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Does Quantum Learning Model Increase Academic Achievement?: A Meta-Analysis Study

Mahmut Sami YİĞİTER

Distance Education Application and Research Center, Social Sciences University of Ankara, Ankara, Turkey

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ABSTRACT

Quantum Learning Model (QLM) is a model that enables students to have a joyful learning experience, aims to realise permanent learning, and aims to learn by making sense in the mind of the individual. This study aimed to systematically synthesise the effect of QLM on academic achievement through meta-analysis method through existing research. A search of five databases yielded 25 studies that met the inclusion criteria. The findings of the random effects meta-analysis showed that the effect of QLM on academic achievement was positive and large (d=1.051 [0.769, 1.331], p<.05). According to the moderator analysis results, the results concluded that publication year, sample size, publication type, course, country and pretest status variables were not significant sources of heterogeneity. The highest effect of QLM on academic achievement was found at the middle school level, followed by primary school, high school and university levels, respectively. The results of the study suggest that QLM is effective on academic achievement. The study also provides suggestions for future studies on QLM.

Keywords: Meta analysis, achievement, learning model, education, quantum learning model, academic achievement.

Kuantum Öğrenme Modeli Akademik Başarıyı Arttırıyor mu?: Bir Meta-Analiz Çalışması

Süreç
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Bu çalışma ön inceleme sürecinde ve yayımlanmadan önce iThenticate yazılımı ile taranmıştır.

ÖZ

Kuantum Öğrenme Modeli (KÖM), öğrencilerin keyifli bir öğrenme deneyimi yaşamalarını sağlayan, kalıcı öğrenmeyi gerçekleştirmeyi hedefleyen ve bireyin zihninde anlamlandırarak öğrenmesini amaçlayan bir modeldir. Bu çalışma, mevcut araştırmalar üzerinden meta-analiz yöntemiyle KÖM'ün akademik başarı üzerindeki etkisini sistematik olarak sentezlemeyi amaçlamıştır. Beş veri tabanında yapılan taramada dâhil edilme kriterlerini karşılayan 25 çalışma bulunmuştur. Rastgele etkiler meta-analizinin bulguları, KÖM'ün akademik başarı üzerindeki etkisinin pozitif ve büyük olduğunu göstermektedir (d=1.051 [0.769, 1.331], p<.05). Moderatör analizi sonuçlarına göre yayın yılı, örneklem büyüklüğü, yayın türü, ders, ülke ve öntest durumu değişkenlerinin önemli heterojenlik kaynakları olmadığı sonucuna varılmıştır. KÖM'ün akademik başarı üzerindeki en yüksek etkisi ortaokul düzeyinde bulunmuş, bunu sırasıyla ilkokul, lise ve üniversite düzeyleri izlemiştir. Çalışmanın sonuçları, KÖM'ün akademik başarı üzerinde etkili olduğunu göstermektedir. Ayrıca çalışma KÖM ile ilgili gelecekte yapılacak çalışmalar için öneriler sunmaktadır.

Anahtar Kelimeler: Meta-analiz, başarı, kuantum öğrenme modeli, öğrenme modeli, eğitim, akademik başarı.

mahmutsamiyigiter@gmail.com *https://orcid.org/0000-0002-2896-0201*

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Introduction

In the 21st century, there are many important developments and changes in education as well as in many other fields. When we look at the basis of these developments and changes, it is seen that information has increased and multiplied rapidly compared to previous centuries (Cogan & Derricott, 2014). Rapidly advancing technology brings nations closer to each other and increases communication. All nations have agreed that education systems should be redesigned to adapt to development and changes (Pont, Moorman & Nusche, 2008). With the effect of these rapid changes, rigid and precise facts in teaching have been replaced by flexibility and openness to change (Earl, Hargreaves, Moore, & Manning, 2002). Therefore, teaching practices with passive participation of students in education have turned into active participation. With the effect of this transformation, the role of education has become to educate individuals who provide permanent learning, develop skills, gain attitudes and behaviours, are open to innovations, and think critically instead of teaching knowledge by rote (National Research Council, 2012). In this context, many learning models have been developed, especially Discovery Learning, Inquiry Learning, Cooperative Learning, Quantum Learning models (Felder & Brent, 2007; Castronova, 2002). One of these models is the Quantum Learning Model (QLM) (Le Tellier, 2006), which enables students to have a pleasant learning experience, aims to achieve permanent learning, and enables the individual to learn by making sense in his/her mind instead of rote learning.

The Quantum Learning Model (QLM) is a learning model proposed by Bobbi DePorter in the USA in the 1980s and developed with the work of Lazanov (Karamustafaoğlu, 2018). The QLM emerged with the idea that the principles of quantum physics can also apply to the human brain and thoughts. This model aims to ensure the development and self-realisation of the individual as a whole (Abidin, 2018). The model has a number of basic aims. These can be listed as ensuring the permanence of knowledge, expanding the imagination by using the right part of the brain effectively, enabling the individual to recognise themselves, offering the individual the chance to realise their characteristics, introducing ways of learning to learn, and setting effective goals that will motivate them to learn (Taşpınar, 2017).

The main goal of the QLM is to ensure that the person realises themselves holistically and gains a positive worldview (Ekici, 2019). In QLM, individual differences of learners and different learning approaches are considered important (Usanmaz, Alcı, & Çelikgöz, 2017). In this learning model, it is aimed that learners with different types of intelligence develop physically, affectively and cognitively. Therefore, it can be stated that QLM is suitable for the educational purposes of the modern period in terms of taking individual development into account.

There are many learning models and theories that influence and shape QLM. These models and theories are presented in Figure 1 (Ekici, 2019).

There are many studies in the literature explaining the theories and models in Figure 1 (Minewiser, 2000; Walsh, 2002; Polat, 2014; Politano & Paquın, 2000; Caine, 2002; Goleman, 1996; Ekici, 2019).

According to QLM, the learning environment works like a symphony orchestra. Just as each unit of the orchestra (sounds, musical instruments, body language) works in harmony, in the classroom environment, the teacher, students, equipment and learning environment are in integrity and harmony (DePorter, Reardon, &, Norie, 1999). QLM consists of six stages and there is a close relationship between these stages and these stages have the feature of complementing each other. These stages are; enroll, experience, label, demonstrate, review and celebrate (Çelik, 2018). These stages should also cover academic and lifelong learning skills in the most effective way. In the enroll stage, the lesson can be started with an interesting saying, short plays - skits - or a short video on the subject that will attract students' attention to the lesson. In the experience stage, mind maps, simulations or metaphorical expressions are used to associate the new subject to be taught with the old subjects (Le Tellier, 2006). In the label stage, the relationship between what the students have learnt and life is tried to be established. At this stage, memory technique, graphic, poster can be used. Students are also expected to make some arrangements on what they have learnt. In the demonstrate stage, students are given opportunities to apply what they have learnt in different situations. The basic purpose of this stage is to ensure that students gain self-confidence that they can overcome the new subject. Therefore, students can be offered opportunities and environments where they can generate original ideas and look from different perspectives. Team work, video shootings, games, songs, graphic drawings can be done as activities (Sujatmika, Hasanah, & Hakim, 2018). In the review stage, it is aimed to facilitate the retention of what is learnt by strengthening the neural connections where learning takes place in the brain. For this purpose, multiple intelligence applications can be included. What is important at this stage is to ensure that students reinforce the information they have learnt. In the celebrate stage, students are appreciated in order to maintain their motivation and ensure that their success continues to increase. At this stage, competitions can be organised for students to enjoy the newly learned information (Ekici, 2019).

