Chapter 19
The Effect of Learning Types/Styles on Student Achievement

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19.1 Introduction

An individual difference among students is one of the situations that teachers encounter in the educational environment. This is one of the many variables that influence the academic achievement of students. It should be recognized and taken into account that individual differences will emerge as a natural result of the presence of many different people in the educational environments. The fact that each student has a unique learning style is widely accepted today.

The concept of "learning style" was firstly proposed by Rita Dunn in 1960. It has been worked on continuously over the years and various studies have been conducted. The purpose of these studies was to demonstrate that people get, process, store, restore and learn the knowledge differently from each other, putting the concept of style in the center. This topic entered into schools and has found an application area much later than the 1960s (Boydak 2001). Although different authors propose different definitions based on different conceptualizations, learning style is usually defined as "characteristic strengths and preferences that individuals have in the process of receiving, holding and processing the information" (Felder and Silverman 1988). Loo (2002) has described learning style as the way people respond to or interact with the stimuli they receive from the environment while learning a new subject; whereas Shaughnessy (1998) has defined it as the concentration, the process and the internalization of the knowledge and the ways/processes of recalling new and difficult information. Keefe (1979) explained learning style noting that it is the source of relatively stable cognitive, affective and psychological behaviors about how people respond to their learning environment as well as about how they interact with their learning environment and perceive it; whereas Curry (2000) has defined it as the individual differences in perception,

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memory, thinking and judging in case of a stimulus. Finally, according to Kolb (1981), learning style is the personally preferred way/method for grasping and processing information.

Individuals, who are different from each other in many ways, such as in their cognitive, affective, social and psychomotor characteristics, have different ways of learning. Instead of treating the different individuals as a homogenous group and teaching them all through the same learning methods, educators should identify individuals' learning styles and take these different styles into account in the regulation of education environments. In this way the learning process and the cognitive and emotional development of students will be enriched (Sapancı 2014).

Various learning style models are presented in the literature. The theories of personality, the results of the studies which examined individual abilities and various evaluations of educational institutions were all used in the formation of these models (Keefe and Ferrell 1990).

The most famous models regarding the identification of learning styles are the following: Myers–Briggs Type Indicator, Kolb's Experiential Learning Style Model, Felder-Silverman Learning Style Model, Hermann Brain Dominance Model, Gregory's Learning Style Model, McCarthy's Learning Style Model, Dunn-Dunn Learning Style Model and Grasha Learning Style Model (Bilgin and Bahar 2008).

Recently, the focus of the literature is on the relationship between learning styles and academic achievement in different disciplines and subjects: biology (Fan et al. 2015), economics (Terregrossa et al. 2012; Englander et al. 2011), English (Elliot 2006), foreign language (Bailey et al. 2000; Cesur and Fer 2011), history (Bozkurt 2013), humanities (Rezaeinejad et al. 2015), language (Shay 1994; Williams 2008; Chen et al. 2010; Ahmad et al. 2011), mathematics (Shay 1994; Treacy 1996; Bilgin and Durmuş 2003; Husch 2001; Davis 2007; Williams 2008; Chen et al. 2010; Sriphai et al. 2011; Jahanbakhsh 2012; Rezaeinejad et al. 2015), microeconomics (Terregrossa et al. 2009), non-technical subject (Omar et al. 2015), psychology (Busato et al. 2000), reading (Snyder 1999; Littin 2001), science (Bilgin and Durmuş 2003; Williams 2008; Chen et al. 2010; Jahanbakhsh 2012; Rezaeinejad et al. 2015), social science (Bilgin and Durmuş 2003; Williams 2008), technical writing (Roberts 1999), Turkish (Bilgin and Durmuş 2003), vocabulary (Leone 2008), accounting (Terregrossa et al. 2012), agriculture (Dyer 1995).

A number of different variables, along with the results of previous research studies, were used to test the following hypotheses of this research:

H_1 Learning types/styles have a positive effect on student achievement.
H_2 Publication type is a moderator for the positive effect of learning types/styles on student achievement.
H_3 Sample group is a moderator for the positive effect of learning types/styles on student achievement.
H_4 School subject is a moderator for the positive effect of learning types/styles on student achievement.

