

REPUBLIC OF TURKEY
YILDIZ TECHNICAL UNIVERSITY
GRADUATE SCHOOL OF SCIENCE AND ENGINEERING

THE EFFECT OF FLIPPED LEARNING MODEL ON STUDENTS'
ACHIEVEMENTS IN SCIENCE LESSONS: A META-ANALYSIS
STUDY

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MASTER OF SCIENCE THESIS

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A thesis submitted by Merve YAVUZ in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE is approved by the committee on 29.06.2022 in Department of Mathematics and Science Education Program of Science Education.

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Merve YAVUZ

Signature

Dedicated to my beloved family



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make them proud of me. I shall strive to be worthy of the environment and affection they have bestowed upon me.

Merve YAVUZ



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LIST OF ABBREVIATIONS

FLM	Flipped Learning Model
FLA	Flipped Learning Applications
FL	Flipped Learning



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The Effect Of Flipped Learning Model On Students' Achievements in Science Lessons: A Meta-Analysis Study

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Master of Science Thesis

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Meta-analysis is used as a method in this thesis, which aims to investigate the effects of courses designed according to the flipped learning model applied in science courses in elementary schools on the academic achievement of the students. Meta-analysis provides the opportunity to examine and interpret studies with a comprehensive and systematic perspective based on the findings. In order to achieve this, the researcher conducted a meta-analysis study on studies conducted in the field of science education at the elementary school level and adopted the flipped learning model. This process, which started with the literature review, continued with the development of the coding form after the determination of the study criteria to be included in the meta-analysis and the coding of the studies that fit the criteria in a way that could be included in the analysis. Afterwards, data analysis was made and the obtained findings were evaluated.

In order to include studies that met the eligibility criteria in the analysis, the researcher reached the descriptive statistical information of each study in order

to define the data. Due to the nature of the meta-analysis method, only studies containing quantitative data were included in this study, which aimed to systematically review experimental studies. For this research, it is aimed to reach all studies that were made between 2012-2022 and suitable for the research problem. For this, Proquest, JSTOR, Scopus, ERIC, EBSCOHost, YÖK (Higher Education Council) National Thesis Center, TÜBİTAK Ulakbim databases were scanned and Google Academic search engine was used. Principal component analyzes were conducted to determine the effect of flipped learning model applications on academic achievement in science courses. In order to reach the findings related to publication bias in principal component analysis, the Funnel Scatterplot was examined and interpreted in this way.

As a result of the study, in which Hedges & Olkin's effect size calculation formulas were used, it shows that the applications of the flipped learning model in science lessons have a moderate effect on the academic achievement of the students.

Keywords: Flipped Learning Model, meta-analysis, academic achievement, science education.

Ters-Yüz Eğitim Modelinin Fen Bilgisi Derslerinde Öğrencilerin Akademik Başarılarına Etkisi: Bir Meta-Analiz Çalışması

Merve YAVUZ

Fen Bilgisi Eğitimi Anabilim Dalı

Yüksek Lisans Tezi

Danışman: Prof. Dr. Bayram COŞTU

Fen bilgisi derslerinde uygulanan ters- yüz eğitim modeline göre tasarlanmış derslerin öğrencilerin akademik başarılarına etkisini araştırmayı amaçlayan bu tezde metot olarak meta-analiz kullanılmıştır. Meta- analiz, araştırmaların bulgularına dayalı olarak kapsamlı ve sistematik bir bakış açısı ile inceleme ve yorumlayabilme imkanı sağlamaktadır. Bunu sağlamak için araştırmacı, ortaokul düzeyinde fen eğitimi alanında yapılmış ve ters-yüz eğitim modelini benimsemiş olan çalışmalar üzerinden bir meta-analiz çalışması yapmıştır. Alan yazın taraması ile başlayan bu süreç, meta-analize dâhil edilecek çalışma kriterlerinin belirlenmesinin ardından kodlama formunun geliştirilmesi ve kriterlere uygun çalışmaların analize dâhil edilebilecek şekilde kodlanmasıyla devam etmiştir. Daha sonrasında ise veri analizi yapılmış, elde edilen bulgular değerlendirilmiştir.

Araştırmacı uygunluk ölçütlerini sağlayan çalışmaları analize dahil edebilmek için verilerin tanımlanması amacıyla her bir çalışmanın betimleyici istatistikî bilgilerine ulaşmıştır. Deneysel çalışmaların sistematik bir şekilde gözden geçirilmesinin amaçlandığı bu çalışmaya meta-analiz yönteminin doğası gereği sadece nicel veri içeren çalışmalar dahil edilmiştir. Bu araştırma için 2012-2022 yılları arasında yapılmış, araştırma problemine uygun tüm çalışmalara ulaşmak hedeflenmiştir. Bunun için Proquest, JSTOR, Scopus, ERIC, EBSCOHost, YÖK (Yükseköğretim Kurulu) Ulusal Tez Merkezi, TÜBİTAK Ulakbim veri tabanları taranmış, Google Akademik arama motoru kullanılmıştır. Ters-yüz eğitim modeli uygulamalarının fen bilgisi derslerindeki akademik başarıya olan etki düzeyini saptayabilmek için temel bileşen analizleri yapılmıştır. Temel bileşen analizinde yayın yanlılığı ile alakalı bulgulara ulaşabilmek için ise Huni Saçılım Grafiğine bakılmış ve bu sayede yorumlanmıştır, yayın yanlılığı bulgularını detaylandırmak amacıyla Begg Mazumdar Sıra Korelasyonu ve Kendall İstatistiği sonuçlarına bakılmıştır.

Hedges & Olkin'in etki büyüklüğü hesaplama formüllerinin kullanıldığı çalışma sonucunda fen bilgisi derslerinde yapılan ters-yüz eğitim modeli uygulamalarının öğrencilerin akademik başarıları üzerinde orta düzeyde etkisi olduğunu göstermektedir.

Anahtar Kelimeler: Ters- Yüz Eğitim Modeli, meta- Analiz, akademik başarı, fen bilgisi eğitimi



YILDIZ TEKNİK ÜNİVERSİTESİ
FEN BİLİMLERİ ENSTİTÜSÜ

1.1 Literature Review

Although the traditional learning model is widely used, there are some limitations, such as the learning takes place in a teacher-centered instruction. The student is not involved in any way in the process of instruction. As a result, for the learning process to be completed permanently and effectively, the student must participate and engage more actively. Classrooms where a teacher is the sole source of knowledge have been replaced by innovative classrooms where the teacher and student work together to create new information (Singh & Boisselle, 2018). In these new classrooms, it has become imperative to redesign learning and teaching environments in order to incorporate educational technology and to make learning more effective and more long-lasting in the classroom.

Every field has been impacted by technological advancements, including education. The ever-changing nature of technology has necessitated the development of new paradigms for teaching and learning (Bishop & Verleger, 2013). Arguing that the best method for students' learning is not the traditional teaching method, which is an old structure, Talbert (2017) stated that students are outside the classroom when they need teacher help the most and they have to do the challenging tasks outside of the classroom.

Various in-class applications are available for different grade levels and different application areas, and various technological tools are used in these applications, according to educational technology studies. As a result of these educational technologies, a variety of different learning approaches have begun to be used (Aydın, 2016; Bell, 2015; Farah, 2014; Johnson & Renner, 2012; Yestrebsky, 2015; Hayırsever & Orhan, 2018). Blended learning is just one of these methods.

Blended learning, which emerges by blending the strengths of face-to-face and distance education (Garrison & Kanuka, 2004), brings the advantages of both learning environments. It is a strategy that makes use of In other words, it is the combination of a learning activity that the student carries out outside the classroom with various online tools and can adjust the time, place, and speed according to his/her needs (Staker & Horn, 2012). In other words, the student benefits from the advantages of both technology-supported learning environments and face-to-face teaching. It is possible to teach online using electronic materials such as text, video, and audio recordings, or asynchronously with activities like forum discussions and synchronously with applications like instant messaging, audio/video conferencing or distance education platforms. It can also occur simultaneously as Hew and Cheung stated (Hew&Cheung, 2014). In addition, with blended learning, access between students and teachers is increased, costs are reduced and classroom time can be used more actively and more efficiently (Stein & Graham, 2014).

According to the research, there are a variety of classifications for the blended learning model. Rossett and Frazee (2006) divided blended learning into three groups, Twigg (2003) into five groups, and Staker and Horn (2012) into four groups. Staker and Horn's (2012) classification is as follows:

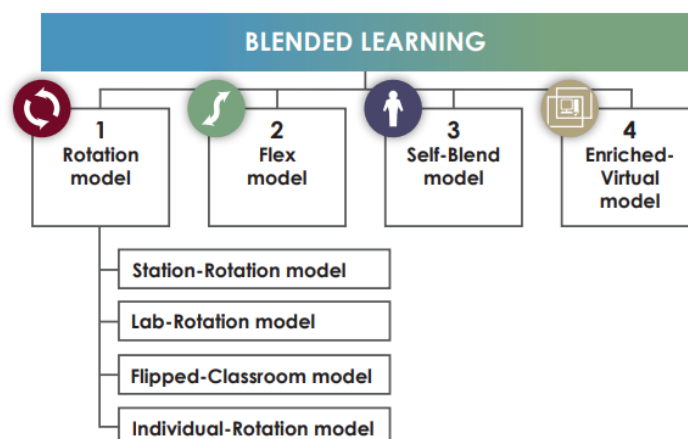


Figure 1.1 Blended learning (Staker & Horn, 2012)

In the rotational model, which is one of the blended learning types, the student makes transitions between different learning environments within the scope of a course or a subject, either according to a program or according to the direction of the teacher (Staker & Horn, 2012). These learning environments can include face-to-face and group work as well as project assignments, but at least one of them must be an online environment. In the flipped learning model, the advantages of face-to-face education and technology-enriched online learning environments are best combined. The flipped learning model is the primary focus of this study. The flipped learning model is depicted as follows by Staker and Horn (2012).