There are many studies in the literature investigating the effect of QLM on academic achievement (Acat & Yusuf, 2014; Afandi & Wahyuningsih, 2020; Anggaraeni, Negara & Putra, 2018; Khozaei, Zare, Moneghi, Sadeghi & Taraghdar, 2022; Sihite & Sinulingga, 2013; Nurlita, Kartono, & Yulianto, 2020).

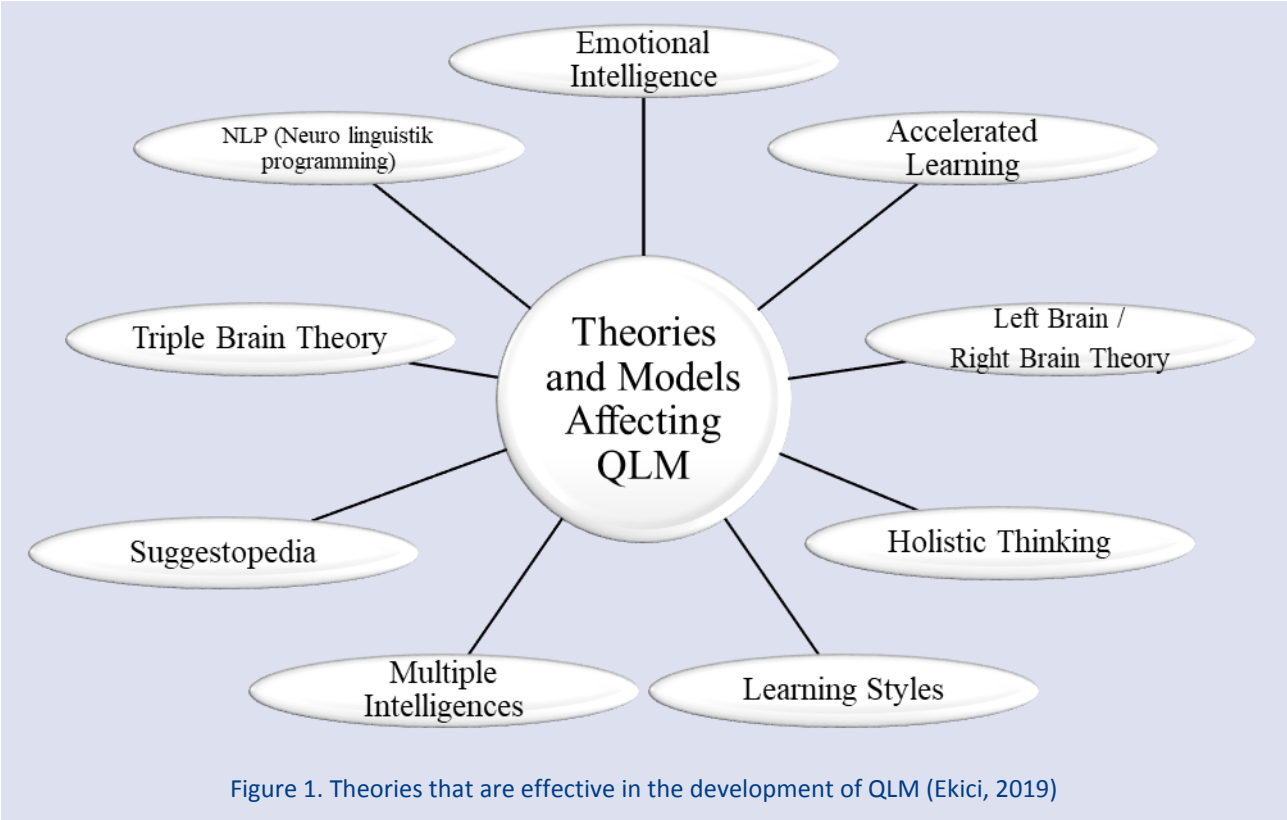

Figure 1. Theories that are effective in the development of QLM (Ekici, 2019)

Some of the primary studies report a low impact of QLM on academic achievement (Ari ve Alaca, 2015; Basuki ve Bon, 2020; Fenar, 2022), while others report a high impact (Trisnawati et al., 2015; Beyaztaş, 2022). Syukria (2019) states that QLM positively affects students' foreign language learning success. Lenny, Firman and Desyandri (2018) state that QLM increases science achievement. Similarly, Alkaustar (2015) states that QLM increases text writing skills with his experimental study. As can be seen, there are many national and international studies examining the effect of QLM on achievement. The existence of these studies has revealed the need to examine the effect of QLM on academic achievement by meta-analysis method. Kanadlı, Ünal, and Karakuş (2015) examined the effect of QLM on academic achievement with meta-analysis. In this study, it is stated that QLM has a positive and small effect on academic achievement. Kanadlı et al. (2015) examined 13 studies conducted between 2004 and 2014 by meta-analysis method. The primary objective of this study is to address the studies conducted after 2014. With this study, it is thought that it will be possible to compare the effect of QLM on academic achievement compared to previous years. The aim of this study is to combine the effect of QLM on academic achievement based on the results of the primary studies in the literature with the meta-analysis method and to examine this effect according to variables. In this direction, the research questions are given below.

1. Does the QLM increase academic achievement?
2. Does the effect of QLM on academic achievement differ according to year of publication, sample size, publication type, school type, course, country, control group and pretest status?

Method

Meta-analysis is a powerful way of summarising multiple studies and obtaining valuable information from these studies (Hedges & Olkin, 1985; Yigiter, Demir & Dogan, 2023). This study was conducted in Turkey. In order to reach all studies related to the research topic, Web of Science, ERIC, Ulakbim, Google Scholar, and National Thesis Centre databases were searched between March and April 2023. The keywords "quantum learning model", "achievement", "experimental" were used in the search. It is recommended to follow the PRISMA guidelines in order to accurately perform the screening and reporting for meta-analysis (The PRISMA Group, 2009). The flow diagram prepared in this direction is presented in Figure 2.

As seen in Figure 2, 1194 studies were reached from the five databases analysed. It was seen that 19 of these studies met the inclusion criteria in meta-analysis.

Coding Form

Previous meta-analysis studies were examined in order to code the studies reached as a result of the review and eight moderator variables were determined as (a) Year of Publication, (b) Sample Size, (c) Publication Type, (d) School Type, (e) Course, (f) Country, (g) Control Group, and (h) Pretest Status. All of these moderator variables are typical variables in previous meta-analysis studies. A coding form was created to standardise the coding. The coding form is shown in Table 1.

