Dr. Yunus Emre Baysal[1]
Inonu University, Institute of Education Sciences
Malatya/Turkey

Original scientific paper
UDC: 37.043.2
DOI: 10.5937/IstrPed2301001B

Assoc.Professor Fatma Mutlu[2]
Inonu University, Faculty of Education, Department of Mathematics and Science Education
Malatya/Turkey
Assoc.Professor Oguzhan Nacaroglu[3]
Sivas Cumhuriyet University, Faculty of Education, Department of Mathematics and Science Education, Sivas/Turkey

===

THE EFFECT OF GENDER ON MOTIVATION TOWARDS SCIENCE LEARNING: A META-ANALYSIS STUDY

Abstract: The purpose of this study is to determine the effect size of gender on motivation towards science learning by combining the results of studies, which were conducted to determine the effect of gender on motivation towards science learning, via the meta-analysis method. In this context, master's thesis, doctoral dissertations, and articles, which were conducted between 2010 and 2020, were suitable for the research problem, and had statistical data to be included in the meta-analysis study, were reviewed and examined in Turkish and English from national and international databases. As a result of the literature review, 2435 national and international studies were collected. Forty-nine studies, containing data suitable for coding protocol in accordance with the criteria determined by the researchers, were included in the meta-analysis. The sample size of 20.862 participants was obtained in the study (10.446 females and 10.416 males). The effect sizes and the combined effect sizes of the studies were calculated using "Comprehensive Meta-Analysis v 2.0 (CMA)." In the studies using the random effects model, the effect size of the gender variable on motivation towards science learning was determined to be 0.155 (95% CI, SE = 0.040). This value showed that the overall effect of the gender variable on motivation towards science learning was at an "insignificant" level in favor of the women. The results of the anova similarity analysis performed for the categorical moderators of publication type, scale type, and education level indicated that these moderators did not cause any statistically significant difference in the effect sizes. As a result of the meta-regression analysis performed for the publication year moderator – which was evaluated as a continuous variable – this moderator did not make any significant difference on the effect sizes of motivation towards science learning.

Keywords: Motivation towards science learning, gender, effect size, meta-analysis.

[1] y.emrebaysal@gmail.com
[2] fatma.mutlu@inonu.edu.tr
[3] onacaroglu44@gmail.com

INTRODUCTION

Motivation is the most basic and necessary component that enables people to learn, direct their attention, and acquire and exhibit the information necessary for behavior (Bandura, 1997). When learning is explained as a behavioral change, it can be asserted that motivation is necessary for behavioral change (Kian, Yusoff, & Rajah, 2014; Sevinc, Ozmen, & Yigit, 2011). Motivation has cognitive, affective, and bodily components, and guides individuals to work for a goal and stimulates them to achieve this goal (Glynn, Taasoobshirazi, & Brickman, 2009). According to Waterman (2005), motivation refers to internal factors that activating individuals and the external factors that encourage them to act and is a force that start the necessary behaviors to meet a need. There is a highly positive correlation between learning and motivation—which is one of the most important parameters of learning (Garon-Carrier et al., 2016; Glynn, Aultman, & Owens, 2005; Noar, Anderman, Zimmerman, & Cupp, 2005).

Science Learning and Motivation

Academic motivation should be taken into account especially in science lesson so that societies to keep up with the rapid changes in science and technology (Chan and Norlizah, 2017). In this context, motivation is an important factor that improves conceptual change, critical thinking, and scientific process skills of students in learning science (Yilmaz and Cavas, 2007). Motivation is important and effective in science teaching and is a supportive and encouraging force for students to achieve, to study efficiently and learn in school (Martin, 2001). When students see a learning outcome or process as important, their motivation increases. A well-motivated student finds the subject of the lesson fun (intrinsic motivation), becomes interested in certain subjects (personal interest), has the desire to fully figure out the subject (main goal), believes that success is a result of effort (belief) (Ng, Soon, & Fong, 2010) and has an increasing active participation in the classroom (Cimer, 2007). Many education researchers have revealed that the students' motivation towards science has a positive effect on their academic achievement (Alkan and Bayri, 2017; Bircan and Sungur, 2016; Bryan, Glynn and Kittleson, 2011; Cavas, 2011; Demir, Ozturk, & Dokme, 2012; Kubanyiova, 2006; Pintrich, 2003; Pintrich and Schunk, 2002; Singh, Granville, & Dika, 2002; Karakaya, Avgin, & Yilmaz, 2018). Therefore, it is crucial for students to have a high motivation in science class.

Motivation Towards Science Learning and Gender

In the literature, many studies support the notion that students' motivation towards science can be affected by numerous variables. Tuan, Chin, and Shieh (2005) state that students' motivation towards science learning is affected by performance and achievement goals, the science learning self-efficacy of students, their learning environment, and the value they place on science. On the other hand, gender, grade level, the level of education of the student's parents, students' attitudes towards science, their interest and abilities, their marks and feedback, their achievement status, their overall goals and orientations in the classroom, their pass marks for science, and their active participation in the classroom are all important factors that can influence students' motivation in science education (Aydin, 2007; Azizoglu & Cetin, 2008; Ekici, Kaya, & Mutlu, 2014; Tuan, Chin, & Shieh, 2005; Tseng, Tuan, & Chin, 2009; Wilson, 2001).

The results of studies investigating the effect of gender on motivation towards learning science are in favor of both males (Liou, Wang, Lin, & Areepattamannil, 2020; Liu, Ferrell, Barbera, & Lewis, 2016; Rana, Mahmood, & Reid, 2015) and females (Chan and Norlizah, 2017; Demir, Ozturk, & Dokme, 2012; Karakaya, Avgin, & Yilmaz, 2018; Ozarslan & Sarac, 2019; Salih, Mai, & Shibli, 2016; Sevinc, Ozmen, & Yigit, 2011; Yildirim and Karatas, 2018). However, there are also studies reporting that gender is independent from the students' levels of motivation towards science learning; in other words, there is no statistically significant difference between men and women (Akkus, 2020; Andressa, Mavrikaki, & Dermitzaki, 2015; Bawahenh, Zain, Saleh, & Abdullah, 2012; Cetin and Kirbulut, 2006; Eslek, 2015; Eymiroglu, 2019; Genc and Goksu, 2019; Kan and Akbas, 2006; Izgi-Onbasili, 2018; Sert Cibik, 2015).

Purpose of the Study

There are numerous studies from the literature that examine the effect of the gender variable on the motivation towards science learning. The current meta-analysis study would make contributions both to reveal if motivation towards science learning differs by gender and to clarify the inconsistencies in studies examining the effect of the gender variable on motivation towards science learning. It is believed that clarifying these results from a broad perspective would make a great contribution to the literature. In this regard, this study sought answers to the following questions:

1) What is the effect level of the gender variable on motivation towards science learning?
2) Does the effect of the gender variable on motivation towards science learning show a significant difference according to the moderators (publication type, learning level, scale type, and publication year)?

METHOD

Design

In this study, the meta-analysis method, which is a quantitative research synthesis method, was used. Meta-analysis is the process of combining quantitative results of individual studies and doing their statistical analysis again (Card, 2012).

Data Collection

In this study, “Google Scholar, Dergipark, Higher Education Council (YOK) National Thesis Center, and Eric and ProQuest” databases were used in order to collect studies which investigated the effect of the gender variable on students’ motivation towards science learning. While screening these databases, the following keywords were used: “motivation towards science, motivation towards science learning, motivation towards science learning scale, science motivation scale, and motivation to science learning.”