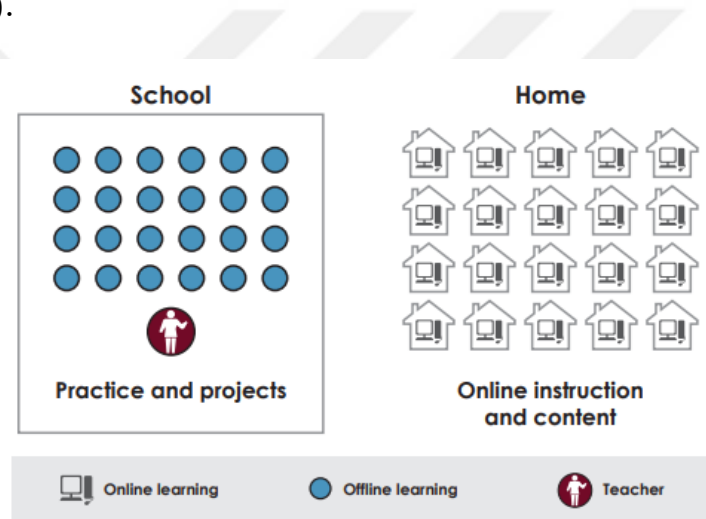


Figure 1.2 Flipped learning (Staker & Horn, 2012)

Terminology in The Literature About Flipped Classroom (FC) and Flipped Learning (FL)

The flipped classroom and flipped learning model are not the same thing, and these terms should not be used interchangeably, according to the information available on the electronic network Flipped Learning Network [FLN]. This is because flipped classrooms and the flipped learning paradigms are fundamentally different from one another in key essential regards. These are the points:

1. Flipped classes may or may not result in learning in all instances.

2. By the use of flipped classrooms, teachers may supply students with access to information both outside of school and even in the classroom. Additional materials, such as videos and texts, and the extension of some in-class activities outside of the classroom may be used to provide access to learning materials outside of class.

3. Flipped classrooms are organizational arrangements that are made to ensure that learners' background information is prepared, the students are registered in online learning environments, and that learning materials are uploaded to the learning environments. Flipped learning, on the other hand, focuses on the process of learning and achievement of the learners (Gündüz & Akkoyunlu, 2016; Lafee, 2013; Hayırsever & Orhan, 2018).

The terminology used in international literature can help us comprehend the flipped learning model more thoroughly and help us understand it more comprehensively. When referring to flipped learning models in the international literature,

"inverted classrooms" (Bates&Galloway, 2012; Lage, Platt, and Treglia, 2000; Morin, Kecskemetry, Harper and Clingan, 2013; Talbert, 2012),

"classroom flip" (Baker, 2000),

"flipped classroom" (Bergmann & Sams, 2012; Butt, 2014; Dove, 2013) are the most commonly used terms.

In Turkish academic writings such as articles, journals, and publications for the flipped learning model concepts such as,

inversed classrooms (tersine sınıflar) (Boyras, 2014),

flipped classrooms (ters yüz edilmiş sınıflar) (Aydın, 2016; Genç, 2015; Turan & Göktaş, 2015),

reversed classroom (çevrilmiş öğrenme) (Sever, 2014),

flipped learning (ters yüz edilmiş öğrenme) (Filiz & Kurt, 2015),

lesson at school, homework at home (evde ders, okulda ödev) (Demiralay & Karataş, 2014) are commonly used.

According to the literature, when the concept was first developed, it placed a strong emphasis on the classroom setting. Over time, the focus has shifted from the classroom setting to the learning process itself. As a result, while the notion of "flipped classrooms" was popular in the early years, it has since been supplanted by a slightly different concept called "flipped learning". As a result of the model being discussed with various notions in the literature, it is reasonable to assert that there should be conceptual coherence for the further studies. This coherence of concepts will assist researchers in addressing specific literature gaps while avoiding the risk of being misunderstood or misunderstanding. The model presented in this thesis is referred to as a flipped learning model (FLM), and the activities undertaken on this topic are referred to as flipped learning practices (FLP) as a result of the points listed above. The flipped learning itself will be abbreviated by FL.

In the research conducted by Sakar and Sağır in 2017, academic studies related to FLM in Turkey were examined with the method document analysis. Within the scope of this analysis, 50 articles, 8 master's theses, 2 books, and 1 doctoral thesis were examined by using databases such as EBSCOhost, ScienceDirect, IEEE, Internet Archive, and Google Academic. The literature review was limited to the studies conducted between 2000 and 2017. According to the results, the grade levels in which the FLM is applied are examined; At a rate of 70 percent, it is observed that it is primarily used at the university level. At the elementary school level, it is seen that it has the least application rate at 5%. When we look at the frequency distribution according to the application topics, it is seen that the most common course area where FLM is used is in information technologies education with 23.3%, information technologies education is followed by health sciences education and foreign languages education. When the science lesson applications are examined, it is seen that the applications are mostly at the graduate level, and the results of the studies applied in secondary school and elementary school are rarely encountered in the literature. When the frequency

distribution of the studies according to the variables is examined, it is revealed that they are examined in terms of academic success (35%), perception (15%), satisfaction (6.7%), and motivation (6.7%) (Sakar & Sağır, 2017).

1.1.1 Related Studies

Several studies have been conducted in subjects such as mathematics, English, biology, engineering, and computer education to assess the difference and applicability of the flipped classroom approach vs traditional teaching on the influence of students' learning successes nationally and internationally. This section of the thesis focused on research on flipped education from around the world, as well as in Turkey. The purpose of this section is to provide the reader and the researcher a comprehensive understanding of how the related research has been addressed and studied in the literature.

There has been a rise in the number of research examining the FLM in recent years, however they are clearly insufficient (Bull & Kjell., 2013; Kong, 2014). Considering that academic achievement is the best variable by which to judge the performance of the FLM, especially at the university and high school levels, this influence on academic success has been emphasized when relevant research are studied. In this study, we looked at the studies in the literature about this strategy and split them into two categories, one for studies involving students in high school and beyond, and another for studies involving learners in middle school and below.

1.1.1.1 Studies with Secondary School and Upper Grade Level Participants

This section of the research analyzed the results of previous studies that had examined at how the FLM model had been implemented in several educational settings, including secondary schools, colleges, and universities. The first variable is the most widely used measure of academic success in the research. (Baepler, et al., 2014) post-test pattern research for unequal groups with college students enrolled in general chemistry is the first study reviewed. First, in the 2012 spring semester, 350 students were randomly assigned to a control group

that received the standard three hours of instruction each week. In the second phase of the research, the experimental group taught one lesson each week to three groups totaling 117 students throughout the fall 2012 semester. Students have the option to study ahead of time using internet resources. Students participated in a variety of activities, including problem-solving mini-games, computer simulations, and a chemistry-themed version of the game show Jeopardy. The FLA were used again, this time with a focus on blended learning, in the second experimental section of the course. Over the course of three semesters, 1100 students in total (400 in each of the experimental and control groups) took part in the study. They concluded that the FLA contributed to the students' improved academic performance.

Similar to the results of the above study, (Tune, Sturek & Basile, 2013) conducted an experimental and control group study with first-year medical students and found that the experimental group, which had the FLM applied, had considerably higher test outcomes than the control group. High-quality outcomes were reported, particularly with regard to pre-class films and in-class tests. In a nutshell, they arrived at the verdict that the FLM is a reliable strategy for medical school students.

Similar findings were found in another Turkish investigation by Boyraz (2014). The study aimed to determine if and how the FLM improved student achievement and effective teaching in the English classroom. This study employed a pretest-posttest control group design to compare the performance of two cohorts in Aksaray University's Compulsory Vocational Foreign Language program during the 2013-2014 school year. The study included both an experimental and a control group that each participated in the study once. The results showed that students in the FLM group performed better academically than those in the Traditional Education group.

The literature is rife with examples of FLA constructed at the level of college students. Some research has been done with undergraduates in the Analysis-2 course (Laman, Brannon & Mena, 2012) and Civil Engineering curriculum

(McGivney-Burelle & Xue, 2013). Students in a university Mathematics-2 course made similar observations about the pedagogical benefits of flipping the classroom. (Schwankl, 2013). The findings are research with a direct bearing on achievement, student satisfaction, and the formation of favorable opinions of the learners and positive attitudes towards the courses.. The FLM has been shown to boost student achievement, contentment, and favorable opinion in certain research (Strayer, 2011). While some research suggests that using the FLA improves students' chances of succeeding, others have found the opposite to be true. According to the research of Johnson and Renner (2012), While it has been shown in some studies to have little effect on student's academic outcomes, it has been shown to boost their satisfaction.

Although it is so popular, apart from the studies related to the model, these studies have just started to be done in Turkey, and therefore it can be said that there are not many in the literature, according to a newly emerged model, flipped education has a large place in the literature.

When it is examined that the FLM applied studies in Turkey, some studies were done in high school and university-level science-related courses as follows. In a master's thesis, the effect of science teaching laboratory applications courses in which the flipped classroom model was used on the technological pedagogical content knowledge development of teacher candidates was examined (Öztürk, 2017). As a result of this study, 3rd-grade science teacher candidates who are taking the Science Teaching Laboratory Practices II course, a positive development was observed in the technological pedagogical field knowledge levels with the teaching carried out according to the flipped classroom model. In another study, the effects of FLM and STEM activities on pre-service teachers' self-efficacy beliefs and STEM approaches were examined (Göğebakan Yıldız & Kıyıcı, 2016). In this study, FLM practices were handled more qualitatively and aimed to measure pre-service science teachers' approaches, attitudes, and self-efficacy beliefs regarding FLM. When we look at another study, the effect of cognition awareness and epistemological beliefs on the relationships of science teacher candidates of the flipped classroom model was examined (Göğebakan

Yıldız & Kıyıcı, 2016), and as a result of this study, positive results were obtained related to the effect of FLM practices on their epistemological beliefs.