Table 1. Coding System

m	Variable Type	Coding Technique
Study Code	Categ.	Number assigned to the studies in sequence.
Authors	Categ.	Indicates the surnames of the authors.
Title	Categ.	Indicates the title of the study.
Year of Publication	Categ.	Indicates the year of the study.
nEpre	Cont.	The number of students from the experimental group who took the pretest.
mEpre	Cont.	Mean pretest scores of the experimental group.
SdEpre	Cont.	Standard deviation of pretest scores of the experimental group.
nCpre	Cont.	Number of students from the control group who took the pretest.
mCpre	Cont.	Mean pretest scores of the control group.
SdCpre	Cont.	Standard deviation of pretest scores of the control group.
mEpost	Cont.	Mean posttest scores of the experimental group.
SdEpost	Cont.	Standard deviation of posttest scores of the experimental group.
mCpost	Cont.	Mean posttest scores of the control group.
SdCpost	Cont.	Standard deviation of the posttest scores of the control group.
Publication Type	Categ.	Indicates the type of publication of the work. 1 = article, 2 = thesis, 3=congress.
School Type	Categ.	Indicates the sample group in which the study was conducted. 1 = primary school, 2 = middle school, 3 = high school.
Course	Categ.	Indicates the course in which the experimental research was conducted (science, social sciences, mathematics, language teaching, other).
Country	Categ.	Indicates the country where the study was conducted (Turkey, Indonesia, other).
Control Group	Categ.	Indicates whether the study has a control group (available, not available).
Pretest Status	Categ.	Indicates the status of pretesting in the study (available, not available).

Categ. = Categorical, Cont.= Continuous

Table 1 shows the coding method of the studies included in the meta-analysis. The coding was first prepared as a Microsoft Excel document and then transferred to R software for statistical analyses.

Screening Results

The screening results obtained by examining these 25 studies included in the meta-analysis are presented in Table 2. As seen in Table 2, 13 (52.0%) of the 25 studies analysed were articles, 10 (40.0%) were theses and 2 (8.0%) were theses. According to school type, 7 (28.0%) of the studies were conducted in primary school, 12 (48.0%) in middle school, 5 (20.0%) in high school and 1 (4.0%) in university. According to the course variable, 6 (24.0%) of the studies were conducted in science, 5 (20.0%) in social sciences, 5 (20.0%) in mathematics, 7 (28.0%) in language teaching and 2 (8.0%) in other fields. It is also seen that the included studies were published between 2015 and 2022.

Data Analysis

The most conspicuous output of meta-analysis studies is the common (overall) effect size. In meta-analysis studies involving experimental studies, Cohen's d effect size is generally calculated with the following formula:

$$d = \frac{\bar{X}_{\text{Experimental}} - \bar{X}_{Control}}{Sd_{Pooled}}$$

$\bar{X}_{\text{Experimental}}$ and $\bar{X}_{Control}$ in the equation represent the mean scores of the experimental and control groups, respectively. Sd_{Pooled} indicates the pooled standard deviation.

For pretest-posttest control group designs, Cohen's d effect size value is calculated by the following formula (Becker, 1988; Morris, 2008):

$$d = c_E \frac{\bar{X}_{E.Post} - \bar{X}_{E.Pre}}{Sd_{Pre.E}} - c_C \frac{\bar{X}_{C.Post} - \bar{X}_{C.Pre}}{Sd_{Pre.C}}$$

Here, $\bar{X}_{E.Post}$ means the mean posttest score of the experimental group, $\bar{X}_{E.Pre}$ means the mean pretest score of the experimental group, $\bar{X}_{C.Post}$ means the mean posttest score of the control group, $\bar{X}_{C.Pre}$ means the mean pretest score of the control group. $Sd_{Pool.T}$ and $Sd_{Pool.C}$ indicate the pooled standard deviation of the experimental and control groups, respectively. c_E and c_C values are bias adjustments and can be calculated by the following formula:

$$c_j = 1 - \frac{3}{4(n_j - 1) - 1}$$

Table 2. Details of the Primary Studies

Num.	Authors	Year	Control Grup	Pretest Status	Publication Type	Course	School Type	Country
1	Aydın	2018	Available	Available	Thesis	Language Teaching	Middle Sch.	Turkiye
2	Çelik	2017	Available	Available	Article	Social Sciences	Primary Sch.	Turkiye
3	Arı and Alaca	2015	Available	Available	Article	Science	Middle Sch.	Turkiye
4	Usanmaz et al.	2017	Available	Available	Article	Language Teaching	High Sch.	Turkiye
5	Erkoç	2019	Available	Available	Thesis	Science	Middle Sch.	Turkiye
6	Fenar	2021	Available	Available	Thesis	Social Sciences	Middle Sch.	Turkiye
7	Yalçıntaş	2019	Available	Available	Thesis	Science	Primary Sch.	Turkiye
8	Beyaztaş	2022	Available	Available	Thesis	Social Sciences	High Sch.	Turkiye
9	Şimşek	2016	Available	Available	Thesis	Science	Middle Sch.	Turkiye
10	Çiftcibaşı	2021	Available	Available	Thesis	Science	Middle Sch.	Turkiye
11	Ünal and İnal	2019	Available	Available	Article	Social Sciences	Middle Sch.	Turkiye
12	Bozkurt	2015	Available	Available	Thesis	Mathematics	Primary Sch.	Turkiye
13	Faradiba et al.	2021	Available	Available	Article	-	Primary Sch.	Indonesia
14	Munawarah et al	2020	Available	Available	Article	Language Teaching	Middle Sch.	Indonesia
15	Julita	2017	Available	Available	Article	Mathematics	High Sch.	Indonesia
16	Sari	2018	Available	Available	Thesis	Language Teaching	High Sch.	Indonesia
17	Masrokah et al.	2022	Available	Available	Article	Social Sciences	Primary Sch.	Indonesia
18	Prawiyogi et al.	2020	Available	Available	Congress	Mathematics	Primary Sch.	Indonesia
19	Basuki and Bon	2020	Available	Available	Congress	Mathematics	Middle Sch.	Indonesia
20	Arditya	2019	Available	Available	Article	Language Teaching	Middle Sch.	Indonesia
21	Trisnawati et al.	2015	Not available	Available	Article	Mathematics	Middle Sch.	Indonesia
22	Darmanah	2020	Not available	Available	Article	Language Teaching	High Sch.	Indonesia
23	Rahmayanti	2017	Not available	Available	Thesis	Language Teaching	Primary Sch.	Indonesia
24	Khozaei et al.	2022	Available	Not available	Article	-	University	Indonesia
25	Anggaraeni et al.	2018	Available	Not available	Article	Science	Middle Sch.	Indonesia

The variance of the effect size is calculated by the following formula (Becker, 1988):

$$var(d) = \frac{2(1-r)}{n_j} + \frac{d^2}{2(n_j-1)}$$

The r value in the equation expresses the correlation coefficient among pretest and posttest scores. In order to calculate the variance of the effect size, the correlation value among pretest and posttest scores is necessary. It was observed that none of the 25 studies analysed in this study reported this correlation value. Salminen et al. (2015) reported that pretest-posttest correlation coefficients were between 0.72 and 0.90. When this correlation value is missing, it is recommended to user r = 0.7 for normally distributed scores (Estrada et al., 2019). The effect sizes obtained from the included studies were interpreted according to Cohen's (1988) criteria: small [0.2, 0.5]; medium [0.5, 0.8]; large [0.8, +] effect.

The reason for heterogeneity between studies conducted on different groups with the same method may be sampling errors, application conditions or effect sizes. Therefore, it is recommended to use random effects model in such cases (Field & Gillett, 2010). In this meta-analysis study, random effects model was used and common effect sizes were computed with Cohen's d coefficient.

Q and I^2 statistics were used to evaluate the heterogeneity between the studies in this meta-analysis (Higgins and Thompson, 2002). If the result of the *Q* statistic is significant, this indicates that there is heterogeneity between the studies. The I^2 statistic is generally interpreted as 25% low, 50% medium and 75% high heterogeneity.

