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Full Length Research

The effect of differentiated instruction approach on students' academic achievement and attitudes: A meta-analysis study

Sayed Shafiullah SAFAWI[1]* and Cenk AKAY[2]

[1]Kabul Education University, Faculty of Special Education, Kabul, Afghanistan.
[2]Mersin University, Faculty of Education, Department of Curriculum and Instruction, Mersin, Turkey.

*Corresponding author. Email: sayedshafiullahsafawi@gmail.com; ORCID ID: 0000-0001-5953-7695.
Co-author. Email: cenkakay35@hotmail.com; ORCID ID: 0000-0001-9892- 6255.

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ABSTRACT: In order to study the effect of differentiated instruction approaches on students' academic achievement and attitudes in this meta-analysis, CoHE Thesis Center, Google Scholar, Dergi Park, Research Gate, and ERIC search engines were used to retrieve studies published in Turkey between 2010 and 2021. Out of 23 quantitative studies selected, 10 experimental and 13 quasi-experimental studies focused on students' academic achievement and eight quantitative studies comprising three experimental and five quasi-experimental studies focused on students' attitudes. These studies measured the pretest-posttest differences between the experimental and control groups using parametric tests such as t-test, ANOVA, and ANCOVA. The effect sizes were examined under a random-effects model, using Cohen's *d* and Hedges' *g* indexes. According to the results, the analyses yielded a moderate effect size value of 0.791 for academic achievement and a small effect size value of 0.359 for attitude, and the overall effect size favoured the experimental group. In studies included in the analysis, the interventions lasted from 2 to 12 weeks, and the meta-regression analysis results showed that the longer the intervention duration, the more positively the academic achievement and attitude of the students are affected. However, its effect on attitude is greater than its effect on academic achievement.

Keywords: Academic achievement, attitude, differentiated instruction, meta-analysis, students.

INTRODUCTION

Differentiated instruction is one of the instructional methods that bring students' potential abilities to the maximum level possible by taking their characteristics into consideration. According to the existing studies, differentiated instruction facilitates using various strategies per students' characteristics and is considered one of the most positive and powerful methods (Deringöl and Davaslıgil, 2019; Olçay Gül, 2014; Beler and Avcı, 2011). The differentiated method is a student-focused educational system, which makes students more active and increases their learning quality using various instructions (Tomlinson, 2001). When planning differentiated education, students' characteristics, course elements, and teaching strategies are evaluated carefully (Tomlinson and Edison, 2003).

"Differentiated instruction is a sensitive form of teaching" (Tomlinson and Edison, 2003, p. 2). In this method, teachers are aware of the contents and rules and take on the responsibility to uncover students' different needs and help students to practice more, act independently, and counter challenges more effectively. On the other hand, they bring students' potential talents to a higher level using this approach and lessen the distance between them. This way, a sensitive education, comprehensive teaching, and active learning will take place. Through implementing differentiated learning, significant achievements are reached by considering the needs of all students in a class (Tomlinson and Edison, 2003). In the differentiated teaching approach, all students are considered to have abilities and thinking. Therefore, differentiated learning affects students' abilities and thinking skills (Üçarkuş,

2020).

Historically, in the late 21st century, the learning styles of students turned out different by understanding the brain and psychology in education better. Therefore, what is presented, why and how is not on the agenda of differentiated education. Herein, an instructional planning approach tailored according to the abilities of all students in a class is introduced by discovering individual differences and unique learning methods of students in the class (Tomlinson, 2001; Tomlinson, 1999). Because of changes in modern education approaches, Thompson is considered to be the founder of differentiated education. According to Tomlinson (2001), we should know the difference between the terms, individualized and differentiated, because it is true that differentiated learning presents several ways of learning but does not assume a different level for every student. It should not be expected from differentiated education that every student responds the way we want or answer a complex question the way we desire.

Considering the literature, studies on differentiated approaches focus on academic achievement, problem-solving, higher-order thinking, reflective thinking, motivation, attitude to lessons, and scientific process skills, conducted between 6 to 10 weeks (Kalemkuş, 2020; Kahyaoğlu, 2016). As study groups, studies mostly are conducted with primary education and undergraduate students (primary education 1 – 8 and undergraduate students), and questionnaires, interest scales, attitude scales, personal ability scales, achievement tests, and interviews are used as data collection tools (Kahyaoğlu, 2016). Most studies are master's theses and are conducted in secondary schools. Most of these theses and articles are quasi-experimental, mixed, or quantitative studies (Kahyaoğlu, 2016; Coşkun *et al*., 2014). Studies have been approved and published by academic and professional institutes, but some flaws have emerged because of different concepts and issues in some studies.

According to a study by Salar (2018), there was a significant difference between the academic achievement of the experimental group students exposed to the differentiated instruction approach and the control group students exposed to the traditional teaching method favouring the control group in only one of three activities. Some studies found no big difference between the experimental and control groups (Uğurel, 2018; Durmuş, 2017). However, according to the results of many studies, differentiated instruction positively and significantly increase students' achievement (Ermiş, 2021; Üçarkuş, 2020; Yıldırım *et al*., 2019), attitude (Yenibertiz, 2019; Faydalı, 2018; Özer and Yılmaz, 2018a), motivation (Bağrıyanık, 2020; Faydalı, 2018), problem-solving skills (Çoban, 2019; Taş and Sırmacı, 2018), self-efficacy (Faydalı, 2018; (Kozikoğlu and Bekler, 2018; Tüfekçi, 2018), and their views and course status (Özer and Yılmaz, 2018b). Besides students, the differentiated approach positively and significantly increase the general abilities and application levels of teachers, too (Kozikoğlu and Bekler, 2018; Çam, 2013).

Although numerous studies have examined the effect of the differentiated instruction approach on educational processes in the literature, few meta-analysis studies exist in Turkey and other countries (Ermiş, 2021; Dehpasi and Sadoughi, 2019). A meta-analysis study by Arslanhan and Sözer (2020) covering studies conducted between 2008 and 2018 only included master's theses to determine the effect of the differentiated instruction approach on students' academic achievement. Out of 19 studies included in the study, 89.5% consisted of quasi-experimental and 10.5% of weak experimental designs. As a result, they determined that the differentiated instruction approach positively increases the experimental group students' academic achievement with a strong effect size of +1.502. From Arslanhan and Sözer's (2020) study, only Şaldırdak (2012) and Umar (2014) were used in this meta-analysis.