1.1.1.2 Studies with Elementary School and Lower Grade Level Participants

In the relevant literature, elementary and middle school students have been the subject of a small number of studies. Even if there has been tremendous growth in the implementation of the flipped education model in the classroom in recent years, it is evident that elementary school-level research is lacking (Özdemir, 2016). The area of interest of this thesis is not limited to Turkey, as the number of studies measuring academic achievement at the elementary and middle school levels in the field of science in Turkey is limited and the studies do not provide quantitative data, which is the appropriate data type for the researcher's planned meta-analysis. It was determined that the uses of FLM in science classes across the world, not only in Turkey, should be quantitative evaluations of academic success. As a consequence, it is anticipated that the outcomes of this study will contribute not only to the Turkish but also to the international literature.

In Hong Kong, 107 students between the ages of 12 and 13 engaged in primary school academics, according to Kong's research in 2014 (Kong,2014). The effects of this model on critical thinking abilities and information literacy were studied for 13 weeks on the topics "economic development in Hong-Kong" and "city plan for New Hong-Kong" by separating the students into four independent courses in which the TYS model was implemented. Consequently, it was discovered that the flipped education model had a favorable impact on critical thinking and information literacy.

In Turkey, Demiralay (2014) gathered data from school administrators, 17 instructors from various branches, 4 parents, and 17 seventh-graders through interviews, observations, and documents pertaining to FLM within the context of a social studies course. Based on the results of the interviews, it was determined that there is no change agent in the diffusion process; that there are different decision stages in teacher-teacher, student-teacher, administrator-teacher, and parent-teacher systems; and that the need variable was influential in the

decision to use the model, whereas the age groups, grade levels, and exam preparation status of the students were influential in the decision not to use the model. It has been discovered that the Homework at Home Homework Model is a flexible learning model that is challenging for instructors, involves the use of tablets, is acceptable based on experience, may be used during a few lesson hours or all lessons, and requires a perception of institutional support.

Examining the studies in their entirety reveals that they are more rigorous, particularly for high school and older pupils. Although there are no relevant studies in the literature, this may be due to the belief that pupils in secondary school and younger age groups will struggle to manage their own learning obligations. Similarly, the amount of FLM knowledge and technology application abilities of instructors of this age group emerge as significant factors. Particularly in the current era of information, the student groups that we refer to as the Z generation are adept at exploiting technology and social networks.

1.2 Original Contribution

Even if there has been tremendous growth in the implementation of the flipped education model in the classroom in recent years, it is evident that elementary school-level research is lacking (Özdemir, 2016). The area of interest of this thesis is not limited to Turkey, as the number of studies measuring academic achievement at the elementary and middle school levels in the field of science in Turkey is limited and the studies do not provide quantitative data, which is the appropriate data type for the researcher's planned meta-analysis. It was determined that the uses of FLM in science classes across the world, not only in Turkey, should be quantitative evaluations of academic success. As a consequence, it is anticipated that the outcomes of this study will contribute not only to the Turkish but also to the international literature.

1.3 Hypothesis

This study used statistical meta-analysis as an analytic approach to quantify the impact size of flipped learning activities during science instructions. This investigation, therefore, addresses following hypotheses:

H₀1. There is no significant change in academic achievement in science lessons in classrooms where the flipped learning model is applied when compared to the traditional classroom layout.

H₀2. There is no significant difference between the effect sizes of the publications in the literature on the effects of the courses in which the flipped education model is applied in science education on the academic achievement of students in science, according to the discipline.

H₀3. There is no significant difference between the effect sizes of the publications in the literature on the effects of the courses in which the flipped education model is applied in science education on the academic achievement of students in science, according to the application duration of the applications.

H₀4. There is no significant difference between the effect sizes of the publications in the literature on the effects of the courses in which the flipped education model is applied in science education on the academic achievement of students in science, according to the grade levels of the students.

H₀5. There is no significant difference between the effect sizes of the publications in the literature on the effects of the courses in which the flipped education model is applied in science education on the academic achievement of students in science, according to the sample sizes.

H₀6. There is no significant difference between the effect sizes of the publications in the literature on the effects of the courses in which the flipped education model is applied in science education on the academic achievement of students in science, according to the application region.

1.4 Restatement of Purpose

The goal of this study is to investigate how science instructors may employ flipped learning more successfully in their classes to suit the educational demands of 21st-century learners while decreasing the students' academic achievements. According to the previous literature review, study syntheses on this issue have generally tended to compare flipped classrooms with traditional teaching methods taking into consideration several modifying and mediating elements that impact the outcomes of flipped learning applications in the science classrooms. The studies in the literature which mostly took the form of document analysis contrasted flipped classroom applications with traditional classroom instructions using both qualitative and quantitative data. In contrast, this thesis is primarily concerned with quantitative data and has developed results based solely on quantitative data analysis. Even though meta-analysis studies on this issue have been conducted in the literature, it has been revealed that this is not particular to the implementation of elementary school level science courses. Furthermore, while there have been studies connected to the issue, it has been seen that they have not been given in the form of a thesis, and the researcher has opted to carry out the thesis study in this manner owing to this gap in the literature.

Science teaching plays an important role in a country's development. That is the reason why the countries place an emphasis on science education and strive to improve its quality in order to provide individuals with the necessary qualifications to survive and thrive within the science and technology race all around the world. These actions, on the other hand, are more focused on curriculum development (Ayas, 1995; Küçükylmaz, 2014). As a result, science education programs should be developed in tandem with advances in science and technology (Aykaç, Küçük, Kartal, Tilkibaş, & Keskin, 2011). As a result, one of the most fundamental requirements for building a good society is providing access to quality science education. People who always think utilitarianism, who never lose their sense of responsibility, who are aware of the beauty around them, can discover themselves, are at peace with themselves, are productive, know their problems, and find solutions to these problems will be successful in the future (Ürey & Çepni, 2014).

By avoiding classroom time constraints in science instructions, FLM allows students to conduct research and inquiry in classroom time (Tomory & Watson, 2015). Also it is described as an educational method in which the lecture and assignments are done in the classroom is what s/he observes outside of class time (Bergmann & Sams, 2012). Students can be benefited by the applications just like videos made by their teachers. An electronic environment and resources recorded in that environment are used for teaching and learning purposes within this model's parameters. As a result, students no longer have to be limited by the constraints of time and space when completing independent studies outside of the classroom. The importance of the flipped classroom model, which has recently become widespread in science teaching and provides positive contributions to students' learning, has been mentioned before. Taking all of this into consideration, the purpose of this study is to examine quantitatively the

impact of flipped education practices in science lessons on students' academic achievement and to draw comparisons and interpretations between countries based on the findings of these studies in Turkey and around the world. The meta-analysis method was utilized to examine these qualitative and quantitative interpretations and data in this study.

In primary and elementary schools, science is one of the "axis subjects." The primary goal of science education is to provide individuals with the skills necessary to solve problems they may encounter in their daily lives. It is critical to learn science and take courses in this field in order to achieve this goal (Coştu, et al., 2007). When learning the fundamental concepts of science, the term "scientific research" is expressed as three distinct situations that complement one another (Bybee, 2002):

- I. Science content to be comprehended
- II. A set of cognitive abilities that students must acquire.
- III. Science teachers' available teaching methods

In terms of the significance of science education, George DeBoer stated, "If we had to use a single word to describe the purpose of science education, that word would be research." (Chiappetta, 1997). Scientific research relies heavily on the development of necessary cognitive abilities. Researchers have conducted joint studies on this subject because researchers believe that research culture is one of the most important points to gain for students who continue their education in primary and elementary schools. Students' approaches to real-life problems and the solutions they find to these problems can be applied to other problems because they can establish these relationships. Because the students' approach to real-life problems and their ability to adapt the solutions they find to these problems will provide the learners' ability to establish these relationships (Dewey, 1907). From this vantage point, it is clear that students possess some cognitive abilities that must be supported during primary and elementary school years.

Raising students who are capable of researching, questioning, self-learning, and problem-solving are among the skills aimed for in the primary and secondary school science education programs (MoNE, 2018). Because individuals who have received a proper science education will be able to research the problems they encounter, establish cause-effect relationships, and propose new solutions to these problems as a result of the skills they acquired during the process (Benli & Sarıkaya, 2016). It is essential to explain the applied methods and the targeted skills in order for science education to achieve this goal. Science education, which is the foundation of social and human sciences, is encountered at many stages of an individual's education process, beginning with the fourth grade of primary school and continuing through undergraduate education. In fact, as the learners' age and cognitive level increase, this course is divided into more detailed and sub-learning areas, and the students are confronted with it (Demirbaş & Yağbasan, 2006).

Arguing that the best method for students' learning is not the traditional teaching method, which is an ancient structure, Talbert (2012) stated that students are outside the classroom when they need teacher help the most and they have to do the challenging tasks outside of the classroom. However, it is the time period when classroom teachers' abilities are at their highest level, but students need the least help and use their cognitive skills at the lowest level (Arslan & Özpınar, 2008). When the above-mentioned skills are insufficient to teach their students in traditional classrooms, the teachers usually explain the particular topic first, while the students listen and take notes. Listening becomes inefficient during the note-taking process, or note-taking becomes unproductive during the listening process (Uzun, 2018). The students only achieve the remember and understand stages of Bloom's taxonomy at the end of this process, which occurs during the teacher's lecture in the classroom. Even these lower cognitive stages are not always possible. Even if it is attained, it cannot be attained effectively by all the students. In some cases, the activities completed by the teacher during the lesson can lead to the application step in Bloom's taxonomy (Yıldız et al., 2021). At the end of the process completed at class, the

teacher assigns homework to be completed at home, and the students complete their homework at home. Students who do their homework appropriately can only progress to the apply and analyze steps of Bloom's taxonomy. Because of this process being reversed in flipped classrooms, this name is being used for this model. According to the flipped learning model, students learn the new topic independently at home before the lesson, while technology integration is included in the task. As a result of their homework, the students achieve the remember and understand stages through their own efforts at home. At school, active learning techniques related to the subject are used, as well as group projects to support social learning and experiments-observations to develop scientific process skills. Designing a new experiment, finding solutions to problems encountered, predicting potential problems and suggesting solutions to them are all skills that develop during this process. Thus, in the classroom environment and under the supervision of the teacher, students reach the higher cognitive stages, namely; applying, analyzing, evaluating, and creating in Bloom's taxonomy.