H_5 Tool of data collection is a moderator for the positive effect of learning types/styles on student achievement.
H_6 The year of the studies is a moderator for the positive effect of learning types/styles on student achievement.
H_7 Culture is a moderator for the positive effect of learning types/styles on student achievement.

19.2 Method

19.2.1 Study Design

In this study, the effect of learning types/styles on student achievement was tested with a meta-analysis design.

19.2.2 Review Strategy and Criteria for Inclusion/Exclusion

To determine the research studies to include in the meta-analysis, the Science-Direct, ProQuest and Ebsco academic databases were used to conduct a literature review. For this process, the terms *learning types/styles* and *student achievement/student success* included in the titles of the studies were used to screen the research studies. The end date for the research studies included in the research was identified as January 2016. Doctoral dissertations and peer-reviewed journals were included in the study.

Many strategies were used to identify the research studies that were appropriate for the meta-analysis of the study. First, a research study pool (443 research studies) was established; it included all studies with learning types/styles and student achievement/success in their titles. The abstracts of these studies were reviewed, and all were found to be appropriate to include in the study. In the second stage, all research studies in the pool were examined in detail. The results of the examination found that 60 of the research studies in the pool were appropriate, and 383 were not found to be suitable. The descriptive statistics of the 60 research studies included in the analysis are presented in Table 19.1.

The criteria for inclusion of the research studies in the analysis study were identified as follows:

- To have the statistical information necessary for correlational meta-analysis (n and r, or R^2 values)
- To be a study measuring the correlation learning types/styles and student achievement/success

Table 19.1 Characteristics of the studies included in the meta-analysis

Variables		1	2	3	4	5	Total
Type of publication		Thesis	Article				–
	n	25	35				60
	%	41.6	58.4				100
Sample group/unit		University	Collage	Elementary school	High school	Middle school	–
	n	22	4	5	17	12	60
	%	36.7	6.6	8.3	28.4	20.0	100

Reasons for not including a research study in the meta-analysis:

- Having no quantitative data (qualitative research)
- Not having a correlation coefficient
- Not focusing on student achievement
- Not focusing on learning types/styles.

19.2.3 Coding Process

The coding process was essentially a data sorting process used to ascertain which data were clear and suitable for the study. In this scope, a coding form was developed before the statistical analysis was conducted, and the coding was conducted according to the form. The main aim was to develop a specific coding system that allowed the study to see the entirety of the research studies in general and that would not miss any characteristics of each individual research study. The coding form developed in the study was comprised of:

- References for the research
- Sample information
- Sample group
- Type of publication,
- School subject
- Data collection tool(s)
- The years of the studies
- Culture.

19.2.4 Statistical Processes

The effect size acquired in meta-analysis is a standard measure value used in the determination of the strength and direction of the relationship in the study

(Borenstein et al. 2009). Pearson's correlation coefficient (r) was determined to be the effect size in this study. Because the correlation coefficient has a value between $+1$ and -1, the r value calculated was evaluated by converting this value into the value as it appears in the z table (Hedges and Olkin 1985). Provided that more than one correlation value is given between the same structure categories in correlational meta-analysis studies, two different approaches are used in the determination of the one to be used in the meta-analysis (Borenstein et al. 2009; Kulinskaya et al. 2008). For this study, (*i*) first, if the correlations were independent, all the related correlations were included in the analysis and were considered to be independent studies, and (*ii*) if there were dependent correlations, then the *highest correlation value* were accepted. A *random effect model* was used for the meta-analysis processes in this study. The *Comprehensive Meta-Analysis* program was used in the meta-analysis process.