Therefore, this study aimed to examine the parametric studies on the effect of differentiated instruction approach on students' academic achievement and attitude conducted using an experimental and quasi-experimental design within the scope of master's or doctoral theses and research articles through a meta-analysis method. According to this purpose, answers were sought to the following questions:

1. What is the effect of the differentiated instruction approach on students' academic achievement?
2. Are there significant differences in the effect of the differentiated instruction approach on students' academic achievement per moderators such as publication type, education level, and course duration?
3. What is the effect of the differentiated instruction approach on students' attitudes?
4. Are there significant differences in the effect of the differentiated instruction approach on students' attitudes according to publication type, education level, and course duration?

METHODOLOGY

A meta-analysis method was employed in this study, as it enables reanalyzing and combining data from various studies on a specific subject (Kanadlı, 2020; Aşık and Özen, 2019; Borenstein *et al*., 2013; Israel and Richter, 2011)., The processes and steps of the meta-analysis conducted to examine the effect of the differentiated instruction approach on students' academic achievement and attitude are illustrated in Figure 1.

In order to include all relevant studies, the Council of Higher Education (CoHE) Thesis Center, Google Scholar, Dergi Park, Research Gate, and ERIC databases were used. The search started in April 2021 and finished in May 2022. Studies on differentiated approaches conducted in

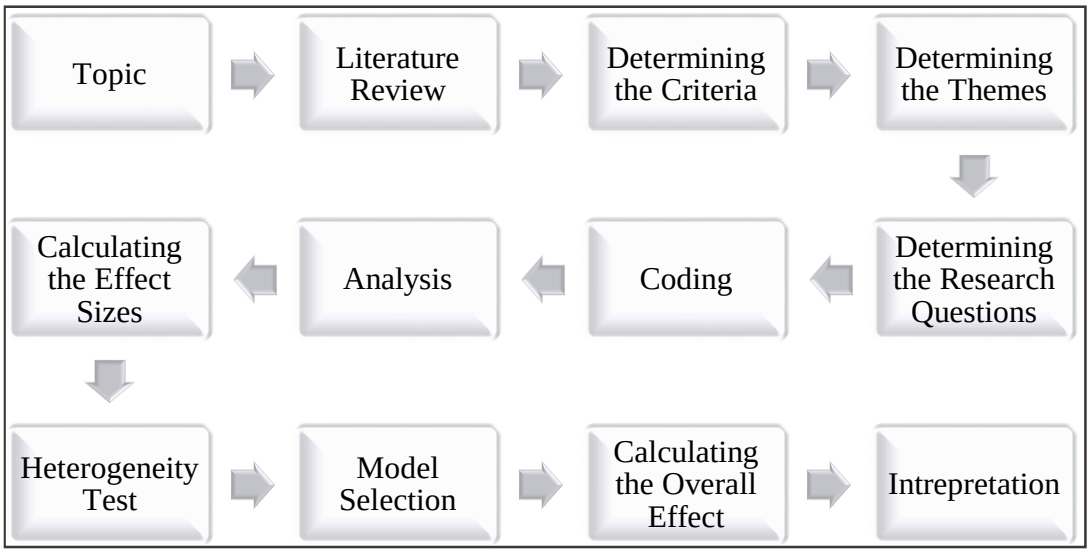

Figure 1. The meta-analysis process (Dinçer, 2014, p.11).

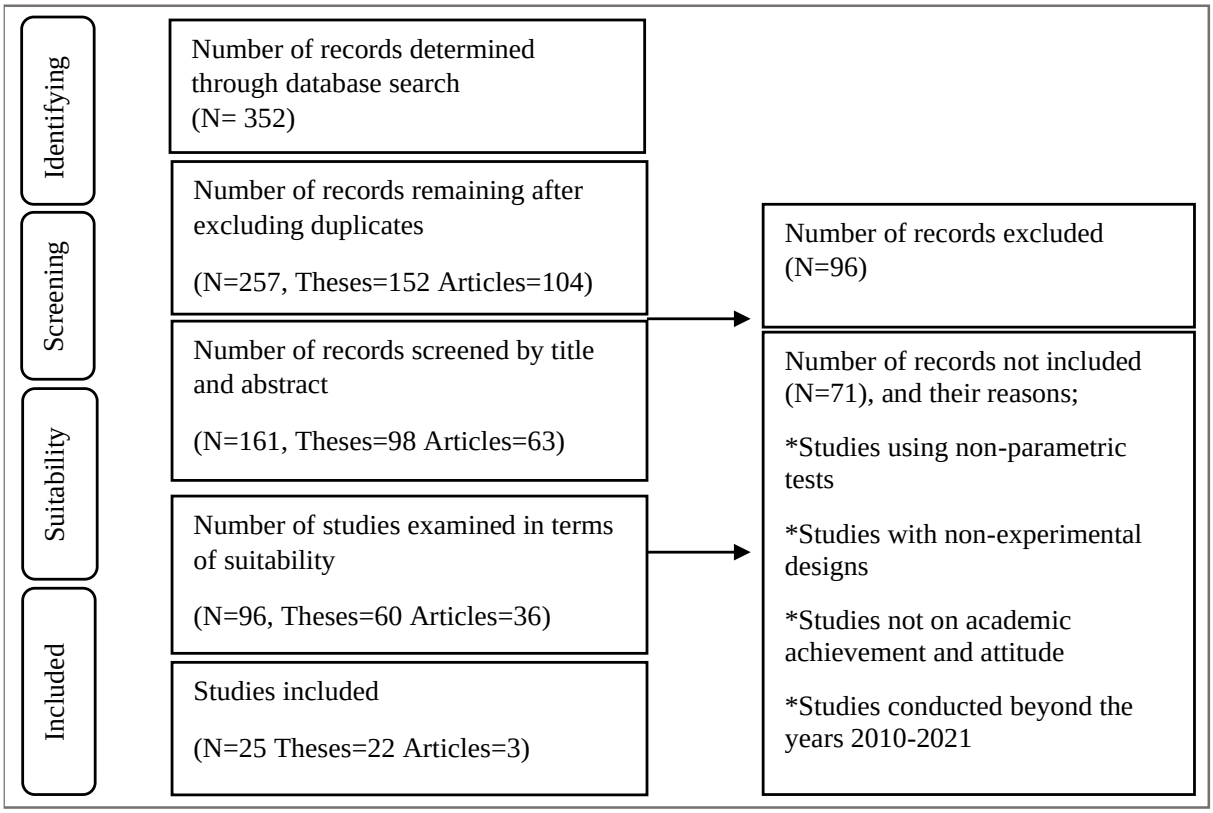

Figure 2. Flow chart of studies included in the meta-analysis (Kanadlı, 2020, p.15).