Bloom's Digital Taxonomy



Figure 2.1 Bloom's digitalized taxonomy (developed based on Bloom,1956)

Vygotsky defines learning as a process in which a student is aided by those who are more competent in the specific skills being learnt, and that learning is improved by collaboration within the learner's zone of proximal growth. These higher achievers can be both the teacher or a peer of the learner which is more competent in learned that specific learning area (Vygotsky,1978). According to Vygotsky, the zone of proximal development (ZDP) is also defined as "the distance between a student's actual development and the level of potential development as established through social factors such as problem-solving under an adult instruction or in collaboration with more capable peers or a teacher's intervention." "Scaffolding" is a term used by Vygotsky to describe how a teacher or a more experienced peer helps a student to succeed. It is important to remember that the learner must be actively engaged in the lesson and independent while scaffolding their own learning progress. A variety of studies

have shown that students learn best when taught in a way that takes into account their unique learning styles. For example, for Piaget, learning is a scientific endeavor in which students act and think like scientists to make sense of the world around them and understand reality. Rather than providing learners with the competency and knowledge, they are expected to quickly comprehend and use, educators should better employ a more gradual approach to learning. "Construct" their knowledge, rather than relying on someone else's. As a result of this, the students are exposed to scientific processing skills and their beliefs about science are established. In addition, they learn through their own experiences. Thanks to the process, they will be expected to be able to learn on their own and actively by creating schemas or mental models in their heads from their experiences. They will be able to construct their scientific processing skills and learning skills. Assimilation and accommodation are two complementary processes that modify, extend, and strengthen these schemas and mental models. The Piagetian cognitive constructivist theory states that children must engage with their peers to reach a higher level of learning, and the key mechanism driving this development is "cognitive conflict." The flipped classroom incorporates these two important principles of cognitive constructivism. The fundamental tenet is that education is a dynamic process. Preparation for the class is usually accomplished by providing students with some sort of digital tool, often a video provided by the teacher, that introduces them to the material they will be learning during the class. Problem-solving has been made easier because of this material. Flipped classrooms also adhere to the second premise of cognitive constructivist theory, which emphasizes peer instruction and higher-order cognitive skills in the classroom. It is possible for teachers to develop classes with some argumentation sessions or to use digital learning tools such as learning management systems (LMS) to create forums once the students have already reached the digital media before attending classes.

Harvard University professor, in the early 1900s, Dr. Eric Mazur used the flipped learning concept to create his lessons. Students are expected to complete the

assigned readings for this lesson plan outside of class time. Peer learning allowed students to do their homework in the classroom. As a result, the classroom was redesigned to be student-centered. There are several ways to encourage students to participate in the lesson and create a student centered classroom environment, as shown in the figure below.

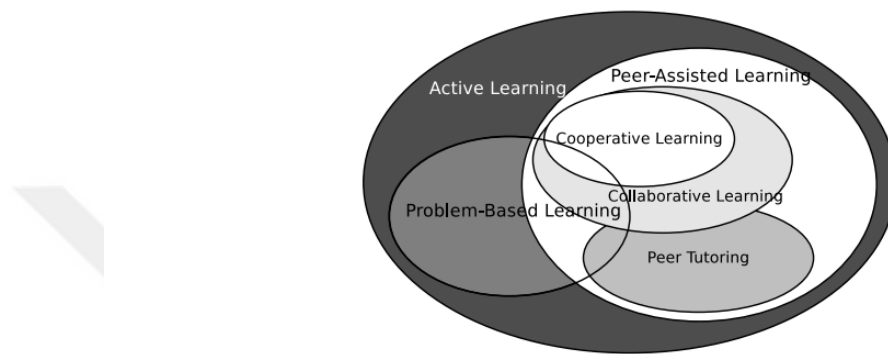


Figure 2.2 Student centered learning, developed based on (Correa, 2015)

In Mazur's teaching, he aims to move students from a passive to an active position (Correa, 2015). As a result of this goal, the resources offered prior to the class have been designed to ensure that the students are prepared to work from textbooks rather than video content as of today's technology. The goal of Mazur's peer learning initiative is to provide students with a place to ask each other questions regarding the course material. Students were able to engage in peer-to-peer learning by posting their reflections on a digital forum. Mazur is said to have provided the groundwork for the flipped education concept (Talbert, 2017). As a result of Mazur's teaching methods, he has established a classroom climate that encourages students to actively interact and actively engage in the lesson.

2.1 Overview of Flipped Learning (FL) Model

Flipped learning is a model of blended learning that involves either technology to influence the learning in a classroom, thus a teacher can have more time to interact with students instead of lecturing, thus there is an opportunity to provide more personal feedback and assistance to students, and in addition to

receiving feedback from their peers about the activities that they are performing and what they don't yet understand (Khadri Ahmed, 2016).

According to the Flipped Learning Network (2014), the flipped learning model is a student-centered approach in which the teaching method is shifted from the group area to the individual area, allowing the group area to become more dynamic and interactive under the guidance of the teacher, and transforming the student into an active learner in the learning environment in which high-level thinking skills are used (FLN, 2014; Johnson, 2012; O'Neil et al. 2012). or a facilitator This learning model encourages teachers to step away from the role of information transfer in the classroom and instead assume the role of a guide or a facilitator who provides continuous feedback to the student and guides the learners during the learning process throughout the instruction (King, 1993; Milman, 2012), as well as to create active learning environments in which the student is at the center of the learning process (Baker, 2000; Hayrsever & Orhan, 2018).

Prior to beginning the lesson, Milman (2012) includes the resources and materials shared by teachers at the conceptual level; subsequent lessons include the more difficult activities such as homework, discussion, and practice; so that these subsequent lessons replace in-class and out-of-class activities; namely homework, discussion, and practices are done in-class (Morin et al., 2013).

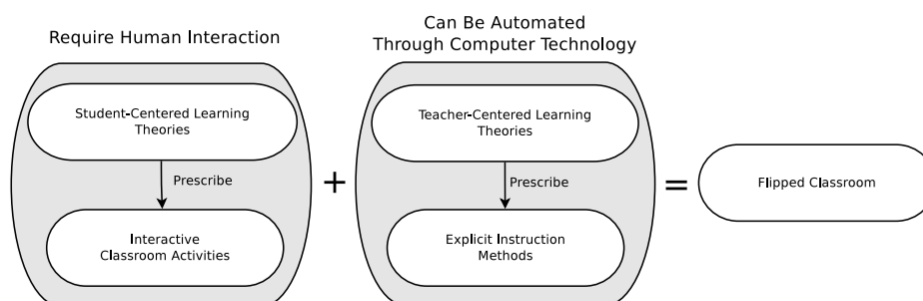


Figure 2.3 Flipped classroom (Morin et al., 2013)

2.2 The Four Educational Pillars of Flipped Learning

The Flipped Learning Network and Person's School Achievement Services have established four pillars of effective and successful flipped learning that may be implemented in any setting. Namely, Flexible Environment, Learning Culture, Intentional Content, and Professional Educator (F-L-I-P™) (Khadri Ahmed, 2016). Figure 2.4 is the visual depiction of The Four Educational Pillars of Flipped Learning showing support for student engagement. Copyright 2014 by the Flipped Learning Network.



Figure 2.4 The four educational pillars of flipped learning

The first pillar demonstrates how learning environments may indeed be flexible and adaptable. Educators routinely rearrange their classrooms in order to make them more conducive to collaborative learning opportunities. Students have the ability to choose when and where they want to learn, as well as whatever methods they want to use, such as group work, individual study, research, performance, and assessment, in this flexible and adaptive learning environment. As a result, flipped learning evolves into a setting in which learning objectives are examined in more detail and learning possibilities are expanded. The most important resource in education is time, and educators make the most of it by interacting with students and assessing students' grasp of the subject matter. Student-centered learning environments encourage students

to explore subjects and learning objectives in more detail while also challenging them to develop higher-order thinking abilities (Khadri Ahmed, 2016).

The second pillar shows how to shape the learning cultures. Learners in a flipped learning environment make use of their valuable time in group activities to engage in more productive and innovative learning processes than they would otherwise. Learners actively contribute to the development of knowledge in the classroom by assessing their own learning and participation in group activities (Hayırsever & Orhan, 2018). A deliberate change away from a teacher-centered approach to one that is student-centered is achieved through the use of the flipped learning model, wherein in-class time is given to face-to-face classroom interactions to evaluate student grasp and synthesis of the subject. Flipped educators assist students in discovering things more completely by utilizing student-centered pedagogies that are tailored to their readiness level or region of proximal development, where they are challenged but not to the point that they become frustrated by the experience (Vygotsky, 1978).

Intentional Content defines the instructional decisions that must be made by the instructor in order for them to be implemented. Those considerations include what subject should be taught by video and what materials students should be allowed to examine on their own, among other things. Based on the findings of Khadri Ahmed, (2016), flipped educators utilize intentional content to make full use of available classroom time with the intention of utilizing a variety of methods of instruction including peer instruction, active learning strategies, problem-based learning, or Socratic methods, as appropriate for their student's grade level and actual content. It seems unlikely that much will be accomplished if they continue to educate in a teacher-centered way (Khadri Ahmed, 2016).

The last pillar, Professional Educators, may well be the most essential since it reflects the importance of the function of educators in flipped learning, despite the fact that their job is "less outwardly apparent" in the traditional classroom. To effectively flip the instruction, educators must choose when and how to

change direct instruction from a full group of students to a single learner. They must be aware of the techniques that will allow them to spend the most time with kids in the classroom (Khadri Ahmed, 2016). Teachers that use a flipped classroom are continually monitoring, evaluating, and providing feedback to students. As previously stated, the presence of an educator who can effectively monitor and guide the learning process can make it possible to implement flipped learning. This is especially true for the preparation and arrangement of content, as well as the creation of a learning environment (O'Flaherty & Phillips, 2015).