As seen in the flow chart in Figure 1, 2.435 national and international studies were obtained. It was determined that only 49 out of these studies met the inclusion criteria. Some studies included more than one effect size related to gender, whilst 54 effect sizes were identified in the 49 studies.

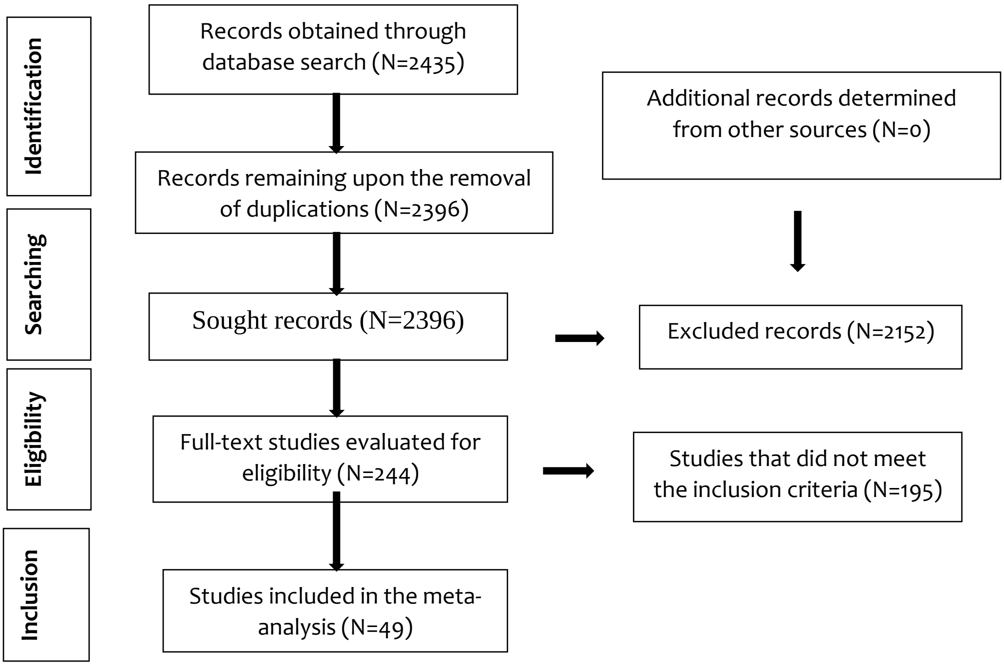

Figure 1. *Flow Chart for Selection of the Studies*

Inclusion and Exclusion Criteria

The following criteria for the studies included in the meta-analysis were taken into account when selecting which studies would be included in the meta-analysis:

1) Being published between 2010 and 2020.
2) Being published or unpublished master's theses and/or doctoral dissertations, articles in electronic academic journals, and papers presented at conferences and symposiums.
3) Examining the effect of the gender variable on motivation towards science learning
4) Giving the arithmetic mean, sample size, standard deviation, t or p values to calculate the effect sizes.
5) Being published in Turkish or English.

In this meta-analysis study, studies that do not examine the effect of the gender variable on motivation for science learning, qualitative studies, studies examining motivation for learning biology/physics/chemistry, alongside studies with incomplete data were deemed as exclusion criteria.

Data Coding

Recording the studies, obtained upon the literature review, through using a coding form is one of the most important steps when synthesizing the studies (Lipsey and Wilson, 2001). In this study, a coding form with three parts ("study identity," "study content," and "data in the study") was prepared in order to record the studies obtained upon the literature review. The first part includes the following titles: study no., title of the study, name of the author or authors, publication year, country, publication type, and publication status. The second part includes information such as sample group, education level, scale type used, and the scale author. The third part includes blanks to record numeric data (such as arithmetic mean, sample size, standard deviation, t-value, and p value) in the individual studies.

Recording data by using the coding form and obtaining similar results by applying the same steps by other researchers are regarded important in terms of reliability (Card, 2012). However, it is also recommended to ensure the reliability of the coding form (Petitti, 2000). The Agreement Rate and Cohen's Kappa statistic are widely used while conducting reliability analyses between coders during the synthesis of the studies. In this study, the inter-coder agreement rate was calculated to be 92.5%. In case of categorical variables, the agreement rate can be affected by the chance factor and a higher rate than expected can be obtained (Hartmann, 1977). Therefore, the use of Cohen's Kappa statistics is recommended because it offers more reliable results against the chance factor (Card, 2012). The kappa reliability value between coders was calculated to be 0.893. This value showed that there was a "very good level of agreement" between coders according to the interpretation classification proposed by Landis and Koch (1977).

Data Analysis and Interpretation

Effect sizes constitute the basis of the meta-analysis. Effect size indicates the sensitivity of an experimental procedure and the size of the experimental effect (Thalheimer and Cook, 2002). The effect sizes obtained from individual studies to be included in the meta-analysis studies are combined using statistical models. In the literature, two models – the "fixed effects model" and the "random effects model" – are preferred. The fixed effects model assumes that all studies have a single effect size, and the deviations in the effect sizes are caused by the sample changes (Card, 2012). The random effects model does not include the assumption that there is a single average effect size in the studies included in the analysis. On the contrary, it assumes that the effect sizes in the studies vary. This variation is caused by the central tendency and deviations (Card, 2012). The researchers should decide upon which one of these two models will be used before analysis (Borenstein, Hedges, Higgins, & Rothstein, 2010). All analyses were conducted under the random effects model, given that factors such as the individual studies included in the current meta-analysis study were conducted at different education levels, in different countries, with different sample sizes may cause differences in effect sizes.

Some classifications are used while interpreting the effect sizes obtained as a result of the analysis made by using statistical models in meta-analysis studies. There are more than one classification in the literature. The classification of Cohen, Maniom and Morrison (2007) is one of most frequently used classifications. According to Cohen et al., (2007), the classification of effect size is as follows:

- $0 \leq$ An effect size value ≤ 0.20 indicates poor level of effect,
- $0.21 \leq$ An effect size value ≤ 0.50 indicates modest level of effect,
- $0.51 \leq$ An effect size value ≤ 1.00 indicates moderate level of effect,
- $1.01 \leq$ An effect size value indicates strong level of effect.

One of the points to take into consideration in meta-analysis studies is the publication bias. Publication bias occurs since the studies yielding statistically significant and positive results are more likely not to be published compared to the studies yielding negative and statistically insignificant results. Thus, the average effect size value is more likely to be high (Borenstein, 2009). In this study, "Funnel Plot," "Orwin's Fail-Safe N," "Egger Regression, and "Duval and Tweedie 's Trim and Fill" methods were used to assess publication bias.

In this study, the statistics Q (Cochran's Q) and I^2 were used to evaluate the heterogeneity. Cochran's Q can be used as a measure of heterogeneity. It is calculated as the sum of the differences of the weighted squares between the weights used in the combination method and the effects of the individual studies and the combined studies (Borenstein, 2009). I^2 includes heterogeneity against the chance factor and shows the percentage of variance in the studies included in the analysis (Higgins and Thompson 2002; Higgins, Thompson, Deeks, & Altman, 2002).