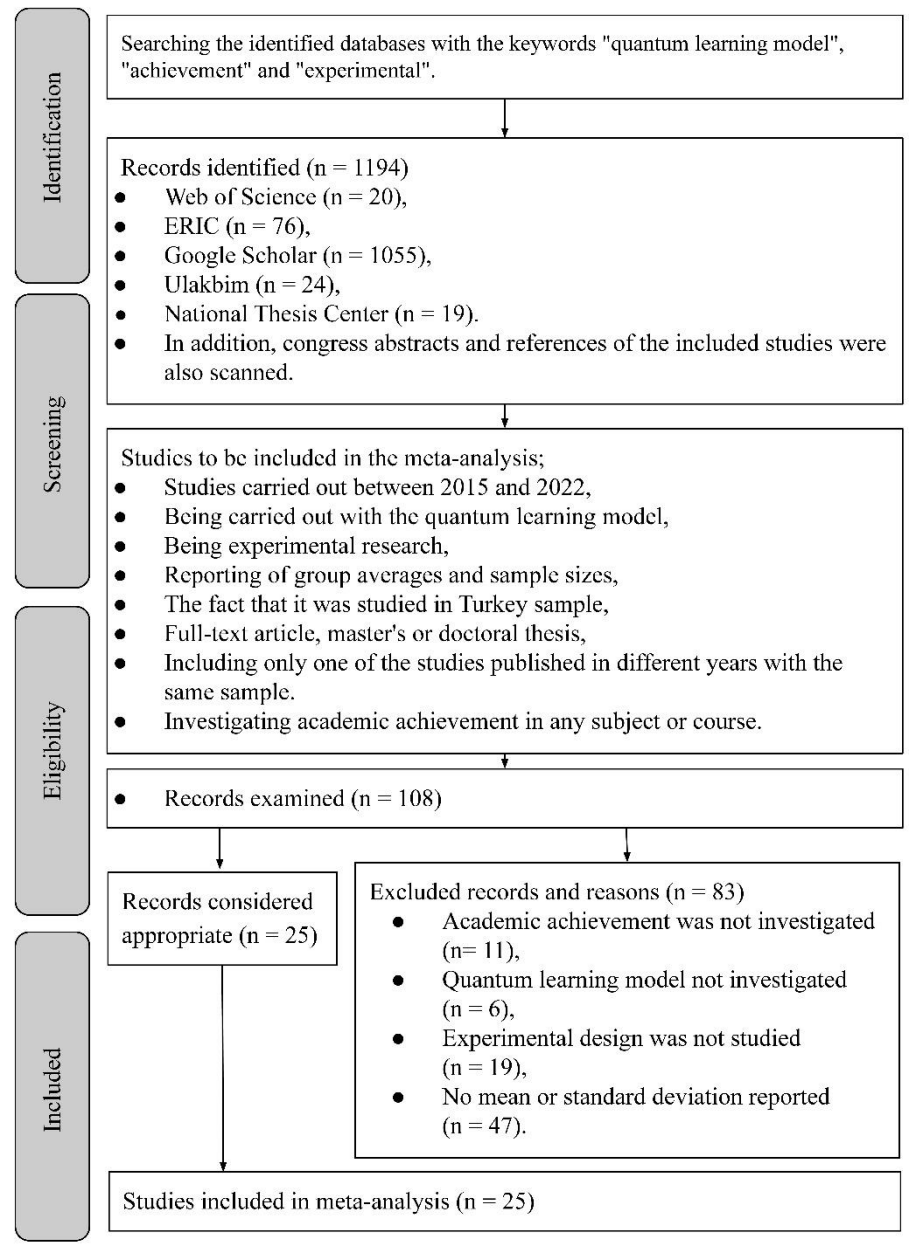

Figure 2. Literature review process

Analogue ANOVA and meta-regression analyses were conducted to identify possible source of heterogeneity between studies. It is stated that there should be two or more studies in each subgroup for analogue ANOVA analysis and ten or more studies for meta regression analysis (Borenstein et al., 2010). In this study, moderator analyzes were performed with the variables that met this criterion. All analyses were performed with the "metafor" (Viechtbauer, 2010) package in the R program.

Results

This section presents the findings of common effect size, heterogeneity tests and moderator analyses.

Findings on Common Effect Size

In this study, in which the effect of QLM on academic achievement was examined, the common effect size calculated according to the random effects model of 25 studies included in the meta-analysis is presented in Table 3.

As seen in Table 3, the common effect size was estimated as 1.051. In addition, the lower limit for the 95% confidence interval of the common effect size was calculated as 0.769 and the upper limit as 1.331. Morever, the common effect size value was statistically significant ($z(24) = 7.33$, $p < .0001$). These results show that the QLM increased academic achievement positively and large effect level ($d > 0.8$).

The forest plot of the effect size and average effect size of each of the 25 studies is presented in Figure 3.

Table 3. Effect Size

N	Effect Size	Standart Error	z	p	95% Confidence Interval	
					Lower	Upper
25	1.051	0.143	7.33	<.0001	0.769	1.331