2.3 History of Flipped Learning

The peer instruction technique established by Mazur in the early 1990s may be traced back to the theoretical foundations of the flipped learning paradigm (Correra, 2015). Students' conceptual comprehension of complicated subjects can be improved by using the peer teaching paradigm, which was developed by Eric Mazur, a physics professor at Harvard University. To learn basic facts in this paradigm, students complete their reading assignments at home and their homework assignments are saved to be done in the classroom (Mazur, 1997). Assignment early, Mazur has established an electronic platform where students may gain basic information about the course as well as access the course materials before the actual lecture. Students can also ask questions of one another and receive answers to their inquiries. Consequently, he devotes classroom time to reinforcing information and correcting incorrect learnings and misconceptions, if any, through the use of cooperative learning and peer instruction approaches, among others. Even though the fact that this approach, which Mazur employs, was developed for the goal of teaching, it may be considered one of the earliest examples of flipped learning methods since their theoretical foundations are so comparable (Talbert, 2017).

Professor J.Wesley Baker, who was working at Cedarville University in 1995, also carried out an application similar to the application developed by Mazur. During Baker's class lectures, he noticed that the learners copied the material

immediately into their notebooks and never considered it. He even puts it this way: "the information on the presentation slides passes directly via students' notes without going through their brains." When confronted with this issue, Baker collapsed in the classroom. He remarked that time went by simply by exchanging information and taking numerous notes, and he sought treatment for this (Talbert, 2017). To address this unpleasant circumstance and make better use of classroom time, Baker shared PowerPoint presentations of the topics he was teaching with students prior to the session and urged them to review and reflect on the presentations before coming to the lecture. As a result, class time is more productive and may be used for learning activities. This strategy was coined the "classroom flip" during the 2000 International Conference on College Teaching and Learning, which he attended (Baker, 2000).

Around the same time as Baker, Maureen Lage, Gleen Platt, and Micheal Treglia argued that students with varying learning styles could not be taught the content of the course through direct narration in an introductory economics course and that classroom time should be used for individualized activities (Talbert, 2017). According to these three professors, no single method of teaching could possibly appeal to all learners in the class, and hence it was critical to employ individualized teaching strategies to ensure that each student got the most out of the lecture. They coined this technique an inverted classroom because it attempts to build foundational knowledge prior to the lesson by sharing lesson materials with students prior to the lesson and to reach all students by enhancing the classroom time with a variety of activities (Lage et al., 2000).

In 2007, two teachers, Jon Bergmann and Aaron Sams used flipped learning applications to complete all of their classes in one semester at a high school in Woodland Park, Colorado, where they teach chemistry. The goal of these programs was to allow students who missed the session to compensate for their absences on their own. Aaron Sams is inspired by an article he reads in a magazine to learn a computer software that enables them to record presentations with a voice-over and video (Talbert, 2017). This strategy quickly gained the attention of other instructors and students (Bergmann, 2011), and

they rescheduled their dual teaching activities. Convinced that students can acquire basic knowledge outside of the classroom through the use of course materials and that they require additional knowledge while engaging in higher-level activities such as problem-solving with the guidance of the teacher, Bergmann and Sams videotaped all their lessons and began implementing the completely flipped learning model in the 2007-2008 academic year. The success of this learning approach has gained global attention, garnered coverage on news networks, and made the flipped learning model more recognizable (Kara, 2016; Hayırsever & Orhan, 2018).

In fact, these approaches became more well-known in 2010 with an article authored by Daniel Pink in London's Telegraph newspaper on flipped educational practices. A math instructor named Karl Fisch also employed it in his courses, and he labeled the flipped learning practices in these lessons. "the Fisch flip" offhandedly referred to by Pink in his article, and published an article in the newspaper. It might be stated that the use of the verb "flip" for flipped learning evolved in this method (Talbert, 2017). Since the techniques of applications employed by Fisch in his lessons were developed according to the knowledge acquired from the workshops organized by Bergmann and Sams, the usage of "flip" is indisputably associated with the teaching approach of flipped learning (Talbert, 2017). In this respect, Bergmann and Sams employed this word in the titles of their publication that would be read and profited from by enormous audiences in 2012. *Flip Your Classroom: Reach Every Student in Every Class Every Day* (2012)

The Flipped Learning Network (FLN) was founded in 2012 by widely recognized pioneers of the flipped learning model, including Jon Bergmann, Aaron Sams, April Gudenrath, Kristin Daniels, Troy Cockrum, and Brian Bennett and others. In 2016, the FLN revised its mission to focus more directly on serving as an online hub for educators worldwide to share and access resources, tips, and tools. This electronic learning network serves as an effective instructional environment where instructors and learners may have access to a variety of resources, tools, and instructional materials. This platform covers both how to

deliver flipped learning environments and how to build activities that adhere to the flipped learning model of learning outcomes and organized into lessons.

2.4 Benefits of Flipped Learning Model (FLM)

Thanks to FLM, students who spend more time with technology to access digital materials may keep a closer eye on technological advancements. With FLM, students have self-control while independently studying a subject at home. Each student organizes and takes responsibility for their own learning. The student who feels the lack of it when he or she attends a lesson unprepared will desire to attend the next lesson better prepared. Thus, the student has better control over their own learning process management. FLM can help students appreciate the subject and the lesson. Clearly, attitudes towards the lesson have a significant role in learning. This model predicts that students with a good attitude toward the lesson would achieve greater academic performance. Time is made available in the classroom environment for social learning, such as peer learning, peer assessment, cooperative and collaborative learning and problem solving, through the use of FLM. Regarding science lessons in particular, the classroom atmosphere offers additional opportunity for experimentation and observation to learners who have learned about the topics outside class. Students who engage in the scientific learning process in a healthier manner have a more profound understanding of science. Through doing and experiencing, kids gain knowledge. The student who participates more actively in class feels more engaged in the process of learning. Moreover, these applications; provides the necessary time and atmosphere for students to use the methods, procedures, or models that enable them to construct their own knowledge. According to Fulton (2012), students learn more effectively in contexts where they are active and accountable for their own learning process. Therefore, with the applications of FLM that provides these conditions, students can enjoy the classes more, which can lead to even greater academic success.

According to Bergmann and Sams (2012), students are able to progress at their own pace thanks to this model. St Stodel students with learning difficulties may be

easier to spot when their teachers assign homework that they must complete in the classroom. Teachers will be able to better tailor their lesson plans with this knowledge of students' specific learning difficulties. Misconceptions and misunderstandings of the students will also be exposed at this point. These misconceptions can be addressed promptly by teachers, preventing them from becoming entrenched in students' minds.

According to Enfield (2013), prepared videos or contents are available during learning or later. It will allow students to repeat the subject whenever they want.

Teachers benefit from the FLM, because it allows them to grow both as instructors and as technology educators. Self-renewing teachers and educators never stand still. The monotony of teaching the same material over and over again is avoided by the FLM. When the teacher meets with FLM, a new practice, he or she becomes enthused and holds on even more to his or her vocation.

According to Bergmann and Sams (2012), the teachers have the opportunity to get to know their students better. They both discover the learning styles of the students and can notice early on what they learned wrong.

When it comes to parents, they'll be able to see the videos their kids view so they may aid them and participate more actively in the learning process.

2.5 Challenges of Flipped Learning Model (FLM)

FLM has many advantages, but it also has limitations (Bergman and Sams, 2012). FLM is a technologically reliant application. Because the course content that the teacher will prepare for his students will be followed on a tablet, computer, or phone, students are open to and in need of technological advancements. As a result, performing these applications in countries or cities where technology is not fully established may be difficult. As a result, before using this application, teachers should assess the technological needs of the class and provide these tools and materials to students who lack the necessary tools and equipment. In their study, Bergman and Sams (2012) stated that at the process of FLM, they try to provide computers to students who do not have one,

and for students who cannot access the internet, they take videos of the topics they will cover, transfer them to CDs, and give them to their students.

If a student is unable to watch the videos for any reason before the classroom time, she or he may fall behind in the lesson and be unable to catch up with his peers' learning levels. As a result, in order to use this application, the teacher should apply to the student group s/he believes will be able to watch the videos. Another option is for teachers to check the grades on whether the videos were watched or not before each lesson, or to conduct a question-and-answer study in the classroom about the content of the videos.

Another limitation of FLM is that students can't open videos, pictures, or audio files prepared by the teacher during the application. Furthermore, teachers may encounter technical difficulties, particularly during video lesson preparation or uploading to the Internet. Teachers should anticipate such technical difficulties and increase their competence in producing solutions.

This chapter is divided into the following sections: *research model, overview of meta analysis, data collection, and data analysis*. In the first section, it begins with a description of the technique that was used for this study before moving on to an explanation of the meta-analysis method itself.

This section will cover topics such as literature search strategy, inclusion and exclusion criteria, evaluation of the quality of the studies, extracting, organizing and grouping research findings from research reports, calculating effect sizes, and validity and reliability. The third section will cover topics such as literature search strategy. The last section of the chapter will include data analysis; it will contain information on the unit of measure of the effect size that was employed, as well as formulae and software that was used.

3.1 Research Model

Research on the impacts of studies on flipped learning applications implemented in elementary school level science instructions in terms of academic performance variables was collected using the meta-analytic approach, which is considered to be one of the synthesis methodologies. The scope of the study is confined to applications submitted in Turkey and abroad, and studies published between the years 2012 and 2022, respectively. The meta-analysis technique is used to aggregate the findings of the studies statistically.

The meta-analysis technique which is one of the systematic content analysis methodologies, was employed in this study. Meta-analysis is a statistical approach for gathering together studies undertaken by various researchers at multiple places and periods on a specific issue, using the right statistical procedure, or for collecting the information gathered from the studies (Hunter & Schmidt, 1990; Şahin, 1999; Kaşarcı, 2013).

Traditional reviews on the other hand, known as **Narrative reviews** are often performed by experts who are specialists in a specific field, carried out without a specific approach and adhering to a single process and gathering knowledge from many sources (Burns & Grove). Narrative review process is scientifically deficient and does not deliver satisfying results to researchers in providing evidence due to several inadequacies at the stage of analysis going to follow data collecting. (For further details, check the section titled Advantages of Meta-Analysis.)