In the present meta-analysis study, the Comprehensive Meta-Analysis Version 2 (CMA Ver. 2.0) was used to analyze the effect sizes, heterogeneity tests, moderator, meta-regression, and publication bias (Borenstein, Hedges, Higgins, & Rothstein, 2005). SPSS 22.0 software was used to calculate the inter-coder agreement rate and Cohen's Kappa statistics. For the statistical significance value, the value of 0.05 was taken as the reference.

RESULTS

In this study, the descriptive statistical analysis was performed for the studies. Table 1 shows the data obtained in this context.

Table 1. *Descriptive Statistics of the Studies Included in the Meta-analysis*

Variables	Frequency (f)	Percentage (%)
Publication year		
2010	5	10.2
2011	2	4.08
2012	4	8.16
2013	1	2.04
2014	3	6.12
2015	7	14.28
2016	8	16.32
2017	2	4.08
2018	8	16.32
2019	6	12.24
2020	3	6.12
Publication type		
Article	36	73.46
Doctoral Dissertation	2	4.08
Master's Thesis	11	22.46
Scale Type		
Ready	22	44.89
Adaptation	27	55.10
Country		
National (Turkey)	32	65.30
International	17	34.70
Education Level		
Primary school	3	6.12
Secondary school	33	67.34

High school	9	18.36
University	4	8.16

When Table 1 was examined, it was observed that most of the studies were conducted between 2016 and 2018 in terms of the publication year, were article in terms of publication type, adaptation in terms of scale type, in Turkey in terms of the countries and in secondary school subgroups in terms of the education level.

Results on Publication Bias

Figure 2 shows funnel plot results of 54 studies included in the meta-analysis.

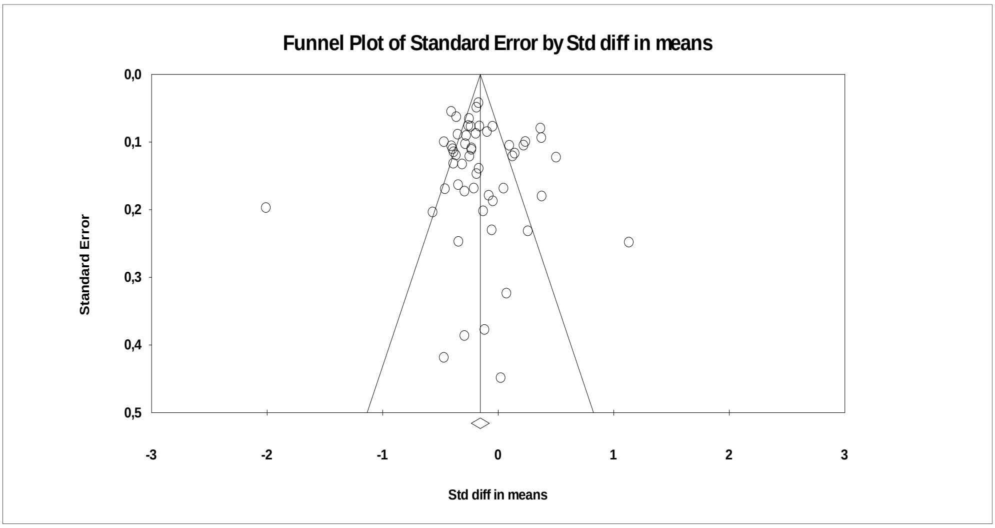

Figure 2. *Funnel Plot Results for Publication Bias*

Based on Figure 2, the average effect size of the studies had an almost symmetrical distribution around the average effect size. This showed that there was no publication bias in the study. In addition, the results of "Orwin's Fail-Safe N," "Egger Regression Test," and "Duval and Tweedie's Trim and Fill" were examined to support that there was no publication bias in the study. Table 2 shows the results of these methods.

Table 2. *Testing results of the publication bias*

Number of Studies Included	Number of studies for Orwin's Fail-Safe N "Insignificant" SOF	Duval and Tweedie's trim and fill method		Egger Regression Test
		Number of Trimmed Studies	Observed (Filled) for SOF	
54	SOF 854 for 0.01	7	0.154 (0.086)	P=0.311 (1-tailed)

Based on Table 2, the number of studies that could reduce the effect size to insignificant level according to Orwin's Fail-Safe N was 854. This number was approximately sixteen times greater than the number of studies included in the current study. Fifty-four studies used in the study were all conducted for the research questions both in Turkey and abroad, and it is unlikely that the researchers would be able to access the remaining 854 studies. It is interpreted in the literature that there is no publication bias issue for the meta-analysis when Orwin's Fail-Safe N is 5 - 10 times greater than the number of studies included (Borenstein et al., 2009). Duval and Tweedie's trim and fill method is another test used in publication bias. In this test, first, the points deteriorating the symmetry in the Funnel Plot are determined. Next, these points are filled temporarily in the second stage and the overall effect size is calculated again. The rise in the difference between two overall effect sizes is interpreted as a possible publication bias (Card, 2012). According to Table 2, there was no difference between the observed effect size (0.154) and the virtual effect size (0.086) to correct the effect caused by publication bias. The result of Egger regression test in Table 2 revealed that p value (1-tailed) was statistically insignificant (p>0.05). All of these results showed that there was no publication bias in the present study.

Results of the Overall Effect Size

Table 3 shows the combined results of 54 studies included in the meta-analysis under random effects model.

Table 3. *The Combined Results of the Studies According to the Random Effects Model*

Model	k	ES*	SH	Variance	Lower Limit	Upper Limit
Random Effects Model	54	-0.155	0.040	0.002	-0.233	-0.077

* Negative value means there is an effect in favor of women.

Based on Table 3, it was observed that the overall effect size value of the 54 studies included in the meta-analysis was 0.155 with a standard error of 0.040 under random effects (lower limit of -0.233 and upper limit of -0.077 at confidence interval of 95%). This value showed that the overall effect of the gender variable on motivation towards science learning was insignificant in favor of women according to Cohen et al.'s classification (2007).

Table 4 shows the statistical results about the heterogeneity in the studies.

Table 4. *Results of Heterogeneity Test*

Q	df	Chi-Square (χ^2)	p	I-squared (I^2)
364.524	53	55.759	0.000	85.460

When Table 4 was examined, Q (364.524) was observed to higher than chi square corresponding value (55.759) with 53 degrees of freedom. This result shows that the studies combined under random effects model had a heterogeneous distribution. This difference in the studies was caused by the factors other than sample error. In addition, I^2 value showing the heterogeneity amount (85.460) indicated that there was a high level of heterogeneity in the study. Figure 3 shows a forest plot showing the effect sizes of the studies included in the current study, their lower and upper limits and p values.