Table 4. Heterogeneity Tests

Q	df	Table χ^2 value	p	I^2
86.875	24	36.415	<0.0001	73.38

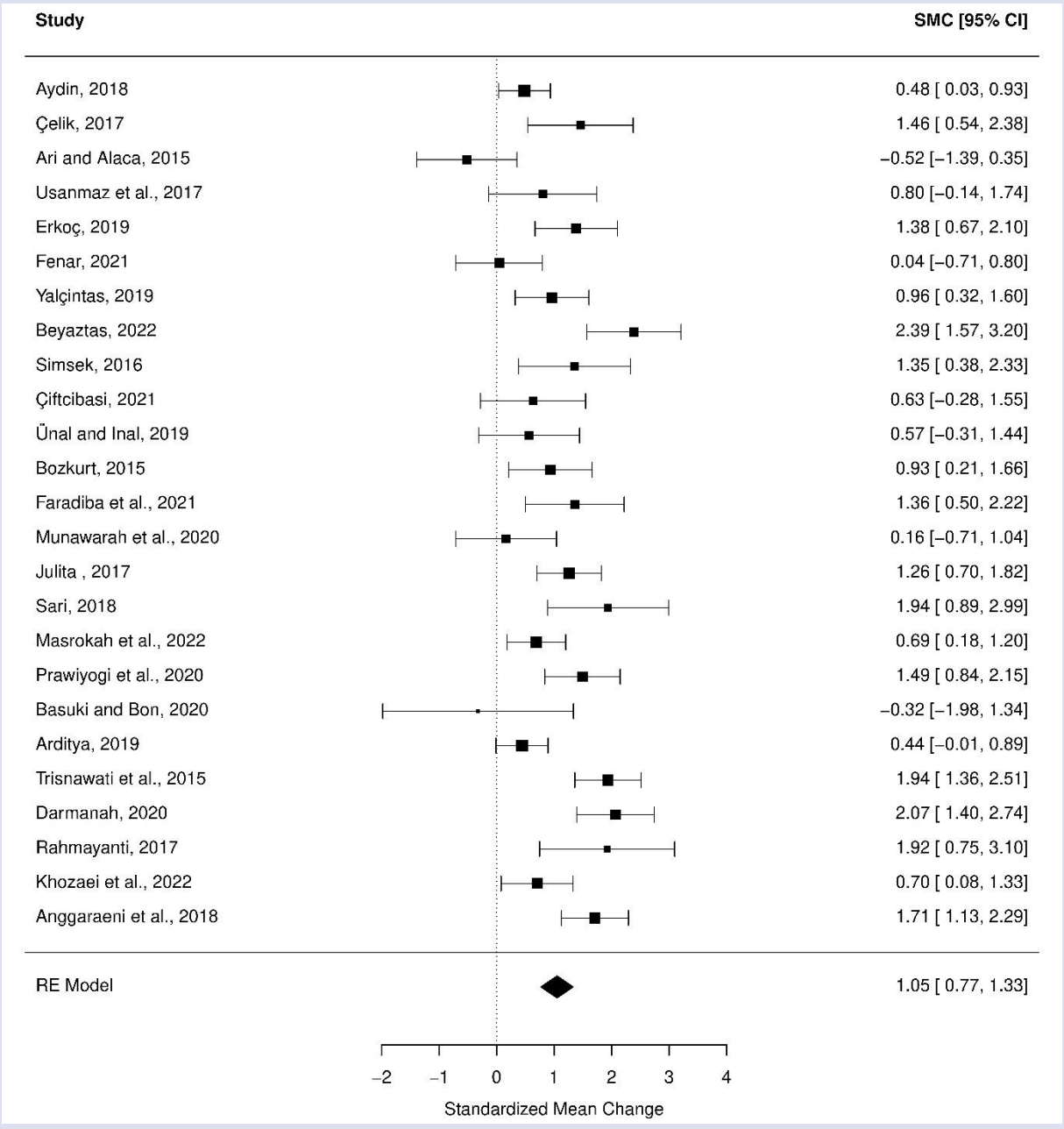

Figure 3. Forest Plot

In Figure 3, the effect sizes of the studies included in the meta-analysis are shown with square shapes in the graph. The horizontal lines above the effect sizes indicate the 95% confidence intervals of the effect sizes. The common effect size of the studies is shown with a rhombus shape. When Figure 4 is examined, it is seen that the effect sizes of the studies examining the effect of QLM on academic achievement vary between -0.52 and 2.39. It can be stated that only two of the effect sizes is negative and the other effect sizes show a positive effect. In addition, the prediction interval was estimated from the effect sizes of the included studies. The prediction interval

was estimated as [-0.150, 2.251], which indicates that 95% of the overall population would have an effect size in the range [-0.150, 2.251].

Moderator Analyses

Moderator analyses (analogue ANOVA and meta regression) were conducted with the variables determined in the study. The results of moderator analyses on the effect of QLM on academic achievement according to year of publication, publication type, application period, course, sample size and school type are presented in Table 5 and Table 6.

When Table 5 is analysed, it is seen that the common effect size according to the publication type variable is 0.994 (95% CI [0.596, 1.393]) for articles, 1.144 (95% CI [0.691, 1.596]) for thesis and 0.661 (95% CI [0.185, 1.137]) for congress. It can be stated that the differences between the effect sizes of the publication type groups are not significant (Q_b = 0.289, p = .865). In other words, it can be stated that the type of publication (article, thesis and congress) is not a significant source of heterogeneity in the effect of QLM on achievement.

When the findings are analysed according to the course variable, it is seen that the common effect size is 0.661 (95% CI [0.185, 1.137]) for science, 1.011 (95% CI [0.219, 1.803]) for social sciences, 1.311 (95% CI [0.846, 1.776]) for mathematics and 1.056 (95% CI [0.448, 1.664]) for language teaching. It can be stated that the differences between the effect sizes of the course types are not significant (Q_b = 2.176, p = .537). In other words, it can be stated that the course variable is not a significant source of heterogeneity in the effect of QLM on achievement.

When the findings are analysed according to the school type variable, it is seen that the common effect size is 1.135 (95% CI [0.826, 1.445]) for primary school, 0.718 (95% CI [0.276, 1.161]) for middle school, 1.689 (95% CI [1.140, 2.238]) for high school and 0.702 (95% CI [0.079, 1.325]) for university. It can be stated that the differences between the effect sizes of the school groups are significant (Q_b = 7.933, p = .047). In other words, course variable is a significant source of heterogeneity in the effect of QLM on academic achievement. It can be said that the effect of QLM on academic achievement is the highest at the high school level, followed by primary school, middle school and university levels respectively.

When the findings are analysed according to the country variable, it is seen that the common effect size is 0.865 (95% CI [0.453, 1.277]) for Turkiye and 1.217 (95% CI [0.844, 1.589]) for Indonesia. It can be stated that the differences between the effect sizes of the country groups are not significant (Q_b = 1.549, p = .213). In other words, it can be stated that the country groups (Turkiye and Indonesia) is not a significant source of heterogeneity in the effect of QLM on achievement.

When the findings are analysed according to the control group variable, it is seen that the common effect size is 0.925 (95% CI [0.649, 1.200]) for “available” and 1.983 (95% CI [1.573, 2.393]) for “not available”. It can be stated that the differences between the effect sizes of the control group variable are significant (Qb = 7.389, p = .006). In other words, it can be stated that the control group variable is a significant source of heterogeneity in the effect of QLM on achievement. It is seen that the effect sizes of the studies with a control group have significantly lower effect sizes than the studies without a control group.

When the findings are analysed according to the pretest status variable, it is seen that the common effect size is 1.034(95% CI [0.733, 1.334]) for “available” and 1.211 (95% CI [0.225, 2.197]) for “not available”. It can be stated that the differences between the effect sizes of the pretest status groups are not significant (Q_b = 0.122, p = .726). It can be said that there is no significant difference between the effect sizes of studies with pretesting and studies without pretesting.

When Table 6 is analysed, it can be stated that according to the meta regression analysis performed to determine the effect of year of publication on effect sizes, year of publication has no significant effect on effect sizes [Qb= 0.067, p = 0.795].

According to the meta regression results regarding the effect of sample size moderator variable on effect sizes, it can be said that sample size has no significant effect on effect size [Qb = 1.709, p = 0.191]. This finding suggests that the sample size variable is not a significant source of heterogeneity in the effect of the QLM on achievement.

Publication Bias

A good literature review is a precondition for meta-analysis studies to reflect the real situation. Publication bias refers to the bias that occurs due to the fact that studies with statistically significant results or conducted with large samples are more likely to be published. This may lead to an overestimation of the common effect size (Borenstein et al., 2009). However, only published studies may not represent the reality of a subject. To prevent publication bias, unpublished and waiting to be published (grey literature) studies should also be included. In addition, another way to prevent publication bias is to conduct a comprehensive review.

In this study, publication bias was analyzed with Fill and Trim method, egger test and fail-safe N values. The funnel plot obtained from the Fill and Trim method is presented in Figure 4.

As can be seen in Figure 4, according to the effect size and standard errors, the 25 studies were distributed symmetrically on both sides of the graph. The trim and fill method indicated that there were no missing studies and did not suggest any missing studies. Therefore, the fill and trim method did not change the pooled effect size. The Egger test was performed to test the symmetry of the graph in Figure 3. As a result of this test, t(24) = 0.046, p = 0.763 (p > .05).

These results show that the funnel plot has a symmetrical distribution and there is no publication bias.