According to the literature, **systematic content analyses** are outline the research that play a key role in spreading research knowledge and shaping future research, framework, practice, and public sentiment and perception. Systematic content analyses of educational studies are also expected to save up time for academics and reduce workloads by making it easier for them to find and examine previously published research (Çalık, Ünal, Coştu & Karataş, 2008; Çiltaş, Güler & Sözbilir, 2012; Gökteş, Küçük et al., 2012; Umdü Topsakal, Çalık & Çavuş, 2012; Çalık & Sözbilir, 2014). **Descriptive content analysis, meta-synthesis (thematic content analysis),** and **Meta-analysis,** are three sub-categories of systematic content analysis (Çalık & Sözbilir, 2014).

Meta analysis studies are defined as studies that synthesize findings, conclusions, and evaluations from two or more publications on a specific issue or by examining multiple studies and synthesizing findings, conclusions, and evaluations. Meta-analysis is fundamentally a technique of synthesis in which all research relating to the relevant issue in the literature are compiled and meta-analyzed. Review studies are referred to in three ways in the literature. These methods and techniques differ depending on the technique and regulations used in these studies.

Since meta-analysis is a statistical procedure it combines the findings of independent studies on a certain issue with the statistical interpretation of these study findings. According to this viewpoint, meta-analysis is not employed in all systematic reviews, but the studies to be exposed to meta-analysis should go

through a systematic review procedure before being subjected to a meta-analysis analysis. Meta-analysis facilitates the examination and interpretation of quantitative data findings in systematic reviews (Aslan, 2018).

3.2 Overview of Meta-Analysis

Meta-analysis can be defined as a statistical interpretation of quantitative data belonging to groups after gathering the findings of a variety of relevant research using specified criteria, making it feasible to get studies on similar concerns or themes within an area of study. The researcher is likely to construct plausible explanations regarding the study area using the data acquired. Since these plausible explanations are premised on statistical data, they provide a scientifically supported conclusion to the researcher. Thus, all studies included in the study can be interpreted as if they were a single study. In this respect, the scope of the term "meta-analysis" is wide, because meta-analysis not only allows for a general conclusion to be reached by integrating the results, but it also allows for the results of a study to be analyzed again. Karl Pearson's research in 1904 to explore the link between vaccination and typhoid illness was the first meta-analysis study identified in the worldwide literature. With this respect meta-analysis was initially employed in health-related scientific research. Its application in the social sciences dates from the 1970s. By creating various approaches, Rosenthal and Rubin (1978) and Schmidt and Hunter (1977) are the first researchers to employ meta-analysis technique in social sciences (Dinçer, 2014).

Glass, McGaw, and Smith (1981) defined meta-analysis as "the quantitative synthesis of results from numerous individual empirical research that focus on the same topic."

3.2.1. Meta-Analysis Implementation Phases

The first step is to conduct a literature review. The search procedure for a meta-analysis, like that of a literature review, should be systematic, reproducible, and transparent, resulting in a sample that contains all relevant

studies (Fisch & Block, 2018; Gusenbauer & Haddaway, 2020). The researchers must determine which papers to include in the meta-analysis while reading the literature. To assure the quality of findings, several recommendations for literature reviews advocate restricting the sample to research published in prestigious academic publications. The relevant literature review papers are gathered so that the researcher may identify the study characteristics and proceed to search for good research questions. They find research questions for these inadequacies and collect studies in this area since it has the ability to detect gaps in the literature. So that the researcher defines the research question or questions. As with any other empirical study, the first step in performing a meta-analysis is to define the research topic. The research topic, most critically, sets the realm of constructs to be investigated or the sort of treatments whose effects will be assessed. The researcher should focus on developing a unique study topic that does not repeat past meta-analyses. Another barrier to determining a sufficient study scope is that the number of publications in many disciplines of research has expanded rapidly in recent decades. The researcher should be aware of current publications in the field of study that he is interested in.

Determining the study characteristics allows the criteria to be constructed so that the researcher may identify the significant topics. Following the literature review, those studies that fulfill the inclusion criteria according to the coding technique are assessed among those found in response to the research questions. The most meticulous work is required in selecting the inclusion criteria in the meta-analysis and coding the studies retrieved throughout the literature research. Because the completion of these steps allows for easy accurate analysis and clear interpretation of the study (Dinçer, 2014).

When the researcher has finished deciding coding criteria the analysis may begin. Following the analysis, the effect size calculation and heterogeneity test are performed. The researcher will be able to evaluate the study data after completing the model selection using the heterogeneity test, due to the general effect size calculation. As a result, the study seems to be completed, and the

researcher can write reviews on the study's findings, discussion, and conclusion parts.

There is an attempt underway to define a reporting standard for meta-analysis. At the head of these efforts are Rosenthal's criteria as he noted in 1995, that a meta-analysis research should include a literature review, inclusion criteria, study characteristics, heterogeneity test, effect size value, confidence intervals, and descriptive statistics.

The processes indicated in the title Meta-Analysis Implementation Phases are depicted below. Figure 3.1 below showing implementation of meta-analysis studies created with using MindMap by the researcher

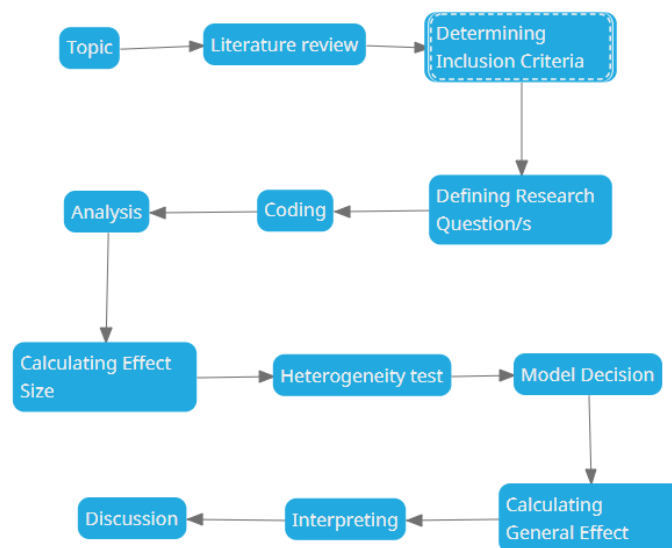


Figure 3.1 Implementation of meta analysis studies

3.2.2 Advantages of Meta-Analysis

Meta analysis is convenient for reaching more certain judgments and drawing conclusions when individual primary research yield contradictory results (Camilli, et al., 2008). By using the meta-analysis technique, the researcher can obtain more confident insights compared to the results obtained from individual studies. As a result, the researcher can argue for the efficacy of a

particular teaching technique using arguments from several papers that have been gathered for meta-analysis.

Traditional narrative review studies are defined as studies that synthesize findings, conclusions, and evaluations from two or more publications on a specific issue or by examining multiple studies and synthesizing findings, conclusions, and evaluations. Experts in a particular field of study usually do so in various ways, without having a structured process for accumulating data from the sources. Correspondingly, traditional narrative studies are lacking in evidence. The meta-analysis, on the other hand, is a quantitative systematic review type in which statistics are used that is superior in terms of scientific proof to traditional review studies. As a result, it has become a popular statistical analysis method in recent years and is frequently included in studies, especially for the ones who gave great importance to evidence-based. Reviewer bias, rather than integrating disparate outcomes into a collection of cohesive and reasonably clear findings, can lead to inaccurate conclusions based on insufficient or inappropriate evidence, and can amplify, rather than resolve, conflicting findings. Correspondingly, traditional narrative reviews are scientifically unsound since they do not depend on evidence. Also, traditional narrative reviews are inadequate for obtaining information from research, notably when there are several studies (greater than 30). Because there are no systematic techniques for extracting and synthesizing data, a reviewer must rely on more intuitive ways to structure correlations among various variables. Systematic reviews and meta-analyses seem to be at top of the "Evidence Pyramid" (see figure below). The amount of available literature on a specific topic decline specific topic declines as you ascend up the pyramid, but the relevance and quality of that literature increases. Because these study designs lower bias and deliver more reliable findings, systematic reviews and meta-analyses are regarded as the best quality evidence on a research issue. However, you may not always be able to locate (or require) the greatest quality of evidence to answer your research topic. In the absence of the most compelling proof, you must

contemplate moving down the pyramid produced by Jan Glover, David Izzo, Karen Odatto and Lei Wang depicted as Figure 3.2 below.

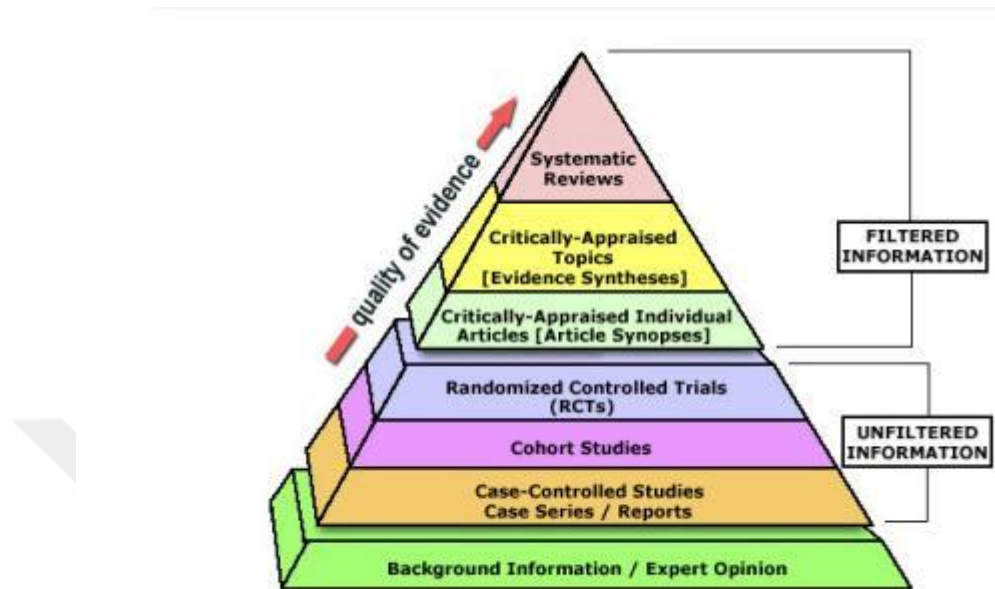


Figure 3.2 Evidence based pyramid

3.2.3 Criticisms Meta-Analysis

Glass, McGaw, and Smith outlined the criticisms of meta-analysis in their work in 1981, in *Meta-Analysis for Social Research*. One of the most common complaints leveled at meta-analysis is that it compares "apples and oranges," pooling results acquired from dissimilar study objectives and techniques. However, as Cooper and Hedges argue, aggregating research is legitimate if they are investigating the same phenomena (Cooper & Hedges, 1994).