Study	Std diff in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Orücü, 2019	-2,005	0,198	0,039	-2,393	-1,617	-10,122	0,000
Karslı, 2015-1	-0,562	0,205	0,042	-0,963	-0,161	-2,748	0,006
Onbaşılı, 2018	-0,465	0,419	0,176	-1,287	0,357	-1,108	0,268
Özarslan and Saraç, 2019	-0,464	0,101	0,010	-0,661	-0,267	-4,612	0,000
Mahanta and Sarkar, 2018	-0,455	0,170	0,029	-0,789	-0,122	-2,675	0,007
Silva et al., 2018	-0,401	0,056	0,003	-0,510	-0,291	-7,180	0,000
Salih et al., 2016	-0,400	0,107	0,011	-0,609	-0,191	-3,751	0,000
Chan and Norlizah, 2017	-0,390	0,111	0,012	-0,607	-0,172	-3,505	0,000
Ercan et al., 2016	-0,383	0,133	0,018	-0,643	-0,123	-2,889	0,004
Karakaya et al., 2018	-0,381	0,116	0,013	-0,607	-0,154	-3,293	0,001
Demir et al., 2012	-0,361	0,120	0,014	-0,596	-0,125	-3,000	0,003
Altunışık, 2016	-0,357	0,064	0,004	-0,482	-0,232	-5,607	0,000
Uzun and Keleş, 2010	-0,345	0,090	0,008	-0,521	-0,170	-3,857	0,000
Okumuş, 2020	-0,341	0,164	0,027	-0,663	-0,019	-2,078	0,038
Nikou and Economides, 2016	-0,339	0,248	0,062	-0,825	0,148	-1,365	0,172
Liu et al., 2016	-0,306	0,134	0,018	-0,568	-0,044	-2,293	0,022
Yazıcıoğlu and Çavuş Güngören, 2019	-0,287	0,387	0,150	-1,046	0,472	-0,741	0,459
Duman, 2014	-0,286	0,174	0,030	-0,626	0,054	-1,647	0,100
Çalvaş, 2011	-0,280	0,104	0,011	-0,483	-0,077	-2,701	0,007
Deniş-Çeliker et al., 2015	-0,272	0,091	0,008	-0,451	-0,092	-2,969	0,003
İnel Ekici et al., 2014	-0,253	0,077	0,006	-0,403	-0,102	-3,292	0,001
Aktaş, 2019	-0,247	0,066	0,004	-0,376	-0,117	-3,720	0,000
Zeyer, 2018-1	-0,243	0,122	0,015	-0,482	-0,004	-1,995	0,046
Yenice et al., 2012	-0,232	0,078	0,006	-0,385	-0,080	-2,983	0,003
İncebacak et al., 2018	-0,226	0,112	0,013	-0,445	-0,006	-2,018	0,044
Seyil and Erdoğan, 2018	-0,225	0,110	0,012	-0,441	-0,010	-2,052	0,040
Karslı, 2015-2	-0,206	0,169	0,029	-0,537	0,126	-1,215	0,224
Sevinç et al., 2011	-0,189	0,088	0,008	-0,362	-0,016	-2,145	0,032
Yıldırım and Karataş, 2018	-0,182	0,050	0,002	-0,280	-0,085	-3,672	0,000
Sert Çıbık, 2015-2	-0,182	0,148	0,022	-0,472	0,108	-1,230	0,219
Güvercin et al., 2010	-0,165	0,043	0,002	-0,249	-0,081	-3,847	0,000
Sert Çıbık, 2015-1	-0,162	0,140	0,020	-0,437	0,112	-1,161	0,246
Buluş Kırıkkaya and Bali, 2017	-0,157	0,078	0,006	-0,309	-0,006	-2,032	0,042
Et, 2013	-0,125	0,203	0,041	-0,522	0,273	-0,615	0,539
Eslek, 2015	-0,113	0,378	0,143	-0,854	0,629	-0,298	0,766
Akkuş, 2020	-0,091	0,086	0,007	-0,259	0,077	-1,063	0,288
Eymiroğlu, 2019	-0,076	0,180	0,032	-0,429	0,276	-0,425	0,671
Köksal, 2012	-0,051	0,231	0,053	-0,503	0,402	-0,219	0,827
Çetin Dindar and Geban, 2010	-0,044	0,078	0,006	-0,196	0,109	-0,560	0,575
Passos and Lynch, 2016	-0,041	0,188	0,035	-0,409	0,328	-0,215	0,830
Cengiz, 2019	0,027	0,449	0,202	-0,854	0,908	0,061	0,951
Stellmacher, 2010	0,052	0,169	0,029	-0,280	0,384	0,306	0,760
Atwood-Blaine, 2015-1	0,077	0,325	0,105	-0,559	0,713	0,237	0,813
Bawaneh et al., 2012	0,102	0,106	0,011	-0,106	0,309	0,959	0,337
Zeyer, 2018-3	0,130	0,122	0,015	-0,109	0,368	1,067	0,286
Doboke, 2016	0,148	0,118	0,014	-0,082	0,379	1,263	0,207
Andressa et al., 2015	0,225	0,106	0,011	0,018	0,432	2,127	0,033
Benzer et al., 2020	0,241	0,100	0,010	0,044	0,437	2,397	0,017
Zeyer and Wolf, 2010	0,262	0,232	0,054	-0,193	0,718	1,129	0,259
Rana et al., 2015	0,371	0,081	0,006	0,213	0,529	4,608	0,000
Kerlan et al., 2016	0,380	0,095	0,009	0,194	0,565	4,013	0,000
Cobb, 2014	0,383	0,181	0,033	0,028	0,737	2,115	0,034
Zeyer, 2018-2	0,507	0,123	0,015	0,265	0,749	4,106	0,000
Atwood-Blaine, 2015-2	1,137	0,249	0,062	0,648	1,625	4,563	0,000

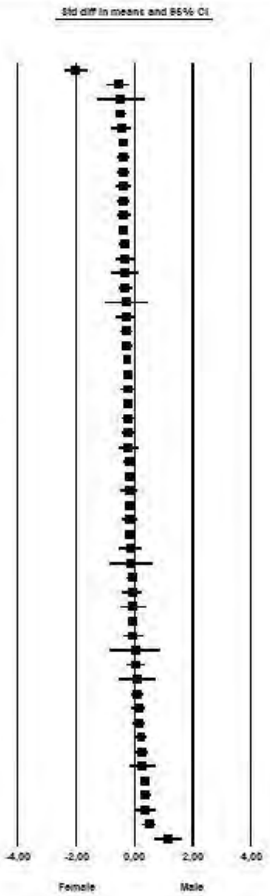

Figure 3. *Forest Plot of the Individual Studies*

When Figure 3 was examined, it was observed that the effect size value was in favor of women in 40 studies and in favor of men in 14 studies. It was concluded that p value was statistically significant ($p<0.05$) in 32 studies and was statistically insignificant ($p>0.05$) in 22 studies.

Results of Moderator Analysis

In this study, the variables of publication year, publication type, scale type, and education level were determined as potential moderator variables and included in the analysis. In this context, publication year was accepted as a continuous variable, whereas publication type, scale type, and education level were accepted as the categorical variables. Hence, the meta-regression analysis was conducted for publication year and the analog anova similarity analysis was conducted for the categorical variables. Table 5 shows analysis results of the categorical moderators.

Table 5. *Results of the Categorical Moderator Analysis*

Moderators	k	ES*	SE	Confidence Interval of 95%			
				Lower Limit	Lower Limit	Qb	p
Publication type						0.005	0.946
Article	39	-0.150	0.040	-0.229	-0.071		
Thesis	15	-0.158	0.116	-0.386	0.069		
Scale type						0.527	0.468
Adapted Scale	30	-0.128	0.062	-0.249	-0.007		
Ready Scale	24	-0.184	0.047	-0.276	-0.092		
Education Level						3.907	0.272
Primary school	3	-0.275	0.098	-0.468	-0.083		
Secondary school	36	-0.155	0.041	-0.235	-0.075		
High school	11	-0.030	0.112	-0.249	0.189		
University	3	-0.531	0.344	-1.206	0.144		

* Negative value means there is an effect in favor of women.