11 years (2010 – 2021) in Turkey were examined using the following keywords: “Farklılaştırılmış Eğitim”, “Farklılaştırılmış Öğretim”, “Farklılaştırılmış Yöntem”, “Bireyselleştirilmiş öğrenme”, “Differentiated learning”, “Differentiated Instruction” and “Individualized Instruction” during the search. Studies retrieved were selected following Israel and Richter (2011) according to Figure 2 (Standardized protocol “Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols” PRISMA-P).

Table 1. Frequency and percentage values for variables relating to academic achievement.

Variables	Frequency (f)	Percentage (%)
Education level		
Primary school, grades 1-4	4	17
Secondary school, grades 5-8	12	52
High school, grades 9-12	5	22
University	2	9
Branch		
Science	19	83
Social sciences	4	17
Publication type		
Thesis	20	87
Article	3	13

Table 2. Frequency and percentage values for variables relating to attitude.

Variables	Frequency (f)	Percentage (%)
Education level		
Primary school, grades 1-4	3	37.5
Secondary school, grades 5-8	3	37.5
High school, grades 9-12	0	0
University	2	25
Branch		
Science	5	62.5
Social sciences	3	37.5
Publication type		
Thesis	7	87.5
Article	1	12.5

Of studies determining the effect of differentiated instruction approach on students' academic achievement, the study published the earliest was in 2012 and the one on attitude published the earliest was in 2016. The variables relating to this meta-analysis are presented in Tables 1 and 2. According to Table 1, the frequency of variables is 100% (f=23). Further, 43% (10) of studies are experimental and 57% (13) quasi-experimental. Of these studies, 17% (f=4) are conducted in primary education, 52% (f=12) in secondary education, 22% (f=5) in high schools, and 9% (f=2) in universities. Moreover, 83% (f=19) of studies are carried out in science and 17% (f=4) in social sciences. Lastly, 87% (f=20) of studies are published as theses and 13% (f=3) as articles. All studies (f=23) used parametric tests.

According to Table 2, the frequency of variables is 100% (f=8). Further, 37.5% (3) of studies are experimental and 62.5% (5) quasi-experimental. Of these studies, 37.5% (f=3) are carried out in primary education, 37.5% (f=3) in secondary education, and 25% (f=2) in universities. Moreover, 62% (f=5) of studies are conducted in science and 37.5% (f=3) in social sciences. Lastly, 87.5% (f=7) of studies are published as theses and 12.5% (f=1) as articles. All studies (f=8) employed parametric tests.

In order to code the study characteristics and extract the data, theses and articles on differentiated approaches were examined and their data were coded using a coding form. Studies were coded per author name(s) and year, dependent variables (academic achievement and attitude), method (research method, design), sample group (grade, number of experimental and control groups), scales (experiment and control conditions and achievement test), data analysis test (parametric, non-parametric), publication type (thesis, article), branch (social sciences, science, mathematics, language, etc.), and intervention duration (week, class hours). Therefore, 25 quantitative experimental studies measuring the pretest-posttest differences between the experimental and control groups through parametric tests such as t-test, ANOVA, and ANCOVA were determined. Following Dinçer

(2021) and Borenstein *et a*l. (2013), sample sizes (N), mean scores (X), standard deviations (SD), and parametric tests (t-test or F statistics) were obtained.

Out of 25 studies retrieved, six examined both attitude and academic achievement but analyzed student achievement and attitude separately when implementing differentiated education. Therefore, 23 studies on the effect of differentiated learning on academic achievement and 8 studies on its effect on attitude were included in the analysis. Academic achievement represented N=1496 students and attitude N=440, totaling N=1936 students. In the academic achievement section, N=782 students constituted the experimental group and N=714 constituted the control group. The smallest number of students in experimental groups was N=17 and the largest was N=85. As such, the smallest number of students in the control groups was N=17 and the largest was (N=84). However, in the attitude section, N=226 students constituted the experimental group and N=226 constituted the control group. The smallest number of students in experimental groups was N=15 and the largest was N=59. Also, the smallest number of students in the control groups was N=15 and the largest was (N=56).

Quality assessment of studies; including low-quality studies in the research affects their reliability. Therefore, the systematic assessment system (Cavaleri *et al.,* 2018) of the Critical Appraisal Skills Programme (CASP) UK (n.d.) containing 10 questions was employed to determine the quality of studies included in this meta-analysis and to help readers verify the quality of research reports and evaluate them in terms of validity and suitability. According to Miles and Huberman's coder reliability formula, the percentage of reliability is obtained from the (Percentage of Reliability = Consensus / (Total Consensus + Disagreement)) formula and a minimum reliability value of 80% is expected (Akay, 2020). In this assessment system, a score of "1" was given when a criterion characteristic was present in a study, 0" when not present, and "0.5" when partially present. Afterwards, the quality score was calculated using the formula: Quality Score = [(Number of present criteria) / (Total number of criteria)] x 100. As a result, Miles and Huberman's coder reliability percentage of 97.5% was obtained, which shows high reliability between the two researchers.

As the data were collected from the literature, the observed effect sizes were determined using a random-effects model. As some studies included sample sizes smaller than 20, the mean effect size was calculated based on Hedges' g index (Kanadlı, 2020, p. 21). In order to analyze the effect sizes, the effect sizes were interpreted using Cohen's *d* coefficient, where 0 – 0.20 = Weak, 0.21 – 0.50 = Small, 0.51 – 1.00 = Moderate, and >1.00 = Strong effect (Cohen *et al*., 2007, p.521).