Another point of contention is that meta-analysis is susceptible to publication bias, commonly known as the 'file-drawer problem' (Rosenthal, 1979). Despite the fact that the literature has a variety of strategies for determining and correcting its existence. The funnel plot approach, for example, looks for asymmetry in a funnel plot that plots effect magnitude by sample size (Light & Pillemer, 1984). Furthermore, the researcher's objective selection of inclusion criteria is the first and most straightforward technique to eliminate publication bias. (Further information will be given)

One of the most common critiques directed at the meta-analysis method is about the number of studies that must be examined. If obtaining a general effect size with the meta-analysis approach is needed, this method can be used with as few as two investigations. Researchers frequently critique this. These objections highlight the significance of the literature review stage in the meta-analysis process. Because the more studies the researcher can incorporate into the analysis, the clearer the outcome.

3.2.4. Types of Meta-Analysis

There are several types of meta-analysis, each with its own aim, unit of analysis, handling of study variation, and products (Bangert-Drowns, 1986; Borenstein et al., 2009). For the purpose of the analysis, two major categories are distinguished, each with two subcategories: *group contrast meta-analysis*, which can involve either treatment effectiveness or group differences issues, and *correlational association meta-analysis*, which can involve either test validity or covariation issues among other types of variables (Durlak & Lipsey, 1991).

3.2.5. Statistical Models Used in Meta-Analysis Method

In Meta-Analysis research, two statistical models are used. These are the Fixed Effects and Random Effects Models, respectively (Dinçer, 2014). There is also a meta-analysis model known as the Mixed Effects Model, however this model will not be discussed here.

3.2.5.1. Fixed Effect Model (FEM)

The overall effect size is determined in the Fixed Effects Model by taking into account the variation introduced by the sampling error identified in the studies. Dinçer (2014) asserts that all factors that might impact the effect size are constant between trials; hence, the actual effect size is constant across investigations. If the universes of the studies included in the meta-analysis are comparable in size, the fixed effect model is appropriate. The heterogeneity test determines whether or not the universe sizes of the research are comparable.

The Fixed Effect Model is employed when the heterogeneity test indicates that the results of individual research are homogenous (Dinçer,2014).

3.2.5.2. Random Effects Model (REM)

Another technique for statistically combining data from research is the Random Effects Model, which determines the total impact by accounting for random mistakes both within and across studies (Card, 2019).

The random Effects Model is employed when the population sizes of separate studies vary and the standard deviation is greater than zero. In other words, if the universes of the experiments are not identical, the Random Effects Model is applicable. The heterogeneity test is used to determine whether the population sizes of the studies are comparable, and the Random Effects Model is recommended since the findings of the separate research vary (heterogeneous).

3.2.6 Model Selection in Meta-Analysis

There are two statistical models applied in Meta-Analysis studies. These are the Fixed Effect Model and the Random Effects Model. For detailed information about these two models, the previous section of this chapter can be examined.

3.2.5. Statistical Models Used in Meta-Analysis Method

This part of the study will include expert perspectives on which of the two models described before fulfills whatever function and which model should be used for specific areas of research.

Dinçer (2014) states the following about model selection:

Borenstein et al. assert that the value of the impact size varies according to the state of the random-effects model's working factors (REM). (Borenstein & T. Higgins, 2013) If the research is in social science, it will involve a large number of moderators and other variables, making the random-effects model more useful. Additionally, Borenstein claimed in his 2013 study that small-scale studies had a greater influence when using a random-effects model rather than a fixed-effects model. On the other hand, when utilizing the fixed effects method, large studies have a higher influence. (Borenstein & T. Higgins, 2013)

Additionally, when the researcher examines the value of the heterogeneity test and determines that it is meaningful (the p -value is less than 0.05), the random-effects model produces more trustworthy findings (Dinçer, 2014).

3.2.8 Heterogeneity Test, Q-value

As with the fundamental statistical tests, it is assumed that the individual effect sizes in the meta-analysis will typically be distributed around the overall effect size coefficient. Individual effect sizes are not likely to be bigger than the sampling error under normal circumstances. It is exceedingly difficult to achieve this expectation in educational sciences research since there are several elements impacting the dependent and independent variable interaction.

The normal distribution of individual effect sizes implies homogeneity in meta-analysis applications, whereas differentiation shows heterogeneity. In other words, when individual effect sizes are found to be non-normally distributed as a consequence of the heterogeneity test, they do not measure the same effect size as when they are regularly distributed. The disparity in individual effect sizes is interpreted to be due to sampling error.

While the p -value is utilized in statistical analysis, the Q -value is often employed in meta-analysis. In comparison to the p -value, the Q -value can provide more precise findings (Dinçer, 2014).

3.2.9 Statistical Power in Meta-Analysis

Ellis (2010) defines power analysis as a test of the probability that a statistical analysis will correctly reject the null hypothesis, Ellis (2010) also describes statistical power as the probability that a test can accurately calculate a real effect. Researchers working with the meta-analysis method can perform a power analysis to determine the number of studies if a study will consist of a large number of studies. Power analyzes in meta-analysis studies are the most common analysis interpretations and are the most informative sources. However, when the Random Effect Model is preferred in the study effect size tests and there are few studies, the power analyzes in the meta-analysis tests may be low

(Cooper, 2016). Cohen (1988) emphasized that there should be at least 80% probability in determining the statistical power of a test.

3.2.10 Publication Bias

Publication bias is one of the factors affecting the meta-analysis results by researchers. Concentrating on a single outcome, scanning the literature narrowly, and including significant difference and relevant effect sizes in the analysis findings reduces the likelihood of publication bias affecting the analysis results.

In addition, one of the biggest criticisms of the meta-analysis method is that the studies in the literature are mostly effective studies and the probability of publication decreases when the application is not effective or produces a different result than expected.

3.2.3 Criticisms Meta-Analysis

The first step toward avoiding publication bias is to establish objective inclusion criteria. Although the inclusion criteria for the publications to be included in the analysis were chosen objectively, it is important for the study's reliability to conduct a test for publication bias. There are several ways to verify this: Funnel Chart, Rosenthal Fault Protection N, Orwin Protection N Number, Egger Regression Analysis, Duval and Tweedie Analysis, Begg and Mazumdar Rank Correlation are the ways to test publication bias.

3.2.11 Charts in Meta-Analysis

The findings of an analysis achieved by merging quantitative data in a meta-analysis are graphically shown. Forest plots and funnel scatter plots are the most often employed graphical representations in meta-analysis. The forest graph displays both the effect sizes of individual studies and the overall effect. The lower and upper bounds of the 95% confidence interval for the effect sizes of the studies included in the study and whose subgroups were merged in the forest graph with 36 studies and 41 effect sizes are shown below. Below it is depicted an example of a forest plot used in Kanadlı and Akay's study (Kanadlı & Akay, 2019).

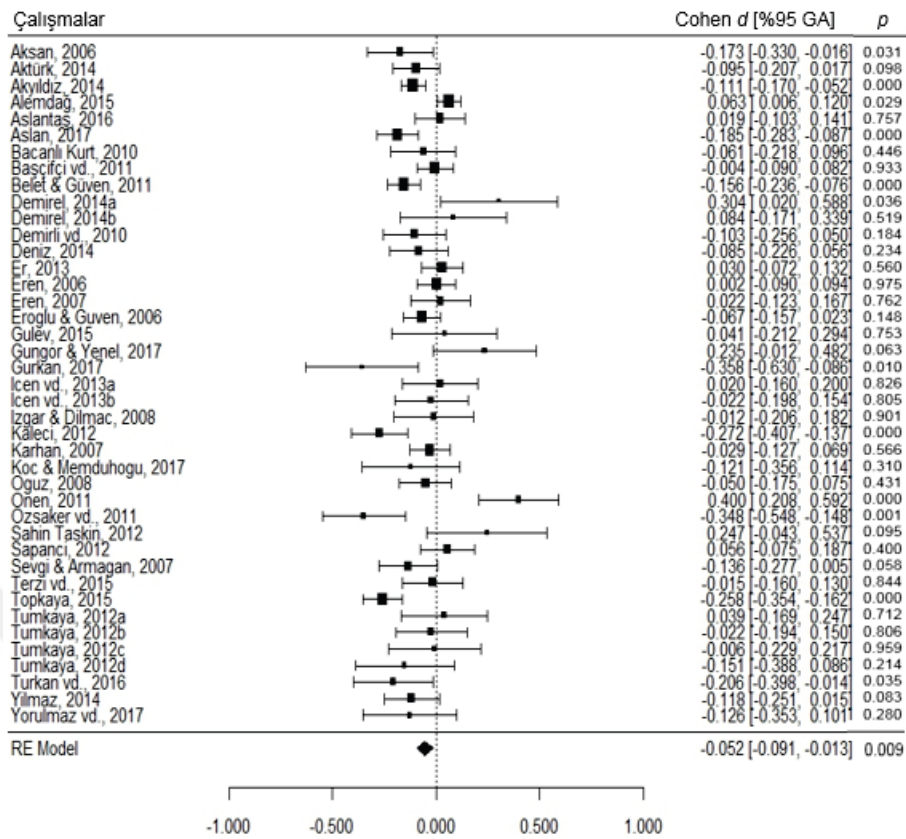


Figure 3.3 An example of a forest plot (Kanadlı & Akay, 2019)

With the funnel plot, which is an also an essential graphical depiction in meta analysis , both the heterogeneity of the research and the existence of publication bias can be explained (Borenstein et al., 2013). Below it is depicted an example of a forest plot used in Kazu and Kurtoğlu Yalçın's study (Kazu and Kurtoğlu Yalçın, 2022).