Based on Table 5 the average effect size of the articles in terms of publication type was 0.150 (lower limit of -0.229 and upper limit of -0.071 at the confidence interval of 95%) in favor of women. The average effect size of the theses was 0.158 (lower limit of -0.386 and upper limit of 0.069 at the confidence interval of 95%) in favor of women. Also, there was no statistically significant difference between the groups (p>0.05).

When the moderator of scale type was examined, it was observed that the average effect size of the studies using the adapted scale was 0.128 (lower limit of -0.249 and upper limit of -0.007 at the confidence interval of 95%) in favor of women. The average effect size for the studies using the ready scale was 0.184 (lower limit of -0.276 and upper limit of -0.092 at the confidence interval of 95%) in favor of women. No statistically significant difference was found between the groups (p>0.05).

Examining the moderator of education level, it was observed that the average effect size of the studies conducted at the primary school level was 0.275 (lower limit of -0.468 and upper limit of -0.083 at the confidence interval of 95%) in favor of women. The average effect size of the studies conducted at the high school level was 0.030 (lower limit of -0.249 and upper limit of 0.189 at the confidence interval of 95%) in favor of women. The average effect size of the studies conducted at the secondary school level was 0.155 (lower limit of -0.235 and upper limit of -0.075 at the confidence interval of 95%) in favor of women. The average effect size of the studies conducted at the university level was 0.531 (lower limit of -1.206 and upper limit of 0.144 at the confidence interval of 95%) in favor of women. There was no statistically significant difference between the groups (p>0.05).

In this study, the moderator of publication year was evaluated as a continuous variable. For this reason, the meta-regression analysis was performed for this moderator. Figure 4 shows the meta-regression results of the moderator of publication year.

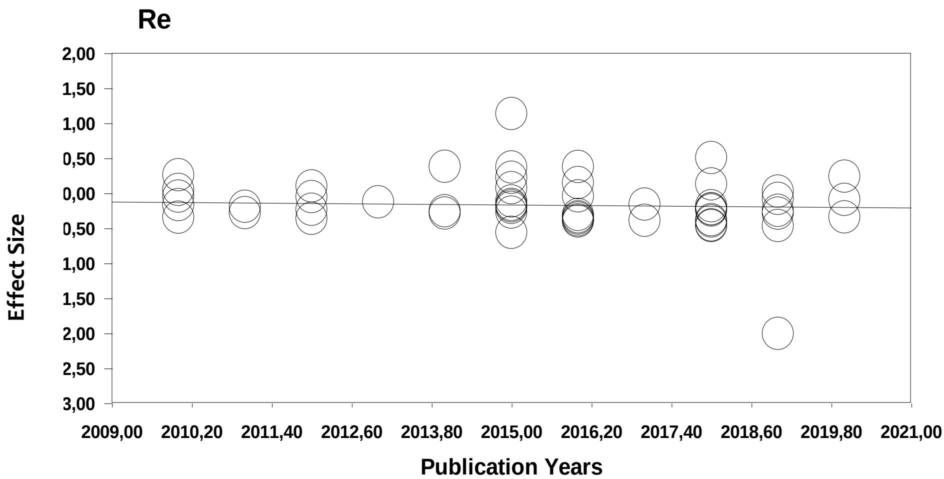

Figure 4. *Correlation Between the Publication Years and the Effect Sizes*

When Figure 4 was examined, it was observed that the slope of the line showing the correlation between the publication year and the effect size decreased as the publication year progressed from past to the present. Table 6 shows statistical significance results regarding this decrease.

Table 6. *Results about the Correlation between the Publication Year and The Effect Sizes*

	Effect Size	Standard Error	Lower Limit	Upper Limit	Z-value	p- value
Publication Year	-0.00702	0.00428	0.02533	-0.01142	-1.63870	0.10128
Intercept	13.97857	8.63282	-2.94144	30.89859	1.61924	

When Table 6 was examined, it was observed that the publication year progressing from past to the present caused a decrease of 0.00702 in the effect size. This decrease was not statistically significant ($p>0.05$).

DISCUSSION

In the study, 49 studies, deemed suitable for a coding protocol investigating the results of studies conducted to determine the effect of gender on motivation towards science learning, were included in the meta-analysis. According to the categorical descriptive characteristics of these studies, the studies were conducted mostly between 2016 and 2018. The most widely studied categories included: "article" (in terms of publication type), "Turkey" (in terms of country), "secondary school" (in terms of level of education), and "adapted scale" (in terms of the scale type).

In addition, the results of "Funnel Plot," "Orwin's Fail-Safe N," "Egger Regression Test," and "Duval and Tweedie's Trim and Fill" which were performed to determine whether or not there was a publication bias in the current study) showed that there was no publication bias in the study. As a result of the combination made under the random effects model, the average effect size was determined to be 0.155. According to Cohen et al.'s classification, (2007), this value showed that the overall effect of the gender variable on motivation towards science learning was insignificant in favor of women. This result gave consistent outcomes with the individual studies conducted both in Turkey and abroad (Chan and Norlizah, 2017; Demir, Ekici, Kaya, & Mutlu, 2014; Karakaya, Avgin, & Yilmaz, 2018; Ozarslan and Sarac, 2019; Salih, Mai, & Shibli, 2016; Sevinc, Ozmen, & Yigit, 2011; Silva, Khatibi, Mahanti, & Sarkar, 2018; Uzun & Keles, 2010; Yildirim and Karatas, 2018). In their study, Hardre, Chen, Huang, Chiang, Jen and Warden (2006) found that female students thought more positively, adapted more easily to their goals and had higher motivation compared to male students. In addition, they emphasized that genders of the students affected their motivation towards learning. Likewise, Khamis, Dukmak and Elhoweris (2008) concluded in their study that female students were more motivated about learning in general compared to their male counterparts. Mahanti and Sarkar (2018) found that female students had higher motivation levels compared to male students and there was no significant difference between students living in rural or urban areas in terms of science motivation levels. Yildirim and Karatas (2018) conducted a study to investigate secondary school students' motivation towards science learning. They discovered that there was a significant difference in favor of female students in the motivation levels of students in terms of the variables of the frequency of conducting experiments, level of participation in the classroom, the level of liking science lesson and gender. Turhan (2020) conducted a meta-analysis study to analyze 22 studies that examined how gender influenced academic motivation in Turkey between 2004 and 2019 and determined that gender had a weak effect on academic motivation and it was in favor of male students.

Some studies have reported a significant difference according to gender, whilst others have reported no significant difference. This is believed to be associated with age of individuals in the sample group and, accordingly, the difference in their perceptions. Another reason for this result may be the difference between the sample characteristics and measurement tools of the studies. In this study, Q (Cochran's Q) and I^2 statistics were used to evaluate heterogeneity. According to the heterogeneity test, there was a high level of heterogeneity in the study ($Q=364.524$; $\chi^2=55.759$; $I^2=85.460$). A moderator analysis was conducted to identify the sources of the high level of heterogeneity between the studies. According to the results of the anova similarity analysis (conducted for categorical moderators including publication type, scale type and education level according to the moderator analysis results), these moderators investigated did not cause a statistically significant difference in the effect sizes.

Accordingly the meta-regression analysis performed for the moderator of publication year (which was evaluated as a continuous variable), the moderator of publication year did not cause any significant difference on the effect size of students' motivation towards science learning. As it progressed from 2010 to 2020, there was a statistically insignificant decrease in the slope of the line showing the correlation between the publication year and the effect size.