19.2.5 Moderator Variables

To determine the statistical significance of the differences between the moderators of the study, only the Q_b values were used. Six moderator variables that were expected to have a role in the average effect size were identified in the study. The first of these considered is the *sample group* as a moderator in regards to the relationship between learning types/styles and student achievement. The second is the *school subject* which was thought to have a role on the average impact of learning types/styles on student achievement. The rest are the *type of publication, the year of the studies, data collection tools* and *culture.*

19.2.6 Publication Bias

A funnel plot for the research studies included in the meta-analysis of can be seen in Fig. 19.1. Evidence that publication bias affected the research studies included in the meta-analysis can be seen in Fig. 19.1. A serious asymmetry would be expected in the funnel plot if there were a publication bias. The concentration of plots on one side under the line of average effect size, particularly in the bottom section of the funnel, suggests the probability of a publication bias in the research studies. Evidence for publication bias was observed for the 9 research studies included in the meta-analysis study.

A publication bias was observed in the funnel plot, and the results of Duval and Tweedie's trim and fill test, which was applied to determine the effect size related to partiality in the publications that was acquired with the meta-analysis using the random effect model, are shown in. As seen in Table 19.2, there is a difference between the observed effect size and the virtual effect size established to correct the effect of the publication bias. The reason for the difference is the asymmetry of the

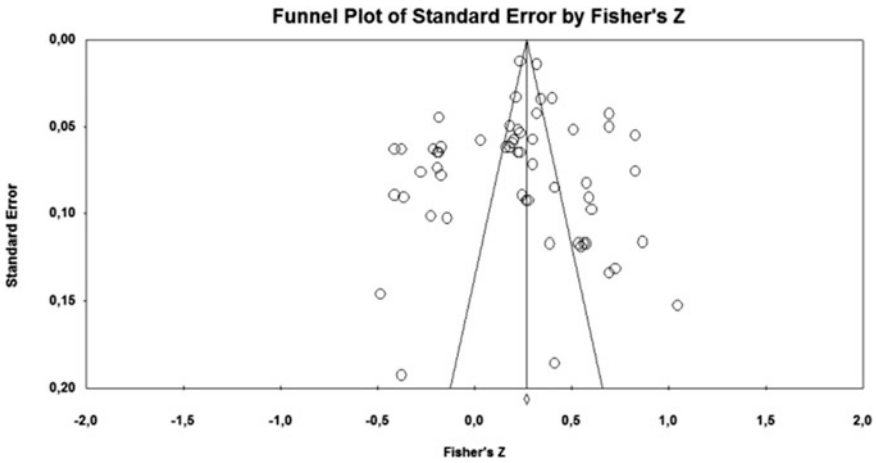

Fig. 19.1 Effect size funnel for publication bias

Table 19.2 Duval and Tweedie's trim and fill test results

	Excluded studies	Point estimate	CI (confidence interval)		*Q*
			Lower limit	Upper limit	
Observed values		0.23	0.17	0.30	1603.35542
Corrected values	9	0.14	0.07	0.22	2633.75865

concentration on both sides of the center line and the studies plotted to the left of and above the center line, skewing the symmetry.

19.3 Findings

Table 19.3 displays the results of the meta-analysis examining the relationship between learning types/styles and student achievement. The findings supported hypothesis H_1 which formulated that there is a positive relationship between learning types/styles and student achievement. The effect size of learning style on student achievement was calculated as 0.23, which shows that learning style has a medium effect (*see* Cohen 1988) on students' academic achievement.

The results of the moderator analysis did not support hypothesis H_2 which formulated that the publication type plays a moderator role in academic achievement. Although the moderator analysis showed that the difference between the effect sizes of the publication types was not statistically significant ($Qb = 3.52$,

Table 19.3 Findings of the correlations between learning types/styles and academic achievement: results of meta-analysis