In order to examine the presence and amount of between-study variance, the Q-value, I^2 value, and χ^2 were examined through a test of heterogeneity (Kanadlı, 2020; Dinçer, 2021). Also, meta-regression and categorical moderator analyses were conducted with continuous and categorical variables to determine if they were the sources of heterogeneity. Finally, the Funnel Plot, Duval and Tweedie's Trim and Fill, Classic Fail-Safe N, and Egger's Regression Intercept were examined for publication bias. All the analyses were carried out using the Comprehensive Meta-Analysis (CMA) software.

RESULTS

The effect sizes obtained from the studies included in this meta-analysis to determine the effect of the differentiated instruction approach on students' academic achievement are given in Figure 3. According to the forest plot, of N=23 studies, thesis studies by Durmuş (2017), Aras (2018), and Kara (2019) yielded weak effect sizes; thesis studies by Ermiş (2021) and Göl (2021) yielded small effect sizes; thesis studies by Avcı (2018), Çoban (2019), Delice (2019), Salar (2018), Uğurel (2018), Umar (2014), Yaprakgül (2019), Özer (2016), and Taş (2013) and research article by Bahçeci and Gürol (2016) yielded moderate effect sizes; thesis studies by Bağrıyanık (2020), Şaldırdak (2012), Şentürk (2017), Üçarkuş (2020), Tüfekçi (2018), and Berber (2021) and research articles by Bal (2016) and Ekinci and Bal (2019) yielded strong effect sizes. According to Cohen's *d*, of studies on academic achievement included in this meta-analysis, three had weak effects, two small effects, ten moderate effects, and eight strong effects. According to the effect sizes calculated, the smallest effect size value was -0.034 and the largest was 2.481. Among the 23 effect size values, only one was negative. Accordingly, the effect of the differentiated instruction technique was in favour of experimental groups in 22 studies.

As seen in Figure 3, the mean effect size is in favour of experimental groups. When combined under a random-effects model, the standard error is 0.105 and the lower and upper limit 95% confidence intervals are 0.585 and 0.998, respectively. In addition, heterogeneity test was conducted to determine the presence and amount of between-study variance and the results showed that the Q-value was 79.483 with 22 degrees of freedom and the I^2 value of 72.321% indicated high heterogeneity between studies.

As the heterogeneity test was significant ($p < .05$), the source of between-study variance was examined through categorical moderators in Table 3 and meta-regression in Figure 5. As seen in Table 3, categorical moderator analyses were conducted to determine whether the mean effect differed significantly according to the education level, publication type, and branch. As the p-values in all groups were greater than 0.05, one could say that differentiated education has equal effects on all variables.

Furthermore, the Funnel Plot was examined to determine whether there was publication bias. According to Aşık and Özen (2019), publication bias is defined that

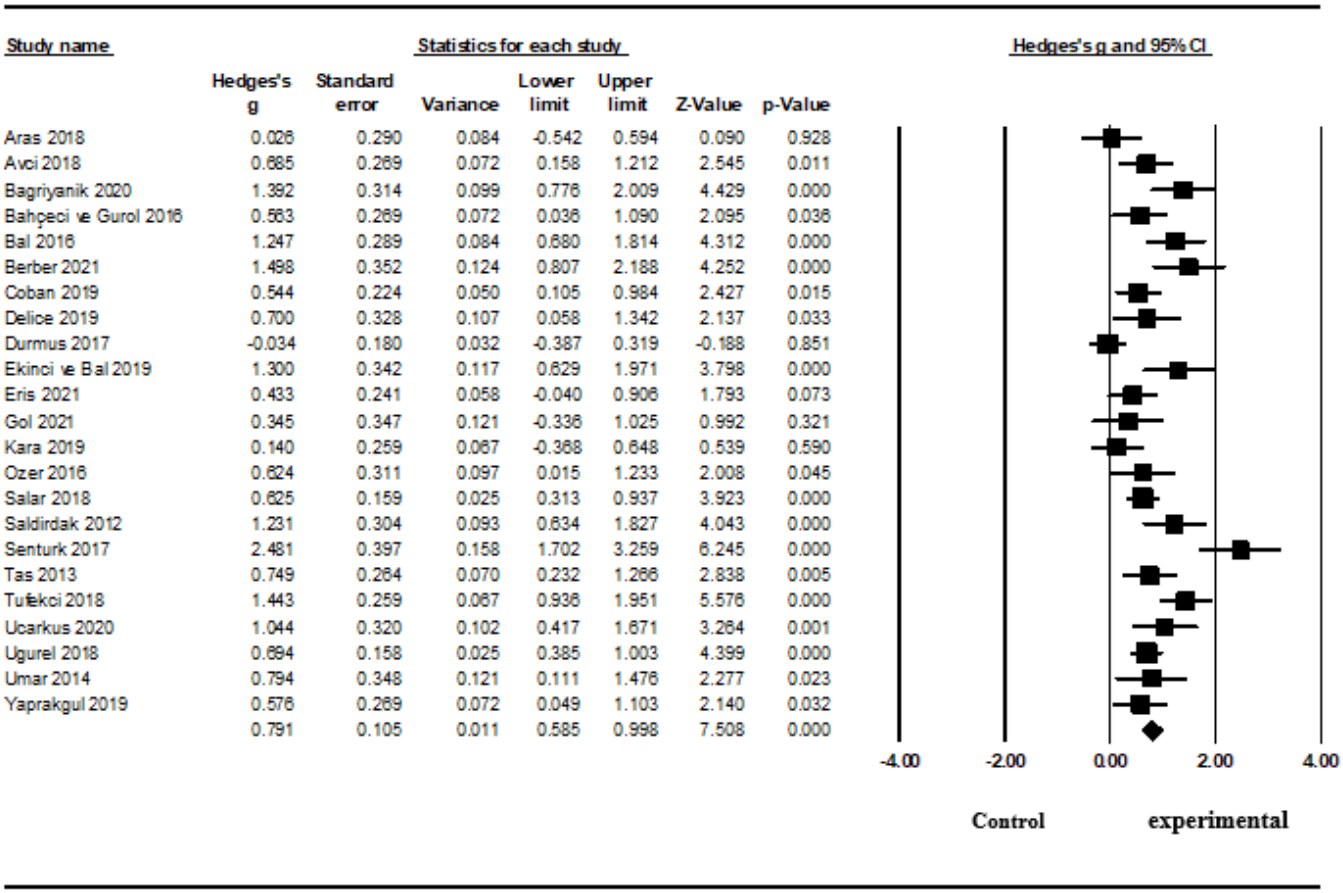

Figure 3. Forest plot relating to academic achievement.