Table 5. Results of Moderator Analyses (Subgroup Analyses)

Moderator Variable	Category	N	Effect Size	95% Confidence Interval		Q_b	*df*	*p*
				Lower	Upper			
Publication Type	Article	13	0.994	0.596	1.393	0.289	2	0.865
	Thesis	10	1.144	0.691	1.596			
	Congress	2	0.752	-0.997	2.501			
Course	Science	6	0.661	0.185	1.137	0.570	3	0.966
	Social Sciences	5	1.011	0.219	1.803			
	Mathematics	5	1.311	0.846	1.776			
	Language Teaching	7	1.056	0.448	1.664			
School Type	Primary School	7	1.135	0.826	1.445	7.933	3	0.047*
	Middle School	12	0.718	0.276	1.161			
	High School	5	1.689	1.140	2.238			
	University	1	0.702	0.079	1.325			
Country	Turkey	12	0.865	0.453	1.277	1.549	1	0.213
	Indonesia	13	1.217	0.844	1.589			
Control Group	Available	22	0.925	0.649	1.200	7.389	1	0.006*
	Not available	3	1.983	1.573	2.393			
Pretest Status	Available	23	1.034	0.733	1.334	0.122	1	0.726
	Not available	2	1.211	0.225	2.197			

*p< .05

Table 6. Results of Moderator Analyses (Meta Regression)

Moderator Variable	Variance		Standard Error	Q_b	df	p
Year of Publication	Intercept	36.174	135.44	0.067	1	0.795
	Year	-0.017	0.06			
Sample Size	Intercept	1.590	0.436	1.709	1	0.191
	N	-0.010	0.008			

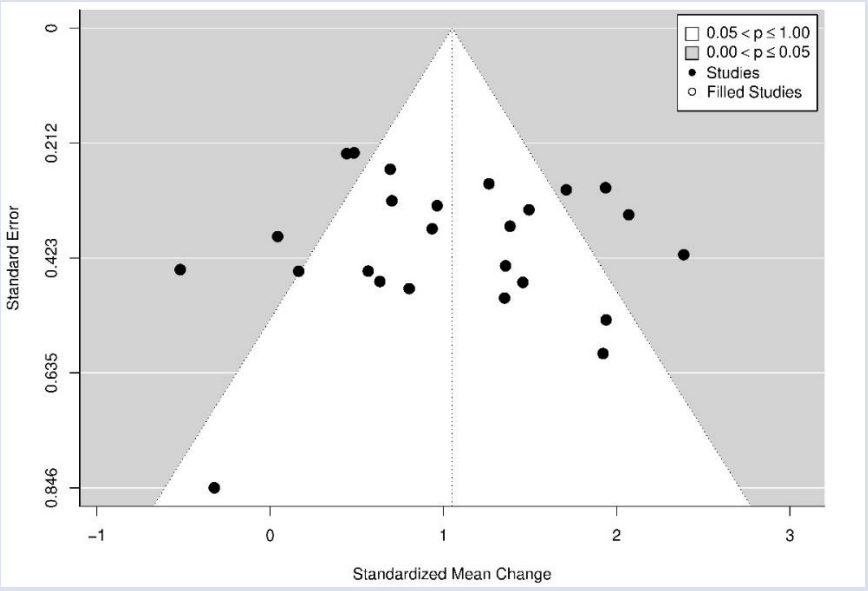

Figure 4. Funnel Plot

The fail-safe number value, which gives the number of studies with zero effect size required to eliminate the statistical significance of the common effect size, was computed. For the current study, Rosenthal's fail-safe number value was computed as 1791. This value shows that there is no publication bias in the current meta-analysis study and indicates that the meta-analysis is reliable (Long, 2001).

Discussion and Conclusion

The present study aimed to statistically synthesise effect sizes of the studies examining the effect of Quantum Learning Model [QLM] on academic achievement by meta-analysis method. In line with the purpose of the study, the findings of 25 studies that met the inclusion criteria in the meta-analysis were combined. The results determined graphically and statistically that there was no publication bias for these studies included in the meta-analysis. It can be stated that this situation indicates that the meta-analysis is reliable.

The analyses using the random effects model showed that QLM had a positive and large (d > 0.8) effect on academic achievement, and the study concluded that this relationship was significant. It can be said that this result is similar to the literature. Kanadlı et al. (2015) examined 13 studies between 2004-2014 in a meta-analysis study on the effect of QLM on academic achievement. This study stated that QLM had a small positive effect on academic achievement. In the current study, studies conducted between 2015 and 2022 and investigating the effect of QLM on academic achievement were discussed. The result that QLM had a large positive effect on academic achievement can also be interpreted as that QLM has achieved efficient results in terms of academic achievement. While the results of Kanadlı et al. (2015) reported a small effect, this study reported a large effect. Basically, the reason for this situation is that 30.76% of the effect sizes in Kanadlı et al.'s (2015) study were negative, while 8.00% of the effect sizes in the current study were negative. This can also be interpreted as an increase in the effect of QLM on academic achievement over time.

According to the results of heterogeneity analyses, the study determined that the included studies showed heterogeneity in terms of effect sizes. In order to determine the sources of heterogeneity, moderator analyses were conducted with the variables of year of publication, sample size, publication type, school type, course, country, control group and pretest status. According to the findings obtained from moderator analyses, the study determined that year of publication, sample size, publication type, course, country, pretest status variables did not cause a significant heterogeneity in the effect of QLM on academic achievement. Similar to the results of the current study, Kanadlı et al. (2015) stated that there was no significant difference between effect sizes according to the course variable. While the publication type (thesis and article) variable was not a significant source of heterogeneity in the current study, Kanadlı et al. (2015) stated that the publication type was a significant source of heterogeneity. The present study and Kanadlı et al. (2015) study differ in terms of this finding.

According to the school type variable, the current study concluded that there was a significant difference between primary school, middle school, high school and university groups. According to this result, the study determined that QLM had the highest effect on academic achievement in the middle school group, followed by primary school, secondary school and university groups, respectively. Kanadlı et al. (2015) stated in their meta-analysis study that effect sizes did not differ significantly according to school type. The findings of Kanadlı et al. (2015) and the current study differ according to the school type variable.

According to the control group variable, the study concluded that there was a significant difference between the effect sizes of the studies with control group and the studies without control group. According to this result, the effect of QLM on academic achievement was greater in studies without a control group than in studies with a control group. In other words, the effect size of the studies without a control group seemed to be more inflated. There are studies reporting that the lack of a control group in experimental studies may mislead the results (Cook & Campbell, 1979; Shadish, Cook, & Campbell, 2002). This finding of the study suggests that experimental studies should include a control group in order to reach effect sizes that reflect the real situation.

Limitations and Suggestions

The current meta-analysis is limited to a total of 25 studies conducted between 2014 and 2022. In the literature review, the statistics (mean, standard deviation, t value, etc.) required to calculate the effect size in many article texts were not included in the current meta-analysis study because they were not shared. It is recommended that researchers conducting research on the Quantum Learning Model report statistics such as mean, standard deviation, t value, pretest-posttest correlation to calculate the effect size. A second level meta-analysis study can be conducted by including new studies examining the effect of QLM on academic achievement in the literature. It was seen that there are many studies examining the effect of QLM on critical thinking skills. In the future, researchers can conduct a meta-analysis study examining the effect of QLM on critical thinking skills. On the other hand, it was observed that there were a limited number of studies examining the effects of QLM on analytical thinking skills, creative thinking skills, problem solving skills and course anxiety. Future researchers can plan studies investigating these relationships.