Variable	k	N	*r*	CI (confidence interval)		*Q*	Q_b
				Lower limit	Upper limit		
Learning types/styles	60	26391	0.23*	0.17	0.30	1603.35*	
Moderator [school subject]							**85.11***
Accounting	1	61	0.62*	0.23	0.83		
Agriculture	1	120	0.27	−0.17	0.62		
Biology	1	46	0.79*	0.49	0.91		
Economics	3	259	0.56*	0.38	0.73		
English	1	125	0.35	0.67	0.08		
Foreign lang.	6	1770	0.38*	0.22	0.52		
GPA	17	16324	0.17*	0.07	0.27		
History	1	175	−0.27	−0.61	0.16		
Humanities	1	50	−0.45	−0.75	0.01		
Mathematics	11	2784	0.41*	0.29	0.51		
Non-technical	1	288	0.19	−0.23	0.55		
Psychology	1	409	0.18	−0.23	0.54		
Reading	5	1133	−0.22*	−0.40	−0.04		
Science	5	1405	0.29*	0.10	0.46		
Social science	2	316	0.15	−0.15	0.44		
Technical	1	32	0.39	−0.13	0.74		
Turkish	1	240	−0.18	−0.56	0.24		
Vocabulary	1	854	0.33	−0.07	0.64		
Moderator [publication type]							**3.52**
Article	35	9800	0.28*	0.20	0.36		
Thesis	25	16591	0.16*	0.05	0.26		

(continued)

Table 19.3 (continued)

Variable	k	N	*r*	CI (confidence interval)		*Q*	Q_b
				Lower limit	Upper limit		
Moderator [sample group]							**8.82***
Collage	4	575	−0.09	−0.37	0.20		
Elementary school	5	1796	0.03	−0.21	0.27		
High school	17	4401	0.28*	0.15	0.40		
Middle school	12	8581	0.30*	0.14	0.44		
University	22	11038	0.26*	0.14	0.37		
Moderator [data collection tool]							**14.27***
BE (Rundle, & Dunn)	1	503	−0.18*	−0.26	−0.09		
FLSI	7	1489	0.19	0.14	0.24		
NEO-FFI	1	308	0.29*	0.18	0.38		
GEFT	3	416	0.22*	0.12	0.31		
GSD	1	562	0.10*	0.01	0.18		
HAQLS	1	300	0.03	−0.08	0.14		
ILP	1	308	0.20*	0.09	0.30		
ILS (Felder and Solomon)	1	877	0.15*	0.08	0.21		
ILS (Vermunt)	2	1323	0.20*	0.14	0.25		
LSA	1	400	0.47*	0.39	0.54		
LSI (Burke & Dunn)	1	854	0.33*	0.26	0.38		
LSI (Dunn and Dunn)	5	420	0.18	0.09	0.28		
LSI (Dunn)	5	559	0.17	0.09	0.25		
LSI (Dunn, Dunn and Price)	1	377	0.22*	0.12	0.31		
LSI (Grasha and Riechmann)	7	1643	0.13	0.09	0.18		
LSI (Kolb)	13	7973	0.33*	0.31	0.35		
LSI (Renzulli and Smith)	2	6743	0.20	0.18	0.23		

(continued)

Table 19.3 (continued)

Variable	k	N	*r*	CI (confidence interval)		*Q*	Q_b
				Lower limit	Upper limit		
LSI (Nigro)	1	59	0.60*	0.40	0.74		
LSP (Keefe)	2	256	−0.08	−0.20	0.04		
LSS	1	376	0.23*	0.13	0.32		
OWLS	1	255	−0.36*	−0.46	−0.24		
SSQ	1	150	0.28*	0.12	0.42		
TVLSPI	1	240	0.23*	0.20	0.34		
Moderator [Publication year of the research]							**40.29***
1980–1984	1	6488	0.23	−0.23	0.61		
1985–1989	2	197	−0.24	−0.56	0.13		
1990–1994	2	530	0.00	−0.33	0.32		
1995–1999	8	7328	0.30*	0.13	0.45		
2000–2004	13	3134	−0.07	−0.20	0.06		
2005–2009	13	4141	0.40*	0.28	0.51		
2010–2015	21	4573	0.34*	0.24	0.44		
Moderator [Culture]							**1.43**
Vertical-collectivist	23	6809	0.28*	0.18	0.38		
Horizontal-individualistic	37	19528	0.20*	0.12	0.28		

*$p < 0.05$

$p > 0.05$), the effect of learning style on academic achievement was medium for both papers [$r = 0.28$] and theses [$r = 0.16$].