Table 3. Moderator analysis by publication type, education level, and branch relating to academic achievement.

Moderators	*K*	Effect Size	95% Confidence Interval		Heterogeneity Test		
			Lower Limit	Upper Limit	*Q*	*Df*	*p*
Education Level	23	0.685	0.546	0.823			
Primary School	4	0.992	-0.083	2.067			
Secondary School	12	0.896	0.635	1.157	4.045	3	0.257
High School	5	0.593	0.411	0.774			
University	2	0.589	0.191	0.988			
Publication Type	23	0.802	0.620	1.024			
Article	3	1.011	0.526	1.497	0.853	1	0.356
Thesis	20	0.760	0.536	0.983			
Branch	23	0.800	0.608	0.991			
Science	19	0.873	0.666	1.081	3.260	1	0.071
Social Science	4	0.377	-0.120	0.874			

studies reporting statistically non-significant effects or showing negative effects beyond expectations are being published less than studies reporting significant or positive relationships. There is no publication bias in studies with small standard errors that cluster at the top of the funnel. However, when there is higher publication bias, studies

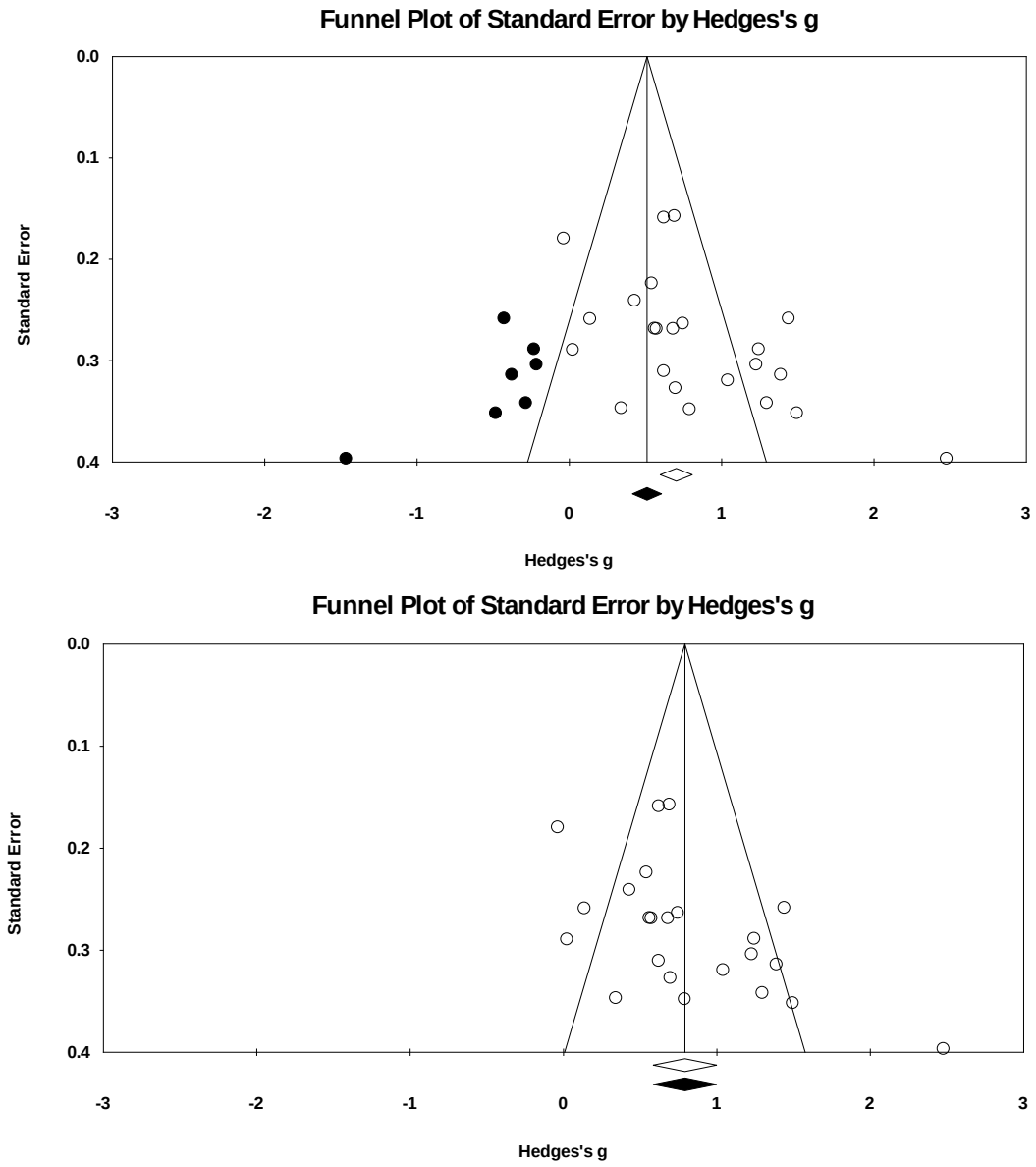

Figure 4. Funnel plots.

cluster more at the bottom of the funnel. Similarly, when they are on the left or bottom, they indicate negative judgement.

Before (left) and after (right) sensitivity analysis of effect sizes against the standard errors are shown in Figure 4. The left graphic indicated an asymmetric distribution of effect sizes. However, the right graphic indicates a relatively symmetric distribution by eliminating the extreme effect. According to Duval and Tweedie's Trim and Fill method, there is a difference between the observed and adjusted mean effect sizes. By contrast, Egger's test indicated the presence of publication bias (p < 0.05). However, Rosenthal's Fail-Safe N test showed that the threshold value is 5*23+10=125. As this threshold is exceeded (1109), it could be stated that there is no publication bias and the observed effect size is robust.

According to Table 4, the meta-regression result was non-significant in academic achievement. However, the regression line in Figure 5 indicates that effect sizes relating to academic achievement increase with an increase in intervention duration. The effect sizes obtained from the studies included in this meta-analysis to determine the effect of the differentiated instruction approach on students' attitudes are given in Figure 6.