Genişletilmiş Özet

Giriş

Bilginin geçmişe göre katlanarak hızla arttığı 21. yüzyılda eğitim sistemleri yeni arayışlar içerisindedir. Yaşanan hızlı değişimlerle birlikte öğretimde katı ve kesin doğrular yerini esnekliğe ve değişime bırakmıştır. Bu dönüşümün etkisiyle eğitimin rolü, kalıcı öğrenmeleri sağlayan, becerileri geliştiren, tutum ve davranışlar kazandıran, yeniliklere açık olan, eleştirel düşünen bireyler yetiştirmek hâline gelmiştir. Bu bağlamda pek çok öğrenme modeli geliştirilmiştir. Bu modellerden biri de öğrencilerin hızlı ve keyifli bir öğrenme deneyimi yaşamalarını sağlayan, kalıcı öğrenmeyi gerçekleştirmeyi hedefleyen, ezbere dayalı öğrenme yerine bireyin zihninde anlamlandırarak öğrenmesini olanak tanıyan Kuantum Öğrenme Modeli'dir (KÖM) (Le Tellier, 2006).

Kuantum Öğrenme Modeli'nin temel hedefi, kişinin kendisini bütüncül biçimde gerçekleştirmesini ve olumlu dünya görüşü kazanmasını sağlamaktır (Ekici, 2019). KÖM'de öğrenenlerin bireysel farklılıkları ve farklı öğrenme yaklaşımları önemli görülmektedir (Usanmaz vd., 2017). Bu öğrenme modelinde farklı zekâ türüne sahip öğrenenlerin fiziksel, duyuşsal ve bilişsel olarak gelişim göstermesi amaçlanmaktadır. Dolayısıyla KÖM'ün bireysel gelişimi dikkate alması açısından modern dönemin eğitim amaçlarına uygun olduğu belirtilebilir.

KÖM'ün akademik başarıya etkisini araştıran literatürde pek çok çalışma bulunmaktadır (Acat & Yusuf, 2014; Afandi & Wahyuningsih, 2020; Anggaraeni, Negara & Putra, 2018; Khozaei, Zare, Moneghi, Sadeghi & Taraghdar, 2022; Sihite & Sinulingga, 2013; Nurlita, Kartono, & Yulianto, 2020). Kanadlı, Ünal ve Karakuş (2015), KÖM'ün akademik başarı üzerindeki etkisini meta-analiz ile incelemişlerdir. Bu çalışmada KÖM'ün akademik başarı üzerinde pozitif yönde ve küçük düzeyde etkisinin olduğu belirtilmektedir. Syukria (2019), KÖM'ün öğrencilerin yabancı dil öğrenme başarısını pozitif yönde etkilediğini ifade etmektedir. Lenny, Firman and Desyandri (2018), KÖM'ün fen başarısını arttırdığı belirtmektedir. Benzer şekilde, Alkaustar (2015), yaptığı deneysel çalışma ile KÖM'ün metin yazma becerilerini arttırdığını ifade etmektedir. Görüldüğü üzere KÖM'ün akademik başarıya etkisini inceleyen yurt içinde ve yurt dışında yapılmış pek çok çalışma bulunmaktadır. Bu çalışmaların varlığı, KÖM'ün akademik başarıya etkisinin meta-analiz yöntemiyle incelenmesi gereksinimini ortaya çıkarmıştır. Bu çalışmanın amacı, kuantum öğrenme modelinin akademik başarıya etkisini inceleyen çalışmaları meta-analiz yöntemiyle birleştirmek ve ortak (genel) etki büyüklüğünü belirlemektir.

Yöntem

Bu araştırmada KÖM'ün akademik başarıya etkisi meta-analiz yöntemi ile incelenmiştir. Meta-analiz, birden fazla yapılmış çalışmaları özetleyerek bu çalışmalardan değerli bilgi elde etmenin güçlü bir yoludur (Hedges ve Olkin, 1985). Bu çalışma Türkiye evreninde gerçekleştirilmiştir. Araştırma konusuyla ilgili tüm çalışmalara ulaşabilmek amacıyla, Web of Science, ERIC, Ulakbim, Google Scholar, Ulusal Tez Merkezi veri tabanları Mart-Nisan 2023 tarihleri arasında taranmıştır. Taramada "kuantum öğrenme modeli", "başarı", "deney" anahtar kelimeleri kullanılmıştır. Tarama sonucunda dâhil edilme kriterlerini sağlayan 25 çalışmaya ulaşılmıştır. Dâhil edilen 25 çalışmanın etki büyüklükleri Becker (1988) ve Morris (2008)'in belirttiği formüller ile hesaplanmıştır. Fill and trim yöntemi altında huni grafiğine göre dâhil edilen çalışmalarda yayım yanlılığı olmadığı sonucuna ulaşılmıştır.

Bulgular

Rastgele etkiler modeli kullanılarak yapılan analize göre dâhil edilen çalışmaların ortak etki büyüklüğü 1.051 olarak kestirilmiştir. Ayrıca, ortak etki büyüklüğünün %95 güven aralığı için alt sınır 0,769 ve üst sınır 1,331 olarak hesaplanmıştır. Ayrıca, ortak etki büyüklüğü değeri istatistiksel olarak anlamlıdır ($z (24) = 7.33$, $p < .0001$). Bu sonuçlar, KÖM'ün akademik başarıyı olumlu yönde ve büyük etki düzeyinde ($d > 0,8$) artırdığını göstermektedir. Ortak etki büyüklüğünün istatistiksel anlamlılığını ortadan kaldırmak için gereken sıfır etki büyüklüğüne sahip çalışma sayısını veren fail-safe sayı değeri hesaplanmıştır. Mevcut çalışma için Rosenthal'ın fail safe N değeri 1791 olarak hesaplanmıştır. Bu değer, mevcut meta-analiz çalışmasında yayın yanlılığının olmadığını ve meta-analizin güvenilir olduğunu göstermektedir (Long, 2001). Orman grafiği incelendiğinde KÖM'ün akademik başarı üzerindeki etkisini inceleyen çalışmaların etki büyüklüklerinin -0,52 ile 2,39 arasında değiştiği görülmektedir. Etki büyüklüklerinden sadece ikisinin negatif olduğu, diğer etki büyüklüklerinin ise pozitif etki gösterdiği ifade edilebilir. Heterojenlik analizlerine göre heterojenliğin %73,38'i çalışmalar arası farklılıktan kaynaklanma olup orta düzeyde heteronjelik olduğu görülmüştür. Bu nedenle, ele alınan değişkenlere göre moderatör analizleri yapılmıştır. Moderatör analizlerinden elde edilen bulgulara göre yayım yılı, örneklem büyüklüğü, yayın türü, ders, ülke ve öntest durumu değişkenlerinin KÖM'ün akademik başarıya etkisinde anlamlı bir değişkenliğe neden olmadığı tespit edilmiştir. Okul türüne göre ise KÖM'ün akademik başarıya ortaokul düzeyinde en yüksek etkiyi gösterdiği, ardından sırasıyla ilkokul, lise ve üniversite gruplarının geldiği görülmüştür. Bir diğer heterojenlik kaynağı ise kontrol grubu değişkenidir. Kontrol grubuna sahip olmayan çalışmaların etki büyüklüklerinin kontrol grubuna sahip olanlara göre daha yüksek etki büyüklüğü gösterdiği görülmüştür.