The following recommendations were presented based on the results of this study:

- This meta-analysis study covered the studies conducted between 2010 and 2020. The study can be repeated in a new meta-analysis study by extending this time range.
- When the studies are investigated in terms of publication years, it was seen that the level of motivation towards learning science decreased as one progressed from the past into the present. Other researchers should investigate the reasons behind this.
- When the frequency and percentage values of the studies in the meta-analysis study were examined in terms of publication type, it was observed that 73.46% of the 49 studies consisted of articles. There was only one doctoral dissertation on the effect of the gender variable on students' motivation towards learning science. This reveals the necessity of increasing the number of such studies.
- It was determined that most of studies (67.34%) were the secondary school level. The number of studies conducted at other education levels was insufficient. Researchers should conduct studies using qualitative methods (e.g. interviews) to determine the

variables associated with secondary school students' motivation towards science learning.

- Studies that are more detailed should be conducted. They should look at the effect of the gender variable on the general and subscale motivations of students towards science learning, and what causes that.

REFERENCES

Akkus, N. (2020). *Yedinci sinif ogrencilerinin fen kariyer yonelimleri, motivasyonlari, oz-yeterlikleri, algilanan destek duzeyleri ve demografik ozellikleri arasindaki iliskilerin incelenmesi,* Yayinlanmamis yuksek lisans tezi, Mugla: Mugla Sidki Kocman Universitesi.

Aktas, S. M. (2019). *Ortaokul ogrencilerinin bilimsel epistemolojik inanclari ve fene yonelik motivasyonlari arasindaki iliskinin cesitli degiskenler acisindan incelenmesi,* Yayinlanmamis yuksek lisans tezi, Kars: Kafkas Universitesi.

Alkan, I., ve Bayri, N. (2017). Fen ogrenmeye yonelik motivasyon ile fen basarisi arasindaki iliski uzerine bir meta analiz calismasi. *Dicle Universitesi Ziya Gokalp Egitim Fakultesi Dergisi, 32,* 865-874.

Altunisik, S. (2016). *Ortaokul ogrencilerinin fene yonelik merak, motivasyon ve akademik basarilari arasindaki iliskilerin incelenmesi: bir yapisal esitlik modellemesi,* Yayinlanmis yuksek lisans tezi, Usak: Usak Universitesi.

Andressa, H., Mavrikaki, E., & Dermitzaki, I. (2015). Adaptation of the students' motivation towards science learning questionnaire to measure greek students' motivation towards biology learning. *International Journal of Biology Education, 4*(2), 78-93.

Atwood-Blaine, D. (2015). *The effect of playing a science center-based mobile game: affective outcomes and gender differences,* Unpublished doctoral dissertation, USA: University Of Kansas.

Aydin, B. (2007). *Fen bilgisi dersinde icsel ve dissal motivasyonun onemi.* Yayinlanmamis Yuksek Lisans Tezi, Yeditepe Universitesi Sosyal Bilimler Enstitusu, Istanbul.

Azizoglu, N., & Cetin, G. (2009). 6 ve 7. sinif ogrencilerinin ogrenme stilleri, fen dersine yonelik tutumlari ve motivasyonlari arasindaki iliski. *Kastamonu Egitim Dergisi, 17*(1), 171-182.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York, NY: W. H. Freeman

Bawahenh, A. K. A., Zain, A. N. M., Saleh, S., & Abdullah, A. G. K. (2012). Using herrmann whole brain teaching method to enhance students' motivation towards science learning. *Turkish Science Education, 9*(3), 3-22.

Benzer, S., Sarisik, Y., & Kocan, H. (2020). Factors affecting the motivation levels of secondary school students for science learning. In: I. Dokme, & S. Benzer (Eds), *Special Topics In Science Education Research,* (pp. 117-129). Akademisyen.

Bircan, H. ve Sungur, S. (2016). The role of motivation and cognitive engagement in science achievement. *Science Education International, 27*(4), 509-529.

Borenstein, M. (2009). Effect sizes for continuous data. In: H. Cooper, L. V. Hedges, & J. C. Valentine (Eds.), *The handbook of research synthesis and meta-analysis,* 2nd edition (pp. 221-235). New York, NY: Russell Sage Foundation.

Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2010). A basic introduction to fixed effect and random effects models for meta-analysis. *Research Synthesis Methods, 1*(2), 97-111.

Borenstein, M., Hedges, L., Higgins, J., and Rothstein, H. (2005). *Comprehensive meta-analysis version 2.* Englewood, NJ: Biostat. Available from: http://www.meta-analysis.com/downloads/Meta-Analysis-Manual.pdf

Bryan, R. R., Glynn, S. M., & Kittleson, J. M. (2011). Motivation, achievement, and advanced placement intent of high school students learning science. *Science Education, 95*(6), 1049-1065.

Bulus Kirikkaya, E., & Bali, G. (2017). Investigation of the relationship of metacognitive awareness and learning motivations of secondary school students to their science achievement. *Recent Developments in Education*, 103-108.

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

Cengiz, B. (2019). *Ilkokul dorduncu sinif fen bilimleri dersinde ozduzenlemeli ogrenme stratejileri kullanmanin ogrencilerin problem cozme becerileri, akademik kaygi, akademik ozyeterlik, fen motivasyonu ve ders basarilarina etkisi,* Yayinlanmamis Yuksek Lisans Tezi, Marmara Universitesi, Istanbul.

Chan Y. L., & Norlizah C. H. (2017). Students' motivation towards science learning and students' science achievement. *International Journal of Academic Research in Progressive Education and Development, 6(4)*, 174-189.

Cobb, G. M. (2014). *Investigating how implementing interactive technologies in a secondary school science program influences student attitude and motivation towards science learning,* Unpublished master thesis, Nipissing University Schulich School Of Education North Bay, Ontario, Canada.

Cohen, L., Manion, L., and Morrison, K. (1997). *Methodology of educational research.* Athens: Expression. http://dx.doi.org/10.4324/9780203282632

Cavas, P. (2011). Factors affecting the motivation of turkish primary students for science learning. *Science Education International, 22*(1), 31-42.

Cetin, A., & Kirbulut, Z. D. (2006). *Kimyaya yonelik bir motivasyon olceginin gelistirilmesi ve lise ogrencilerinin kimyaya yonelik motivasyonlarinin degerlendirilmesi.* VII. Ulusal Fen Bilimleri ve Matematik Egitimi Kongresi. Bildiriler Kitabi, 2.

Cetin-Dindar, A., & Geban, O. (2010). The Turkish adaptation of the science motivation questionnaire. *Contemporary Science Education Research: Pre-Service and In Service Teacher Education*, 119-127.

Cimer, A. (2007). Effective Teaching in Science: A Review of Literature. *Journal of Turkish science education, 4*(1), 20-44.

Demir, R., Ozturk, N., & Dokme, I. (2012). Ilkogretim 7. sinif ogrencilerinin fen ve teknoloji dersine yonelik motivasyonlarinin bazi degiskenler acisindan incelenmesi. *Mehmet Akif Ersoy Universitesi Egitim Fakultesi Dergisi, 12*(23), 1-21.

Denis Celiker, H., Tokcan, A., & Korkubilmez, S. (2015). Fen ogrenmeye yonelik motivasyon bilimsel yaraticiligi etkiler mi? *Mustafa Kemal Universitesi Sosyal Bilimler Enstitusu Dergisi, 12*(30), 167-192.