According to the Forest Plot above, out of N=8 studies, the research article by Ekinci and Bal (2019) and thesis studies by Yenibertiz (2019) and Durmuş (2017) yielded weak effect sizes; thesis studies by Faydalı (2018), Tüfekçi

Table 4. Meta-regression results on whether the intervention duration explains the variance in academic achievement.

Moderator	*k*	Effect size	Standard error	95% confidence interval		*Q*	*df*	*p*	R^2
				Lower limit	Upper limit				
Intervention duration (Week)	23	0.066	0.046	-0.0250	0.1586	2.29	1	0.154	2,12%

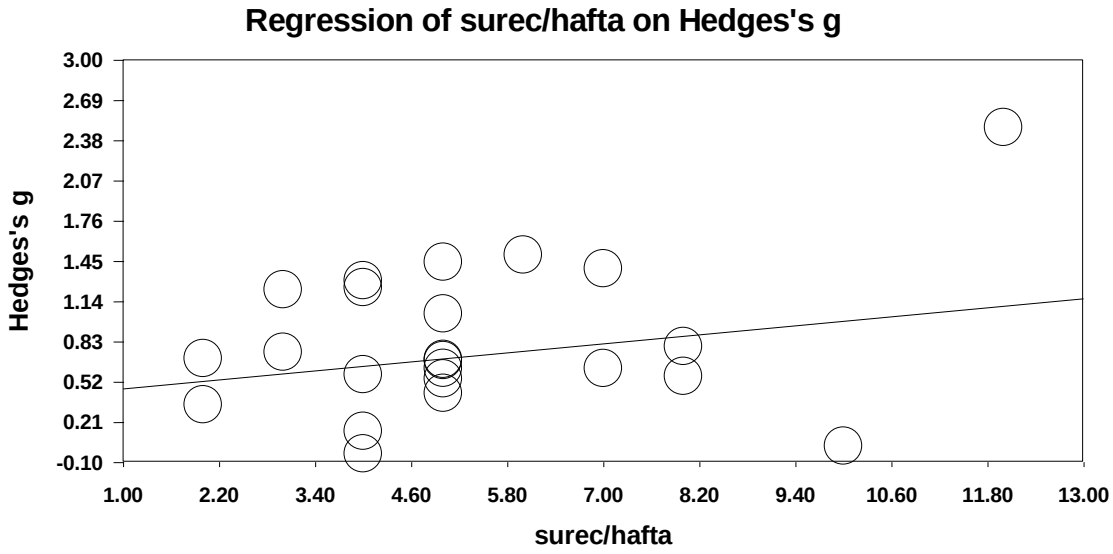

Figure 5. The effect of intervention duration on academic achievement.

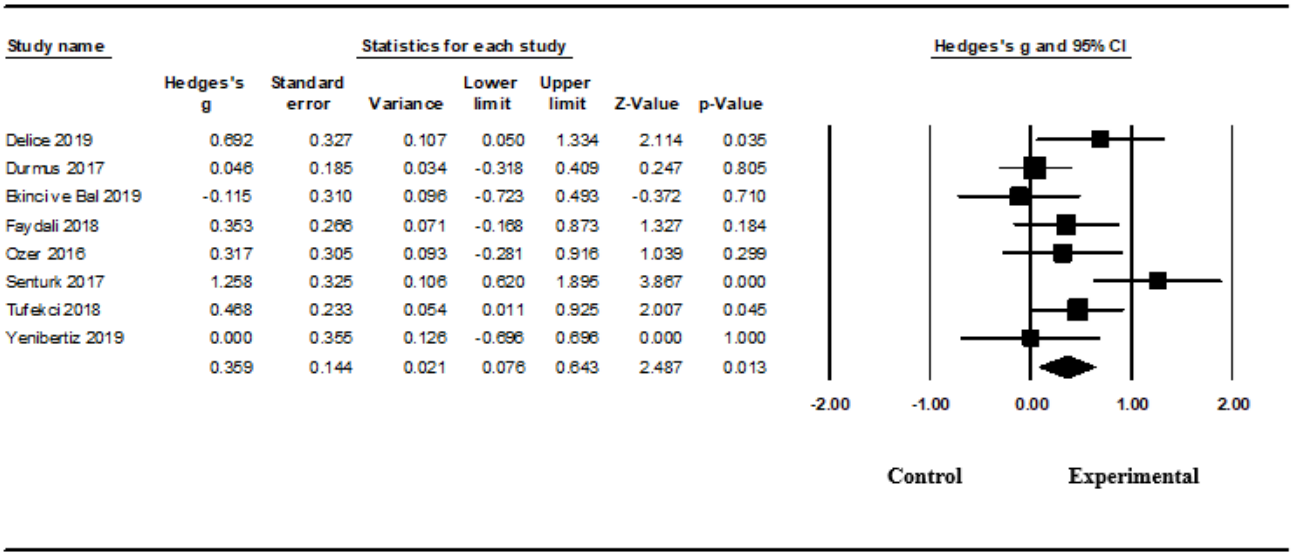

Figure 6. Forest plot relating to attitude.

(2018), and Özer (2016) yielded small effect sizes; the thesis study by Delice (2019) yielded a moderate effect size, and the thesis study by Şentürk (2017) yielded a strong effect size. According to Cohen's *d*, of studies included in this meta-analysis, three yielded weak effect sizes, three yielded small effect sizes, one yielded a moderate effect size, and one yielded a strong effect.

As seen in Figure 6, the mean effect is in favour of

Table 5. Moderator analysis by publication type, education level, and branch relating to attitude.