Tartışma ve Sonuç

Bu çalışmada, KÖM'ün akademik başarı üzerindeki etkisini inceleyen çalışmaların etki büyüklüklerinin meta-analiz yöntemiyle istatistiksel olarak sentezlenmesi amaçlanmıştır. Çalışmanın amacı doğrultusunda, meta-analize dâhil edilme kriterlerini karşılayan 25 çalışmanın bulguları birleştirilmiştir. Meta-analize dâhil edilen bu çalışmalar için yayın yanlılığının olmadığı grafiksel ve

istatistiksel olarak tespit edilmiştir. Bu durumun meta-analizin güvenilir olduğunu gösterdiği ifade edilebilir.

Rastgele etkiler modeli kullanılarak yapılan analizler, KÖM'ün akademik başarı üzerinde pozitif ve büyük (d > 0,8) bir etkiye sahip olduğunu göstermiş ve bu ilişkinin anlamlı olduğu sonucuna ulaşılmıştır. Bu sonucun literatürle benzerlik gösterdiği söylenebilir. Kanadlı ve diğerleri (2015), KÖM'ün akademik başarıya etkisi üzerine yaptıkları meta-analiz çalışmasında 2004-2014 yılları arasındaki 13 çalışmayı incelemişlerdir. Bu çalışmada, KÖM'ün akademik başarı üzerinde küçük bir pozitif etkiye sahip olduğu belirtilmiştir. Mevcut çalışmada ise 2015-2022 yılları arasında yapılan ve KÖM'ün akademik başarıya etkisini araştıran çalışmalar ele alınmıştır. KÖM'ün akademik başarı üzerinde pozitif yönde büyük bir etkiye sahip olduğu sonucu, KÖM'ün akademik başarı açısından verimli sonuçlar elde ettiği şeklinde de yorumlanabilir. Kanadlı ve diğerlerinin (2015) sonuçları küçük bir etki rapor ederken, bu çalışma büyük bir etki rapor etmiştir. Temel olarak bu durumun nedeni, Kanadlı ve diğerlerinin (2015) çalışmasındaki etki büyüklüklerinin %30,76'sı negatif iken, mevcut çalışmadaki etki büyüklüklerinin %8,00'inin negatif olmasıdır. Bu durum, KÖM'ün akademik başarı üzerindeki etkisinin zaman içinde arttığı şeklinde de yorumlanabilir.

Heterojenlik analizlerinin sonuçlarına göre, dâhil edilen çalışmaların etki büyüklükleri açısından heterojenlik gösterdiği belirlenmiştir. Heterojenliğin kaynaklarını belirlemek amacıyla yayın yılı, örneklem büyüklüğü, yayın türü, okul türü, ders, ülke, kontrol grubu ve öntest durumu değişkenleri ile moderatör analizleri yapılmıştır. Moderatör analizlerinden elde edilen bulgulara göre, yayın yılı, örneklem büyüklüğü, yayın türü, ders, ülke, öntest durumu değişkenlerinin KÖM'ün akademik başarı üzerindeki etkisinde anlamlı bir heterojenliğe neden olmadığı belirlenmiştir. Mevcut çalışmanın sonuçlarına benzer şekilde, Kanadlı ve diğerleri (2015) ders değişkenine göre etki büyüklükleri arasında anlamlı bir fark olmadığını belirtmiştir. Yayın türü (tez ve makale) değişkeni mevcut çalışmada anlamlı bir heterojenlik kaynağı değilken, Kanadlı ve diğerleri (2015) yayın türünün anlamlı bir heterojenlik kaynağı olduğunu belirtmektedir. Mevcut çalışma ile Kanadlı ve diğerlerinin (2015) çalışması bu bulgu açısından farklılaşmaktadır.

Okul türü değişkenine göre ilkokul, ortaokul, lise ve üniversite grupları arasında anlamlı bir fark olduğu sonucuna ulaşılmıştır. Bu sonuca göre, KÖM'ün akademik başarı üzerinde en yüksek etkiye ortaokul grubunda sahip olduğu, bunu sırasıyla ilkokul, ortaokul ve üniversite gruplarının izlediği görülmüştür. Kanadlı ve diğerleri (2015) meta-analiz çalışmalarında etki büyüklüklerinin okul türüne göre anlamlı bir şekilde farklılaşmadığını belirtmişlerdir. Bu çalışma ile mevcut çalışmanın bulguları okul türü değişkenine göre farklılaşmaktadır.

Kontrol grubu değişkenine göre, kontrol grubu olan çalışmalar ile kontrol grubu olmayan çalışmaların etki büyüklükleri arasında anlamlı bir fark olduğu sonucuna ulaşılmıştır. Bu sonuca göre, kontrol grubu olmayan çalışmalarda KÖM'ün akademik başarı üzerindeki etkisi, kontrol grubu olan çalışmalara göre daha fazladır. Başka bir deyişle, kontrol grubu olmayan çalışmaların etki büyüklüğü daha şişirilmiş görünmektedir. Deneysel çalışmalarda kontrol grubunun olmamasının sonuçları yanlı sonuçlar üretebileceğini bildiren çalışmalar bulunmaktadır (Cook ve Campbell, 1979; Shadish, Cook ve Campbell, 2002). Çalışmanın bu bulgusu, gerçek durumu yansıtan etki büyüklüklerine ulaşmak için deneysel çalışmaların kontrol grubu içermesi gerektiğini belirtmektedir.

Mevcut meta-analiz çalışması, 2014-2022 yılları arasında yürütülen toplam 25 çalışma ile sınırlıdır. Literatür taramasında birçok makale metninde etki büyüklüğünü hesaplamak için gerekli olan istatistikler (ortalama, standart sapma, t değeri vb.) paylaşılmadığı için mevcut meta-analiz çalışmasına dâhil edilememiştir. Kuantum Öğrenme Modeli üzerine araştırma yapan araştırmacıların etki büyüklüğünü hesaplamak için ortalama, standart sapma, t değeri, öntest-sontest korelasyonu gibi istatistikleri raporlamaları önerilmektedir. Alanyazında KÖM'ün akademik başarıya etkisini inceleyen yeni çalışmalara yer verilerek ikinci düzey bir meta-analiz çalışması yapılabilir. KÖM'ün eleştirel düşünme becerileri üzerindeki etkisini inceleyen çok sayıda çalışma olduğu görülmüştür. Gelecekte araştırmacılar eleştirel düşünme becerileri üzerinde KÖM'ün etkisini inceleyen bir meta-analiz çalışması yapabilirler. Öte yandan, KÖM'ün analitik düşünme becerileri, yaratıcı düşünme becerileri, problem çözme becerileri ve ders kaygısı üzerindeki etkilerini inceleyen sınırlı sayıda çalışma olduğu görülmüştür. Gelecek araştırmacılar bu ilişkileri araştıran çalışmalar planlayabilirler.

Araştırmanın Etik Taahhüt Metni

Yapılan bu çalışmada bilimsel, etik ve alıntı kurallarına uyulduğu; toplanan veriler üzerinde herhangi bir tahrifatın yapılmadığı, karşılaşılacak tüm etik ihlallerde "Cumhuriyet Uluslararası Eğitim Dergisi ve Editörünün" hiçbir sorumluluğunun olmadığı, tüm sorumluluğun Sorumlu Yazara ait olduğu ve bu çalışmanın herhangi başka bir akademik yayın ortamına değerlendirme için gönderilmemiş olduğu sorumlu yazar tarafından taahhüt edilmiştir.

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