The findings supported hypothesis H_3 which formulated that the sample plays a moderator role in the effect size of the learning style on academic achievement. The moderator analysis revealed that the effect size differences of the various samples were statistically significant ($Qb = 8.82$, $p < 0.05$). According to this result, in high school [$r = 0.28$], middle school [$r = 0.30$] and university [$r = 0.26$] learning styles have a medium effect on achievement; whereas the effect of learning style on achievement was not found to be significant for college and elementary school.

The moderator analysis supported hypothesis H_4 which formulated that the school subject used for measuring academic achievement play a moderator role in the effect size of learning style on academic achievement. It was found that learning style has medium effect on students' academic achievement in biology [$r = 0.78$], accounting [$r = 0.62$], economics [$r = 0.58$], mathematics [$r = 0.41$] and foreign language [$r = 0.38$], reading [$r = 0.22$] and science [$r = 0.29$] courses, whereas it has a small effect in GPA [$r = 0.17$]. On the other hand, no significant effect of learning style has been detected in agriculture, English, history, humanities, non-technical, psychology, social science, technical, Turkish and vocabulary courses. According to the moderator analysis conducted through a random effect model, the effect size of learning style on academic achievement is different for each course, and, therefore, the effect size differences among the courses used to measure academic achievement are statistically significant ($Qb = 85.11$, $p < 0.05$).

As it can be seen from the findings in the table, hypothesis H_5 which formulated that the data collection tool plays a moderator role in the effect size of learning style on academic achievement was confirmed. The moderator analysis showed that the effect size differences of the various data collection tools were statistically significant ($Qb = 14.27$, $p < 0.05$). Accordingly, it was found that the effect of learning style on academic achievement was medium or large for LSI (Nigro) [$r = 0.60$], LSA [$r = 0.47$] and LSI (Burke and Dunn) [$r = 0.33$] scales. The effect of LSI (Kolb) Learning Style Inventory, which is the most widely used measurement tool in research, is medium, whereas the effect of LSI (Grasha and Riechmann), which is another frequently used measurement inventory, was not found to be significant [$r = 0.13$].

The study supported hypothesis H_6 which formulated that the publication year of the research plays a moderator role in the effect size of learning style on academic achievement. According to the moderator analysis, the effect size differences among the different publication years are statistically significant ($Qb = 40.29$, $p < 0.05$). In this regard, it was found that learning style had a medium effect on academic achievement in the studies published between 1995 and 1999 [$r = 0.30$], 2006–2010 [$r = 0.40$] and 2011–2015 [$r = 0.34$]. On the other hand, no significant effect has been found in the studies published between 1980 and 1984, 1985–1989, 1990–1994 and 2000–2004 ($p > 0.05$).

The study did not support hypothesis H_7 which formulated that culture plays a moderator role in the effect size of learning style on academic achievement. According to the moderator analysis, the effect size differences of the

countries/cultures examined are not statistically significant ($Qb = 1.43$, $p > 0.05$). On the other hand, the effect of learning style on academic achievement was found to be statistically significant in the publications related to both vertical-collectivist [$r = 0.28$] and horizontal-individualistic [$r = 0.20$] countries ($p < 0.05$).

19.4 Conclusion

The effect of learning types/styles on student achievement was examined in this meta-analysis study. A total of 443 research studies were collected during the literature review, out of which 60 were included in the meta-analysis. The 60 research studies were compiled to obtain a sample size of 26,391 subjects. The results of the random effect model showed that learning types/styles have a *medium-level positive effect* on student achievement. The moderators identified for the study were type of publication, sample group, school subject, tools of data collection, the year of the studies and culture, of which sample group, school subject, tools of data collection and the year of the studies were found to be the moderator variables.