Doppke, M. G. (2016). *The Motivational Effects of Gender, Residency, Worldview, and Acculturation Towards Science Study at American Institutes of Higher Education,* Unpublished doctoral dissertation, Northcentral University, USA.

Dos Santos Passos, A., & Lynch, R. (2016). A comparative study of grade 12 students' motivation for learning science and social science according to gender at escola secundaria 5 de maio in dili, timor-leste. *Scholar: Human Sciences*, *8*(2), 130-145.

Duman, B. (2014). *Ortaokul 6. Sinif ogrencilerinin fen bilimleri dersindeki motivasyon durumlari,* Yayinlanmamis yuksek lisans tezi, Mehmet Akif Ersoy Universitesi, Burdur.

Ekici, D.I., Kaya, K., & Mutlu, O. (2014). Ortaokul ogrencilerinin fen ogrenmeye yonelik motivasyonlarinin farkli degiskenlere gore incelenmesi: Usak ili ornegi. *Mersin Universitesi Egitim Fakultesi Dergisi, 10*(1), 13-26.

Ercan, O., Ural, E., & Kamalak, B. (2016). Searching for the relationship between secondary schools students' motivation and science achievement. *International Journal of Humanities and Social Science Invention, 5*(1), 53-60.

Eslek, S. (2015). *Fen bilgisi ogretmen ve ogrencilerinin proje hazirlama konusundaki bilgi ve becerilerinin arastirilmasi: Bu benim eserim proje calismasi,* Yayinlanmamis yuksek lisans tezi, Dokuz Eylul Universitesi, Izmir.

Et, S. Z. (2013). *Elazig bilim ve sanat merkezi ogrencilerinin fen bilimleri dersine ve motivasyon duzeylerine iliskin gorusleri,* Yayinlanmamis Yuksek Lisans Tezi, Firat Universitesi, Elazig.

Eymiroglu, F. (2019). *Bilim Fuarlarinin Fen Ogrenme Becerisi Ve Fen Motivasyonu Uzerine Etkisi Bakimindan Incelenmesi,* Yayinlanmamis yuksek lisans tezi, Mehmet Akif Ersoy Universitesi, Burdur.

Garon-Carrier, G., Boivin, M., Guay, F., Kovas, Y., Dionne, G., Lemelin, J. P., Seguin, J.R., Vitari, F., & Tremblay, R. E. (2016). Intrinsic motivation and achievement in mathematics in elementary school: A longitudinal investigation of their association. *Child Development, 87*(1), 165-175.

Genc, G. A., & Goksu, V. (2019). Lise ogrencilerinin basari hedef yonelimleri ile fizik ogrenmeye yonelik akademik motivasyonlarinin cesitli degiskenler acisindan incelenmesi. *Mustafa Kemal Universitesi Sosyal Bilimler Enstitusu Dergisi, 16*(44), 307-331.

Glynn, S., Aultman, L., & Owens, A. (2005). Motivation of learn in general education programs. *Journal of General Education, 54*(2), 150-170.

Glynn, S.M., Taasoobshirazi, G., & Brickman, P. (2009). Science motivation questionnaire: Construct validation with nonscience majors. *Journal of Research in Science Teaching, 46*(2), 127-146.

Guvercin, O., Tekkaya, C., & Sungur, S. (2010). A cross age study of elementary students' motivation towards science learning. *Hacettepe University Journal of Education, 39,* 233-243.

Hardre, P.L., Chen, C.-H., Huang, S.-H., Chiang, C.-T, Jen, F.-L., & Warden, L. (2006). Factors affecting high school students' academic motivation in Taiwan. *Asia Pacifc Journal of Education, 26,* 189-207.

Hartmann, D. P. (1977). Considerations in the choice of interobserver reliability estimates. *Journal of Applied Behavior Analysis, 10*(1), 103-116.

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

Higgins, J., Thompson, S., Deeks, J., & Altman, D. (2002). Statistical heterogeneity in systematic reviews of clinical trials: A critical appraisal of guideline sandpractice. *Journal of Health Services Research & Policy*, *7*(1), 51-61.

Incebacak, B. B., Yaman, S., & Tungac, A. S. (2018). Analysis of the relationship between secondary school students' hope levels, their motivation toward science learning and academic success levels. *Samwaad e-Journal, 7*(1), 8-29.

Izgi-Onbasili, U. (2018). Artirilmis gerceklik uygulamalarinin ilkokul ogrencilerinin artirilmis gerceklik uygulamalarina yonelik tutumlarina ve fen motivasyonlarina etkisi. *Ege Egitim Dergisi, 19*(1), 320-337. Doi: 10.12984/egeefd.390018

Kan, A., & Akbas, A. (2006). *Kimya ogretiminde basariyi etkileyen bazi degiskenlerin (tutum, oz yeterlilik, kaygi ve motivasyon) basariya etkisinin arastirilmasi.* VII. Ulusal Fen Bilimleri ve Matematik Egitimi Kongresi: Bildiriler Kitabi, 2.

Karakaya, F., Avgin, S. S., & Yilmaz, M. (2018). Ortaokul ogrencilerinin fen bilimleri ogrenmeye yonelik motivasyonlarinin incelenmesi. *Kahramanmaras Sutcu Imam Universitesi Sosyal Bilimler Dergisi, 15*(2), 359-376.

Karsli, G. (2015). *ARCS motivasyon yonteminin 8. sinif hucre bolunmesi ve kalitim unitesinde ogrencilerin motivasyonu basarisi ve tutumlarina etkisi,* Yayinlanmamis Yuksek Lisans Tezi, Agri Ibrahim Cecen Universitesi, Agri.

Kenar, I., Kose, M., & Demir, H. İ. (2016). Determination of motivation of 5th grade students living in rural and urban environments towards science learning and their attitudes towards science-technology course. *Journal of Education and Training Studies, 4*(7), 155-167.

Kian, T. S., Yusoff, W. F. W., & Rajah, S. (2014). Job satisfaction and motivation: What are the difference among these two. *European Journal of Business and Social Sciences*, *3*(2), 94-102.

Koksal, M. S. (2012). Adaptation study of motivation toward science learning questionnaire for academically advanced science students. *Chemistry: Bulgarian Journal of Science Education, 21*(1), 29-44.

Kubanyiova, M. (2006). Developing a Motivational Teaching Practice in EFL Teachers in Slovakia: Challenges of Promoting Teacher Change in EFL Contexts. *TESL-EJ, 10*(2), 1-17.

Landis, J. R. and Koch, G. G. (1977) The measurement of observer agreement for categorical data. *Biometrics. 33*(1), 159-174.

Liou, P.Y., Wang, C. L., Lin, J. J. H., & Areepattamannil, S. (2020). Assessing students' motivational beliefs about learning science across grade level and gender. *The Journal of Experimental Education,* 1-20. https://doi.org/10.1080/00220973.2020.1721413

Lipsey, M. W., and Wilson, D. B. (2001). *Practical meta-analysis.* Thousand Oaks, CA: SAGE publications, Inc.

Liu, Y., Ferrell, B., Barbera, J., & Lewis, J. E. (2016). Development and evaluation of a chemistry specific version of the academic motivation scale (AMS-Chemistry). *Chemistry Education Research and Practice,* 1-23. doi: 10.1039/c6rp00200e

Mahanti, J., & Sarkar, S. (2018). A study on motivation of high school students towards science learning. *International Journal of Research and Analytical Reviews, 5*(3), 138-142.

