science course academic achievement. Based on the findings of this study, it was stated that the learning-teaching processes in which concept cartoons were at the center were effective on students' academic achievement, and the average effect size value obtained from the studies was positive and had a significant effect size. In their study, Lei et al. (2022) examined the effect of game-based learning on students' science achievement. The results of this study indicate that the effect of game-based learning on academic achievement is positive. Orhan and Durak Men (2018) examined the effect of web-based instruction on students' science course achievement and attitudes through meta-analysis. The study results indicated that web-based instruction's effect size value on students' academic achievement was significant. Sarı and Ören (2020) conducted a meta-analysis study to determine the effect of inquiry-based learning strategies on students' academic achievement. The overall effect size of this learning strategy on students' academic achievement was found to be moderate according to the random effects model. To conclude, non-traditional teaching methods increase science achievement. Considering all the studies in general, although meta-analysis studies on intellectual risk-taking behavior are not numerous, the literature contains many meta-analysis studies examining the effect of non-traditional teaching methods on academic achievement. The overall findings of the studies show that non-traditional methods have a moderate or large effect on academic achievement. However, in our study, the effect of non-traditional methods used in science courses on intellectual risk-taking behavior was determined to be low.

SUGGESTIONS

Only the effect of non-traditional teaching methods on science education on intellectual risk-taking behavior and the studies in the Higher Education Council of Turkey (YÖK) Thesis Center were examined in this study. This is one of the limitations of our research. In future studies, different publication sources related to the topic can be evaluated. In our study, the impact of non-traditional methods on intellectual risk-taking has been examined. Subsequent research can investigate different factors affecting the method of intellectual risk-taking using the meta-analysis method. In this study, only intellectual risk-taking studies in the field of science were examined. In future studies, intellectual risk-taking studies in other fields can be evaluated.

ETHICAL TEXT

This article is a study that does not require an ethics committee.

In this article, the journal writing rules, publication principles, research and publication ethics, and journal ethical rules were followed. The responsibility belongs to the author (s) for any violations that may arise regarding the article.

Author(s) Contribution Rate: Author's contribution rate is 100%.

REFERENCES

Akdağ, E., & Köksal, M. S. (2022). Investigating the Relationship of Gifted Students' Perceptions Regarding Science Learning Environment and Motivation for Science Learning with their Intellectual Risk Taking and Science Achievement. *Science Education International*, *33*(1), 5-17.

Akkaya, G., & Köksal, M. S. (2022). The effect of animations involving role models taking intellectual risks on fourth-grade gifted students' intellectual risk-taking behaviors and science learning. *International Journal of Curriculum and Instruction*, *14*(3), 2812-2843.

Alexander, C. S., Kim, Y. J., Ensminger, M., Johnson, K. E., Smith, B. J., & Dolan, L. J. (1990). A measure of risk taking for young adolescents: Reliability and validity assessments. *Journal of youth and adolescence*, *19*, 559-569.

Ayaz, M. F., & Söylemez, M. (2015). Proje tabanlı öğrenme yaklaşımının Türkiye'deki öğrencilerin fen derslerindeki akademik başarılarına etkisi: Bir meta-analiz çalışması. *Eğitim ve Bilim*, *40*(178).

Ayaz, M. F., & Sekerci, H. (2015). The Effects of the Constructivist Learning Approach on Student's Academic Achievement: A Meta-Analysis Study. *Turkish Online Journal of Educational Technology-TOJET*, *14*(4), 143-156.

Balduzzi, S., Rücker, G., & Schwarzer, G. (2019). How to perform a meta-analysis with R: A practical tutorial. *BMJ Ment Health*, *22*(4), 153-160.

Bayraktar, Ş. (2020). *Eğitimde meta-analiz çalışmaları.* B. Oral ve A. Çoban (Ed.), Kuramdan uygulamaya eğitimde bilimsel araştırma yöntemleri içinde (s. 357-378). Pegem Akademi Yayıncılık.

Begg, C. B., & Mazumdar, M. (1994). Operating characteristics of a rank correlation test for publication bias. *Biometrics*, 1088-1101.

Beghetto, R. A. (2009). Correlates of intellectual risk taking in elementary school science. *Journal of Research in ScienceTeaching, 46*(2), 210–223.

Bransford, J. D., Donovan, M. S. (2005). Scientific inquiry and how people learn. In Donovan M. S., Bransford J. D. (Eds.), *How students learn: History, mathematics, and science in the classroom* (pp. 397–420). The National Academies Press.

Byrnes, J. P., Miller, D. C., & Schafer, W. D. (1999). Gender differences in risk taking: A meta-analysis. *Psychological Bulletin, 125*(3), 367–383.