Moderators	*k*	Effect size	95% confidence interval		Heterogeneity		
			Lower limit	Upper limit	*Q*	*df*	*p*
Education level	**8**	**0.386**	**0.147**	**0.625**	**1.136**	**2**	**0.567**
Primary school	3	0.373	-0.382	1.129			
Secondary school	3	0.479	0.176	0.782			
High school	0	0.000	0.000	0.000			
University	2	0.182	-0.271	0.636			
Publication type	**8**	**0.316**	**0.049**	**0.584**			
Article	1	0.115	-0.723	0.493	**2.401**	**1**	**0.121**
Thesis	7	0.420	0.122	0.718			
Branch	**8**	**0.238**	**0.007**	**0.470**	**2.776**	**1**	**0.096**
Science	5	0.517	0.116	0.918			
Social science	3	0.099	-0.185	0.383			

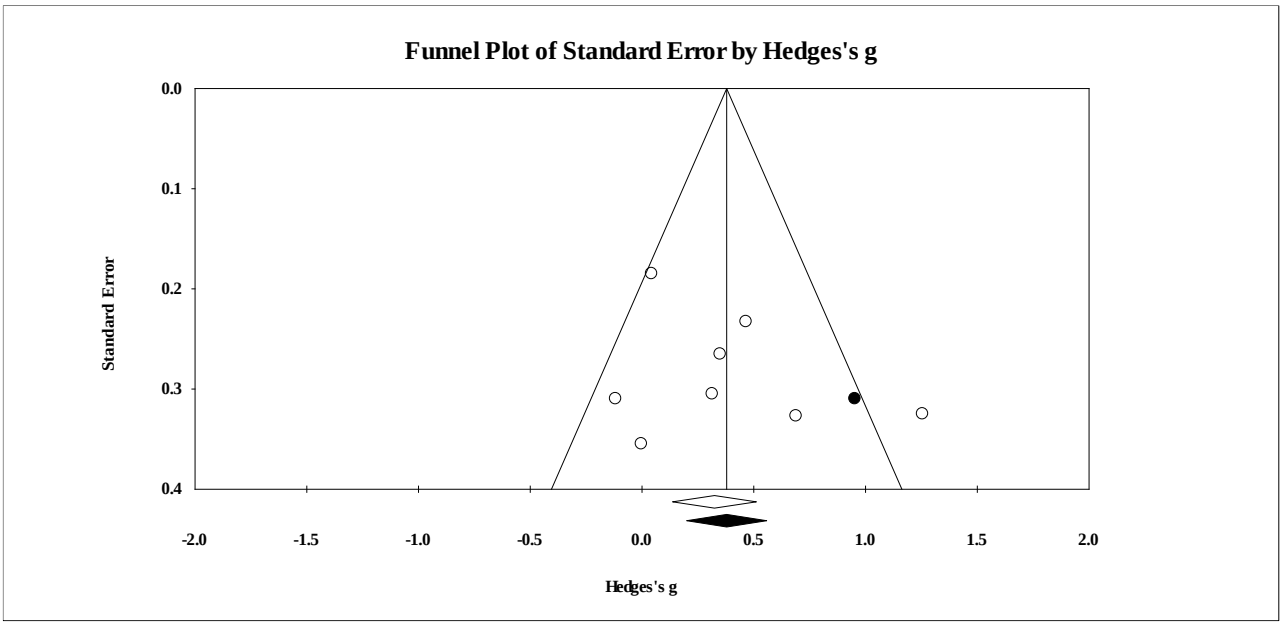

Figure 7. Funnel plot relating to attitude.

experimental groups. A heterogeneity test was conducted to determine the presence and amount of the between-study variance. The results showed that the effect sizes are heterogeneous (Q = 14.990, $p < 0.05$). Meanwhile, the I^2 value of 53.302% showed high heterogeneity between studies according to Kanadlı (2020, p.24).

As the heterogeneity test relating to the effect of the differentiated instruction approach on students' attitude was significant ($p < 0.05$), the sources of variance between studies was investigated through categorical moderator analyses in Table 4 and meta-regression analysis in Figure 8.

As seen in Table 5, categorical moderator analyses were conducted to determine whether the mean effect differ significantly according to education level, publication type, and branch. However, the analyses yielded no significant difference between subgroups ($p > 0.05$), indicating that differentiated instruction have equal effects on all variables.

Figure 7 shows a symmetric distribution of effect sizes around the mean effect within the funnel limits. Also, there is a difference between the observed and adjusted mean effect sizes per Duval and Tweedie's test but Egger's intercept test indicated that there is no publication ($p > 0.05$). Meanwhile, an examination of Rosenthal's Fail-Safe N test showed that the threshold value is 5*8+10=10. As

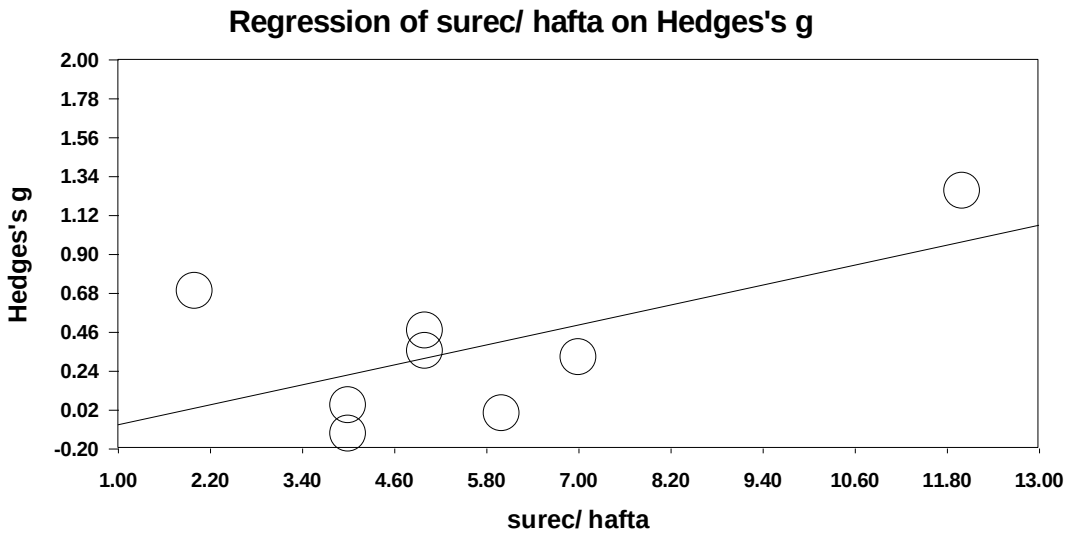

Figure 8. The effect of intervention duration on attitude.

Table 1. Meta-regression results on whether the intervention duration explains the variance in attitude.

Moderator	*k*	Effect size	Standard error	95% confidence Interval		*Q*	*df*	*p*	R^2
				Lower limit	Upper limit				
Intervention Duration (Week)	8	0.0940	0.0469	0.0019	0.1860	4	1	0.045	57%

this threshold value is exceeded (20 studies), one could say that there is publication bias and the observed effect size is not robust.