Martin, A. J. (2001). The student motivation scale: A tool for measuring and enhancing motivation. *Australian Journal of Guidance and Counselling, 11,* 11-20.

Ng, K.T., Soon, S.T. & Fong, S.F. (2010). Development of a Questionnaire to Evaluate Students' Perceived Motivation towards Science Learning Incorporating ICT Tool. *Malaysian Journal of Educational Technology, 10*(1), pp. 39-55.

Nikou, S. A., & Economides, A. A. (2016). The impact of paper-based, computer-based and mobile-based self-assessment on students' science motivation and achievement. *Computers in Human Behavior, 55,* 1241-1248. http://dx.doi.org/10.1016/j.chb.2015.09.025

Noar, S. M., Anderman, E. M., Zimmerman, R. S., & Cupp, P. K. (2005). Fostering achievement motivation in health education: Are we applying relevant theory to school-based HIV prevention programs? *Journal of Psychology & Human Sexuality, 16*(4), 59-76.

Okumus, S. (2020). Investigation of the relationship between motivations for science learning and metacognitive learning skills. *Turkish Studies, 15*(7), 3025-3042.

Orucu, F. N. (2019). *Fen bilgisi egitimi ogretmen adaylarinin fen bilgisine yonelik motivasyonlarinin, ozduzenlemelerinin, tutumlarinin ve teknolojiye yonelik tutumlarinin bazi demografik degiskenler acisindan incelenmesi,* Yayinlanmamis Yuksek Lisans Tezi, Necmettin Erbakan Universitesi, Konya.

Ozarslan, M., & Sarac, H. (2019). The examination of the relationship between perception of secondary school students about science course classroom activities and their motivation towards science learning. *International Journal of Field Education, 5*(1), 21-41.

Petitti, D. B. (2000). *Meta-analysis, decision analysis, and cost-effectiveness analysis* (2nd edition). New York: Oxford University Press.

Pintrich, P.R. (2003). A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of Educational Psychology, 95*(4), 667-686.

Pintrich, P.R., & Schunk, D.H. (2002). *Motivation in education: Theory, research, and applications* (Second edition). Pearson education, NJ: Merrill Prentice Hall

Rana, R. A., Mahmood, N., & Reid, N. (2015). Motivation and science perforamnce: Influence on student learning in science. *Science International (Lahore), 27*(2), 1445-1452.

Salih, M., Mai, M. Y. M., & Shibli, A. A. (2016). Students' motivation toward science learning in secondary schools in Oman and Malaysia: A comparative study. *Journal of Research, Policy & Practice of Teachers & Teacher Education,* 6(1), 16-24.

Sert Cibik, A. (2015). Determination of motivations towards science learning of eighth grade Turkish and German students (a comparative study). *Gaziantep University Journal of Social Sciences, 14*(1), 277-298.

Sevil, H. H. S., & Erdogan, D. G. (2018). Investigation of middle school students' motivation towards science learning in terms of some variables. *Journal of Multidisciplinary Studies in Education, 1*(1), 36-46.

Sevinc, B., Ozmen, H., & Yigit, N. (2011). Investigation of primary students' motivation levels towards science learning. Science Education International, 22(3), 218-232.

Silva, A. D. S. D., Khatibi, A., & Azam, S. M. F. (2018). Do the demographic differences manifest in motivation to learn science and impact on science performance? Evidence from Sri Lanka. *International Lournal of Science and Mathematic Education, 16*(1), S47–S67. DOI 10.1007/s10763-017-9846-y

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *The Journal of Educational Research, 95*(6), 323-332.

Stellmacher, O. (2010). *Development and validation of the dutch science motivation quesionnaire (DSMG),* Unpublished master thesis, University of Twente, Netherlands.

Thalheimer, W., and Cook, S. (2002). How to calculate effect sizes from published research: A simplified methodology. *Work-Learning Research,* 1, 1-9.

Tseng, C. H., Tuan, H.L., & Chin, C. C. (2009). Investigating the influence of motivational factors on conceptual change in a digital learning context using the dual-situated learning model. *International Journal of Science Education,* 1-23.

Tuan, H.L. Chin, C.C., & Shieh, S.H. (2005). The development of a questionnaire to measure students' motivation towards science learning. *International Journal of Science Education, 27*(6), 639-654.

Turhan, N.S. (2020). Gender Differences in academic motivation: A Meta-Analysis. *International Journal of Psychology and Educational Studies, 7*(2), 211-224.

Uzun, N., & Keles, O. (2010). Fen ogrenmeye yonelik motivasyonun bazi demografik ozelliklere gore degerlendirilmesi. *Gazi Egitim Fakultesi Dergisi, 30*(2), 561-584.

Waterman, A. S. (2005). When effort is enjoyed: Two studies of intrinsic motivation for personally salient activities. *Motivation and Emotion, 29*(3), 165-188.

Wilson, J. (2001). *Increasing student motivation through the use of instructional strategy.* ERIC Document Reproduction Service No. ED455962.

Yazicioglu, S., & Cavus-Gungoren, S. (2019). Investigate the effect of game-based activities on middle school students' science learning according to achievement, motivation, attitude and gender variables. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 13*(1), 389-413.

Yenice, N., Saydam, G., & Telli, S. (2012). İlkogretim ogrencilerinin fen ogrenmeye yonelik motivasyonlarini etkileyen faktorlerin belirlenmesi. *Ahi Evran Universitesi Kirsehir Egitim Fakultesi Dergisi, 13*(2), 231-247.

Yildirim, H. İ., & Karatas, F. (2018). Ortaokul ogrencilerinin fen ogrenmeye yonelik motivasyonlari uzerine bir arastirma. *Cumhuriyet International Journal of Education, 7*(3), 241-268. http://dx.doi.org/10.30703/cije.423383

Yilmaz, H., & Cavas, P. H. (2007). Fen ogrenimine yonelik motivasyon olceginin gecerlik ve guvenirlik calismasi. *Ilkogretim online, 6*(3), 430-440.

Zeyer, A. (2018). Gender, complexity, and science for all: systemizing and its impact on motivation to learn science for different science subjects. *Journal of Research In Science Teaching, 55*(2), 147-171.

Zeyer, A., & Wolf, S. (2010). Is there a relationship between brain type, sex and motivation to learn science? *International Journal of Science Education, 32*(16), 2217-2233. doi: 10.1080/09500690903585184

Biographical notes:

Yunus Emre Baysal completed his bachelor's degree at the Ataturk University Faculty of Education in 2007, master degree on science education at the Dicle University in 2016 and PhD degree on science education at the Inonu University in 2020. His work areas are science education, comparative education, meta-analysis. He has been working as a science teacher in Bingol since 2008.

Fatma Mutlu completed her undergraduate, graduate and doctor education at Hacettepe University in 1993, 1996 and 2013, respectively. She works areas are plant biology, science education and biology education. She has been working as an associate professor at Inonu University Faculty of Education since 2016.

Oguzhan Nacaroglu completed his bachelor's degree at the Inonu University Faculty of Education in 2010, master degree on science education at the Inonu University in 2015 and PhD degree on science education at the Erciyes University in 2020. His work areas are science education, gifted education, project based learning and flipped learning. He has been working as an assistant professor at Sivas Cumhuriyet University Faculty of Education since 2022.