Card, N. A. (2012). *Applied meta-analysis for social science research.* The Guilford Press.

Chen, C. H., & Yang, Y. C. (2019). Revisiting the effects of project-based learning on students' academic achievement: A meta-analysis investigating moderators. *Educational Research Review*, *26*, 71-81.

Clifford, M. M. (1991). Risk taking: Theoretical, empirical and educational considerations. *Educational Psychologist,* 26, 263-297.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd. edition). New Jersey: Lawrence Erlbaum Associates, Inc.

Çakır, E., & Yaman S. (2015). Ortaokul öğrencilerinin zihinsel risk alma becerileri ve üst bilişsel farkındalıkları ile akademik başarıları arasındaki ilişki. *Gazi Eğitim Bilimleri Dergisi, 1/2,* 163-178.

Çiftçi, S. (2006). *Sosyal bilgiler öğretiminde proje tabanlı öğrenmenin öğrencilerin akademik risk alma düzeylerine, problem çözme becerilerine, erişilerine, kalıcılığa ve tutumlara etkisi.* (Yayımlanmamış Doktora Tezi). Selçuk Üniversitesi.

Demir, S., & Basol, G. (2014). Effectiveness of computer-assisted mathematics education (came) over academic achievement: A meta-analysis study. *Educational Sciences: Theory and Practice*, *14*(5), 2026-2035.

Dilbaz, G. A., Yelken, T. Y., & Özgelen, S. (2016). Araştırma temelli öğrenmenin fen ve teknoloji dersine yönelik tutum ve araştırma becerileri üzerindeki etkisi. *İlköğretim Online*, *15*(2).

Donker, A. S., De Boer, H., Kostons, D., Van Ewijk, C. D., & van der Werf, M. P. (2014). Effectiveness of learning strategy instruction on academic performance: A meta-analysis. *Educational Research Review, 11*, 1-26.

Egger, M., Smith, G. D., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *Bmj*, *315*(7109), 629-634.

Gajda, A., Karwowski, M., & Beghetto, R. A. (2017). Creativity and academic achievement: A meta-analysis. *Journal of Educational Psychology, 109*(2), 269–299.

Higgins, J. P., & Thompson, S. G. (2002). Quantifying heterogeneity in a meta-analysis. *Statistics in Medicine*, *21*(11), 1539-1558.

Higgins, J. P., Thompson, S. G., Deeks, J. J., & Altman, D. G. (2003). Measuring inconsistency in meta-analyses. *Bmj*, *327*(7414), 557-560.

İleri, Y. E., Selvi, M., & Köse, M. (2020). Fen bilimleri eğitiminde işbirlikli öğrenme yaklaşımının akademik başarıya etkisi: bir meta-analiz çalışması. *Ihlara Eğitim Araştırmaları Dergisi*, *5*(1), 51-84.

Kanadlı, S. (2021). Sosyal bilimlerde R ile meta–analiz ve meta–analitik yapısal eşitlik modellemesi. *Pegem Akademi*.

Lei, H., Chiu, M. M., Wang, D., Wang, C., & Xie, T. (2022). Effects of game-based learning on students' achievement in science: A meta-analysis. *Journal of Educational Computing Research*, *60*(6), 1373-1398.

Orhan, A. (2019). The effect of flipped learning on students' academic achievement: A meta-analysis study. *Cukurova University Faculty of Education Journal*, 48 (1), 368-396.

Orhan, A. T., & Durak Men, D. (2018). Web tabanlı öğretimin fen dersi başarısına ve fen dersine yönelik tutuma etkisi: bir meta analiz çalışması. *Manisa Celal Bayar Üniversitesi Sosyal Bilimler Dergisi, 16*(3), 245-284.

Öner Sünkür, M., & Arıbaş, S. (2020). Fen ve teknoloji/fen bilimleri dersinde tahmin et-gözle-açıkla yöntemi ile desteklenmiş yansıtıcı düşünmeye dayalı etkinlik uygulamalarının başarı, kalıcılık, madde ve değişim öğrenme alanına yönelik tutum, bilimsel süreç becerileri ve akademik risk alma davranışlarına etkisi. *Electronic Journal of Social Sciences*, *19*(76).

Özbay, H. E., & Köksal, M. S. (2021). Middle school students' scientific epistemological beliefs, achievements in science and intellectual risk-taking. *Science & Education*, *30*(5), 1233-1252.

R Core Team (2022). *R: A language and environment for statistical computing*. *R Foundation for Statistical Computing.* URL https://www.R-project.org/.

Robinson, L. E. (2011). *Academic risk-taking in an online environment.* Unpublished PhD Thesis, University of Connecticut.