One of the most important concepts related to individual differences is the concept of learning style. Researchers indicate that the identification of individuals' learning styles can help people to become more successful in their learning, and it allows the educators to arrange personalized learning processes (Claxton 1990). The review of the research results showed that the hypothesis which formulated that the publication type plays a moderator role in the effect of learning style on academic achievement was not supported. Even though the difference between the effect sizes of the two publication types was not statistically significant according to the moderator analysis, the effect of learning style on academic achievement was positive in both papers and theses.

Moreover, the moderator analysis revealed that the effect size differences of the sample groups were statistically significant. According to this result, learning styles in high school, middle school and university have a medium effect on achievement; whereas the effect of learning style on academic achievement was not found to be significant for college and elementary school.

In addition, it has been found that the courses used for measuring academic achievement play a moderator role in the effect size of learning style on academic achievement. It was found that learning style has a medium effect on students' academic achievement in biology, accounting, economics, mathematics and foreign language courses, whereas it has a small effect in GPA, reading and science courses. On the other hand, no significant effect of learning style has been detected in agriculture, English, history, humanities, non-technical, psychology, social science, technical, Turkish and vocabulary courses.

There are two main reasons for which it is important to measure learning styles. The first of them is that we can obtain in this way valid and reliable data about a person's individual features which we can share with him and compare with other

people's characteristics. The second objective is that we can help people to select appropriate learning materials since individuals are usually not aware of their own learning style. The most widely used way of measuring learning styles is self-assessment scales (Şimşek 2007).

When we review the literature on learning styles, we can see that there are many learning style models. According to Coffield's research conducted in 2004, there were approximately 71 learning style models that were frequently used. These were the scales which were both reliable and valid. In addition to them, there are many scales lacking reliability and validity. Most of the learning style models are of the same kind and they use similar measurements. The expansion of the learning styles research field has brought numerous concepts and assessment tools. The most important problem of the researchers who are interested in learning styles is to decide which measurement tool is better or which model is more reliable. One of the basic problems of the various models is the content of the model. This is because the concept of learning style is often defined in different terms (As cited in Şimşek 2007).

Another result of the study is that the hypothesis which formulated that the data collection tool plays a moderator role in the effect size of learning style on academic achievement was supported. The effect size differences of the various data collection tools were found to be statistically significant. The effect of LSI (Kolb) learning style inventory, which is the most widely used measurement tool in research, is medium, whereas the effect of LSI, which is another measurement inventory, was not found to be significant. The reason why the data collection tools play a moderator role may be that the various models which use the measurement tools have each different content.

The research showed that publication year plays a moderator role in the effect size of learning style on academic achievement. In this regard, it was found that learning style had a medium effect on academic achievement in the studies published between 1995 and 1999, 2006–2010, and 2011–2015. On the other hand, no significant effect has been found in the studies published between 1980 and 1984, 1985–1989, 1990–1994 and 2000–2005. The review of the literature showed that the concept of learning style was identified and integrated to the teaching process only in recent years. Learning style had a medium effect on academic achievement in the studies published between 2006 and 2010 and 2011–2015, which shows that the use of teaching techniques based on learning styles started having an effect during these time periods. Many researchers have used the concepts of cognitive or learning style from a historical perspective. This trend may have limitations about the theory and the learning styles inventories that were developed. Recent research focuses on brain, multiple intelligence, creativity, and educational values. Style studies can be considered through these concepts. On the other hand, there are many inventories that carry the same name but they measure different skills.

One of the major points that should not be forgotten and should be considered while assessing learning styles is that our personal learning styles may change according to the education that we receive through our life. Learning styles also vary according to regional differences. Cognitive processes, environment,

motivation, biological faculties, imagination, social interaction and teaching techniques may affect learning as well. For this reason, the variable of culture was also considered as a moderator. The study showed that the culture variable does not play a moderator role in the effect size of learning style on academic achievement. On the other hand, the effect of learning style on academic achievement was found to be statistically significant in the publications related to both vertical-collectivist and horizontal-individualistic countries.

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Note. "*" References marked with an asterisk indicate studies included in the meta–analysis. The in–text citations to studies selected for meta–analysis are not followed by asterisks.

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