According to Table 6, the meta-regression model tested with intervention duration is significant ($p < 0.05$) and explains 57% of the variance in attitude. According to Figure 8, the regression line shows that course duration significantly affects student attitudes. In other words, the upward inclination in the regression line indicates that students' attitudes positively increase with an increase in intervention duration.

DISCUSSION

This meta-analysis examined 11 years (2010 – 2021) years of research on the effect of differentiated education on students' academic achievement and attitude in Turkey. According to the existing studies, differentiated education makes students more active, increases the learning quality (Tomlinson, 2001), maximizes students' potential abilities, diminished the distance among them, and enables assessing student characteristics and course elements (Tomlinson and Eidson, 2003) by paving the way for applying various strategies (Olçay Gül, 2014; Beler and Avcı, 2011). At the same time, many studies show that differentiated instruction increases student achievement (Berber, 2021; Ermiş, 2021; Üçarkuş, 2020; Yıldırım *et al*., 2019), attitude (Yenibertiz, 2019; Faydalı, 2018; Özer, 2016), motivation (Bağrıyanık, 2020; Faydalı, 2018), problem-solving skills (Çoban, 2019; Taş, 2013), self-efficacy (Faydalı, 2018; Kozikoğlu and Bekler, 2018; Tüfekçi, 2018), their views and course status (Özer and Yılmaz, 2018a) at positive and significant levels. It also increases teachers' general abilities and application levels at positive and significant levels (Kozikoğlu and ekler, 2018; Çam, 2013). Only one study (Salar, 2018) reported a significant difference in academic achievement scores in favour of the control group. However, some studies showed that the experimental and control group students' academic achievement (Uğurel, 2018; Durmuş, 2017) and attitude (Ekinci and Bal, 2019) were close to one another and no statistically significant difference existed between them.

Of 23 studies, 43% employed experimental and 57% quasi-experimental designs to determine the effect of differentiated instruction approach on students' academic achievement, and 91% of studies consisted of school students and 9% of university students. As a result of the meta-analysis of these studies on students' academic achievement, three studies yielded weak effects, two yielded small effects, ten yielded moderate effects, and eight yielded strong effects, and the mean effect size was in favour of experimental groups. The combined effect size value obtained for academic achievement was 0.791 with a 95% confidence interval ranging between 0.585 and

0.998, showing a moderate effect according to Cohen *et al*. (2007, p.521) effect size classification. These results support the conclusions achieved in a meta-analysis study on the effect of differentiated instruction conducted by Arslanhan and Sözer (2020). Meanwhile, the positive effects in 19 studies included in Arslanhan and Sözer's (2020) study were in favour of experimental groups and strongly affected students' academic achievement with an effect size of +1.502.

There were no significant differences in education level, publication type, and branch in 23 studies on academic achievement included in this meta-analysis. The intervention duration of differentiated education ranged between 2 to 12 weeks (5-6 weeks on average), of which 17% were conducted with primary school students, 52% with secondary school students, 22% with high school students, and 9% with undergraduate students. According to the meta-regression results relating to students' academic achievement, the effect size was obtained as 0.066, showing that the longer the intervention duration, the more positively the differentiated education will affect students' academic achievement.

Of eight studies, 37.5% used experimental and 62.5% quasi-experimental designs to determine the effect of differentiated instruction approach on students' attitudes. Further, 75% of studies consisted of primary and secondary school students and 25% of university students. As a result of the meta-analysis of studies on student attitudes, three studies yielded weak effects, three yielded small effects, one yielded a moderate effect, and one yielded a strong effect, with the mean effect size being in favour of experimental groups. The combined effect size value obtained for attitude was 0.359 with a 95% confidence interval ranging between 0.076 and 0.643, showing a small effect according to Cohen *et al*. (2007, p.521) effect size classification.

The moderator analysis conducted with education level, publication type, and the branch to determine the variance between eight studies on attitude included in this meta-analysis yielded no significant difference. The intervention duration of differentiated education ranged from 2 to 12 weeks (5-6 weeks on average), of which 75% were conducted with primary and secondary school students and 25% with undergraduate students. According to the meta-regression results relating to student attitude, the effect size was obtained as 0.094, showing that the longer the intervention duration, the more positively differentiation education will affect student attitude.

A comparison of the results indicates that differentiated education has different effects on student achievement and attitude. In order to determine whether there was publication bias, diagnostic analyses of Duval and Tweedie's Trim and Fill statistics, Egger's Intercept Test, and Rosenthal's Fail-Safe N were examined. The observed effect was robust in the academic achievement section but was not in attitude section. According to the meta-regression results on whether the intervention duration explained the variance, differentiated education had a larger effect on students' attitudes than their academic achievement.

Recommendations

According to the resultant findings of the meta-analytic reviews of studies on the effects of differentiated instruction approach on students, the following recommendations are presented to:

Practices:

1. Differentiated education has equal effects on all education levels and increases students' academic achievement and attitude at a positive and significant level. Therefore, it should be used in education levels ranging from primary school to university.
2. Differentiated instruction approach should be used more in education, as it is more effective than traditional instructional methods.
3. The longer the duration of the differentiated approach, the more positive student achievement and attitude will be effective. Thus, it should be continuously used in education.

Researchers:

1. Differentiated education has equal effects on all education levels and increases students' academic achievement and attitude at a positive and significant level. While few studies exist in university level, no study on attitude exists in high school level. Therefore, more studies should be conducted in high school and university levels.
2. Differentiated education increases students' academic achievement and attitude at a positive and significant level. There are few studies in social sciences. Thus, more studies should be conducted in the field of social sciences.
3. According to the studies, differentiated education is effective in different fields of students. Hence, studies on other issues should also be conducted other than academic achievement and attitude.
4. There are few research articles on differentiated education. Therefore, more studies should be conducted on the relevant topic using different methods.

Limitations

This study examined the effect of the differentiated instruction approach on students' academic achievement and attitude by including studies conducted between the years 2010 and 2021 and is limited to studies conducted

in Turkey. Hence, not including studies conducted beyond 11 years, covering only studies conducted using experimental designs, and not addressing topics other than academic achievement and attitude could be considered the limitations of our study.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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NOTE:

(*) marked references were included in the meta-analysis of studies on academic achievement.

(**) marked references were included in the meta-analysis of studies on attitude.