Sahin, D., & Yilmaz, R. M. (2020). The effect of Augmented Reality Technology on middle school students' achievements and attitudes towards science education. *Computers & Education*, *144*, 103710.

Sarı, K., & Şaşmaz, F. (2020). Araştırmaya dayalı öğrenme stratejisinin öğrencilerin akademik başarılarına etkisi: bir meta analiz çalışması. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *35*(3), 540-555.

Skaar, N. R. (2009). *Development of the adolescent exploratory and risk behavior rating scale.* Unpublished PhD Thesis, Minnesota University.

Soutter, M., & Clark, S. (2023). Building a culture of intellectual risk-taking: Isolating the pedagogical elements of the Harkness method. *Journal of Education*, *203*(3), 508–519.

Söner, O. (2021). Kariyer karar verme güçlüğünde cinsiyet farklılıkları: bir meta analiz çalışması. *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi, (57)*, 401-424.

Tay, B., Özkan, D., & Tay, B. A. (2009). The effect of academic risk taking levels on the problem solving ability of gifted students. *Procedia–Social and Behavioral Sciences, 1*(1), 1099–1104.

Taylor, M. E. (2010). *Teaching efficacy, innovation, school culture and teacher risk taking.* Unpublished PhD Thesis, University of Louisville.

Wolf, F. M., (1986). *Meta-analysis: Quantitative methods for research synthesis*. Sage.

Yavuz Topaloğlu, M., & Balçın, M. D. (2021). Doğa eğitim gezisi ve bilim merkezi gezisinde dördüncü sınıf öğrencilerinin fene yönelik tutumlarının incelenmesi. *Trakya Eğitim Dergisi, 11* (1) , 55-75 .

Yokuş, G., & Ayçiçek, B. (2019). Kavram karikatürlerinin fen eğitimi dersi akademik başarısı üzerindeki etkisini belirlemeye yönelik bir meta-analiz çalışması. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, *49*, 223-246.

Theses used in the meta-analysis included in the article

Aksoy, İ. (2020). *Ortaokul fen öğretiminde ters yüz sınıf uygulamaları.* (Yayımlanmış yüksek lisans tezi). Kastamonu Üniversitesi.

Atlı, Z. (2021). *Fen bilimleri dersinde hikâyelerle desteklenmiş argümantasyon yaklaşımının öğrenme ürünlerine etkisi.* (Yayımlanmış yüksek lisans tezi). Ondokuz Mayıs Üniversitesi.

Aydın, N. (2019). *STEM ve STEM temelli robotik etkinliklerinin ortaokul öğrencilerinin problem çözmeye yönelik yansıtıcı düşünme, zihinsel risk alma ve öğrenmede motive edici stratejilerine etkisi.* (Yayımlanmış yüksek lisans tezi). Erzincan Binali Yıldırım Üniversitesi.

Çakır, E. (2017). *Ters yüz sınıf uygulamalarının fen bilimleri 7. sınıf öğrencilerinin akademik başarı, zihinsel risk alma ve bilgisayarca düşünme becerileri üzerine etkisi.* (Yayımlanmış yüksek lisans tezi). Ondokuz Mayıs Üniversitesi.

Çelik, E. (2010). *Fen eğitiminde probleme dayalı öğrenme yaklaşımının öğrencilerin akademik başarısına, tutumuna, akademik risk alma düzeyine ve kalıcılığa etkisi.* (Yayımlanmış yüksek lisans tezi). Gazi Üniversitesi.

Çınar, D. (2007). *İlköğretim Fen eğitiminde probleme dayalı öğrenme yaklaşımının öğrencilerin üst düzey düşünme becerilerine ve akademik risk alma düzeyine etkisi.* (Yayımlanmış yüksek lisans tezi) Selçuk Üniversitesi.

Öner Sünkür, M. (2013). *Fen ve teknoloji dersinde tahmin et-gözle-açıkla yöntemi ile desteklenmiş yansıtıcı düşünmeye dayalı etkinlik uygulamalarının değerlendirilmesi*. (Yayımlanmış doktora tezi). İnönü Üniversitesi.

Özyılmaz Akamca, G. (2008). *İlköğretimde analojiler, kavram karikatürleri ve tahmin-gözlem-açıklama teknikleriyle desteklenmiş fen ve teknoloji eğitiminin öğrenme ürünlerine etkisi.* (Yayımlanmış doktora tezi). Dokuz Eylül Üniversitesi.

Yıldız, Z. (2012). *Proje tabanlı öğrenme yaklaşımında ortaöğretim öğrencilerinin yaratıcı düşünme problem çözme ve akademik risk alma düzeylerine etkisi*. (Yayımlanmış yüksek lisans tezi). Gazi Üniversitesi.