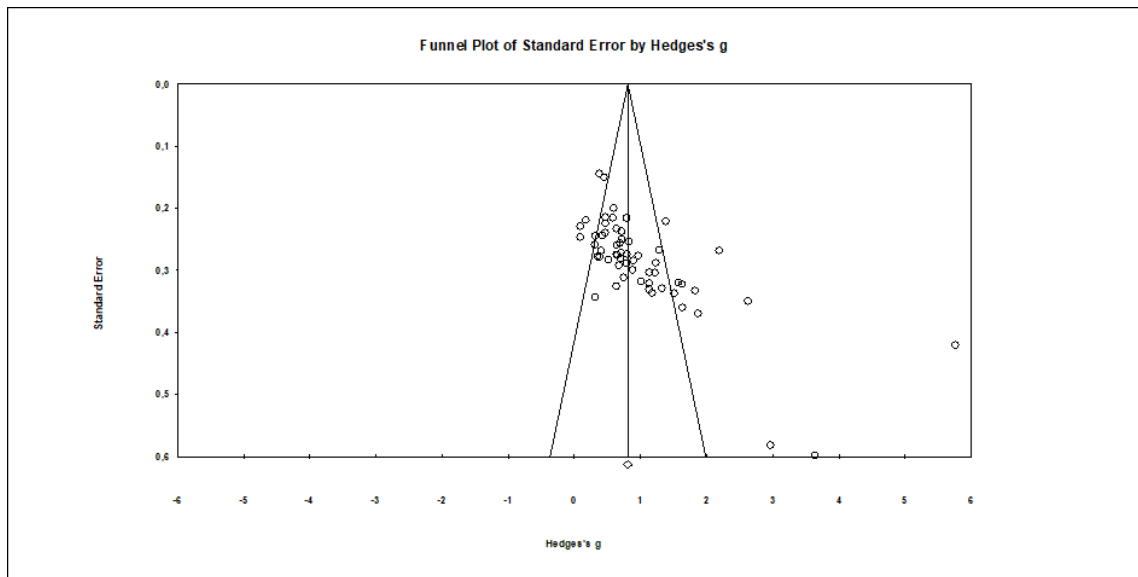


Figure 3.4. An example of a forest plot (Kazu and Kurtoğlu Yalçın, 2022)

3.2.11 Symbols Used in Meta-Analysis

Two separate effect sizes are calculated in the meta-analysis. According to Dincer (2014), the impact size for individual studies and the overall effect size represents the total number of studies assessed. He noted that these two values' representations are also distinct from one another. In individual studies, the effect size is shown by a square, but the general effect size is represented by a diamond. As shown in the table, the breadth of the squares is proportional to the individual study weight as it is depicted below.

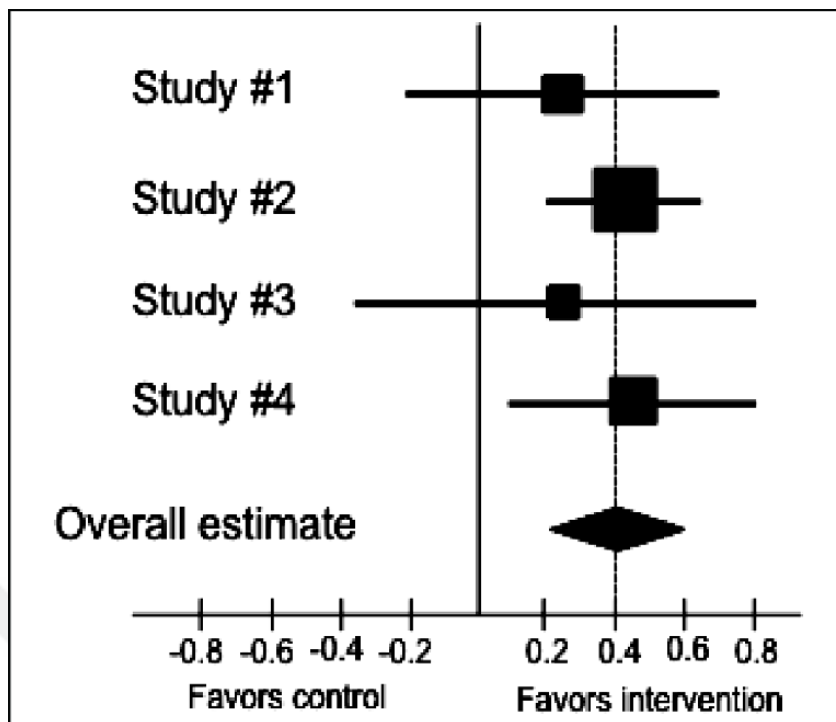


Figure 3.5 Example of a forest plot (Tonelli, 2008)

3.2.12 Package Programs Used in Meta-Analysis

After acquiring the data for the meta-analysis, Microsoft Excel software may be utilized to do direct formula computations. However, this program is only capable of determining the impact size of particular research. Due to the difficulties of performing heterogeneity tests, general effects, and similar computations, using Microsoft Excel and the similar softwares might be quite challenging. SPSS is another program that may be used to determine the effect size. Only the impact size of individual studies and the power of the application may be determined using SPSS software. Meta-Win and CMA tools are frequently used to do sophisticated meta-analyses. Due to the difficulty or impossibility of combining disparate data sets using Meta-Win software, it was determined that CMA software would be better suited for this research's analysis.

3.3 Data Collection

First and foremost, the research attempted to access all local and foreign studies linked to the use of FLA in the science education classrooms regardless of the age of the participants and the science topics covered. As mentioned in the title of the study's limitations, limitation was set according to the literature review. The reason for this is that it is not possible to reach all of the studies that have been conducted throughout all the studies, nor is it possible to do so in a comprehensive manner. This time span was confined to the years 2012 to 2022. The primary data source for this research includes master's and doctoral theses and peer-reviewed studies on FLA in science instructions, as well as related publications published in national and international peer-reviewed journals that the researcher have the right to access full texts.

The researcher divided the data collection process for this study into two stages in order to make the literature review more systematic and to reach as many studies as possible. The first stage of the literature review seeks to identify all applications of flipped learning in science instruction at the 4th and 8th grade levels in *Turkey*. To achieve this goal, five databases are scanned, as explained in detail in the following paragraph.

This thesis investigates FLA in the context of science education at grade levels ranging from 4th to 8th, which were released between 2012 and 2022 and are relevant to the field of science education. There were five electronic databases used by the author to search for related publications: the Education Resources Information Center (ERIC), PROQUEST, Scopus, EBSCO, YÖK National Thesis Center, TUBITAK Ulakbim, JSTOR databases and Google Scholar search engine, among others. "flipped classroom", "flipped class", "flipped learning", "inverted class", "classroom flip", "lecture at home, homework at school" are the search phrases that have been utilized in the titles and abstracts of articles to gather a variety of possibly suitable research.

The table below shows the number of studies reached according to the publication year and the title of the study.

Table 3.1 Literature search terms for the reviewed studies

Searching Ending Date	Search Term	Database	N
15.04.2022	TITLE (ters yüz) AND PUBYEAR > 2011	YOKTEZ	144
15.04.2022	TITLE (evde ders okulda ödev) TITLE (dönüştürülmüş sınıf) AND PUBYEAR > 2011	YOKTEZ	2+5
15.04.2022	TITLE (ters yüz) AND PUBYEAR > 2011	ULAKBIM	209
15.04.2022	TITLE (evde ders okulda ödev) TITLE (dönüştürülmüş sınıf) AND PUBYEAR > 2011	ULAKBIM	4+44
15.04.2022	TITLE (ters yüz) AND PUBYEAR > 2011	EBSCO	63
15.04.2022	TITLE (evde ders okulda ödev) TITLE (dönüştürülmüş sınıf) AND PUBYEAR > 2011	EBSCO	0
15.04.2022	TITLE (ters yüz) AND PUBYEAR > 2011	ERIC	1
15.04.2022	TITLE (evde ders okulda ödev) TITLE (dönüştürülmüş sınıf) AND PUBYEAR > 2011	ERIC	0
15.04.2022	TITLE (ters yüz) AND PUBYEAR > 2011	PROQUEST	16
15.04.2022	TITLE (evde ders okulda ödev) TITLE (dönüştürülmüş sınıf) AND PUBYEAR > 2011	PROQUEST	0+1
15.04.2022	TITLE (ters yüz) AND PUBYEAR > 2011	SCOPUS	6
15.04.2022	TITLE (evde ders okulda ödev) TITLE (dönüştürülmüş sınıf) AND PUBYEAR > 2011	SCOPUS	0
15.04.2022	TITLE (ters yüz) AND PUBYEAR > 2011	JSTOR	0
15.04.2022	TITLE (evde ders okulda ödev) TITLE (dönüştürülmüş sınıf) AND PUBYEAR > 2011	JSTOR	0
Total			495

The distribution of the studies that the researcher has reached regarding the flipped teaching approaches that were employed in primary and elementary school level science lessons in Turkey is displayed in the table above, according to the databases. As indicated in the table, this search was terminated on April 15, 2022, and it was mentioned how many studies were retrieved when a search was done over the names of the studies with the keywords given in the relevant databases.

The PRISMA statement is a publication guidance for researchers that aims to improve the integrity of systematic reviews and meta-analyses (Page et al., 2021). Since its launch in 2009, the PRISMA declaration has been utilized by writers and researchers worldwide to organize, prepare, and publish systematic reviews and meta-analyses. Figure 2.6 below is *From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71* For more information, visit: <http://www.prisma-statement.org/>

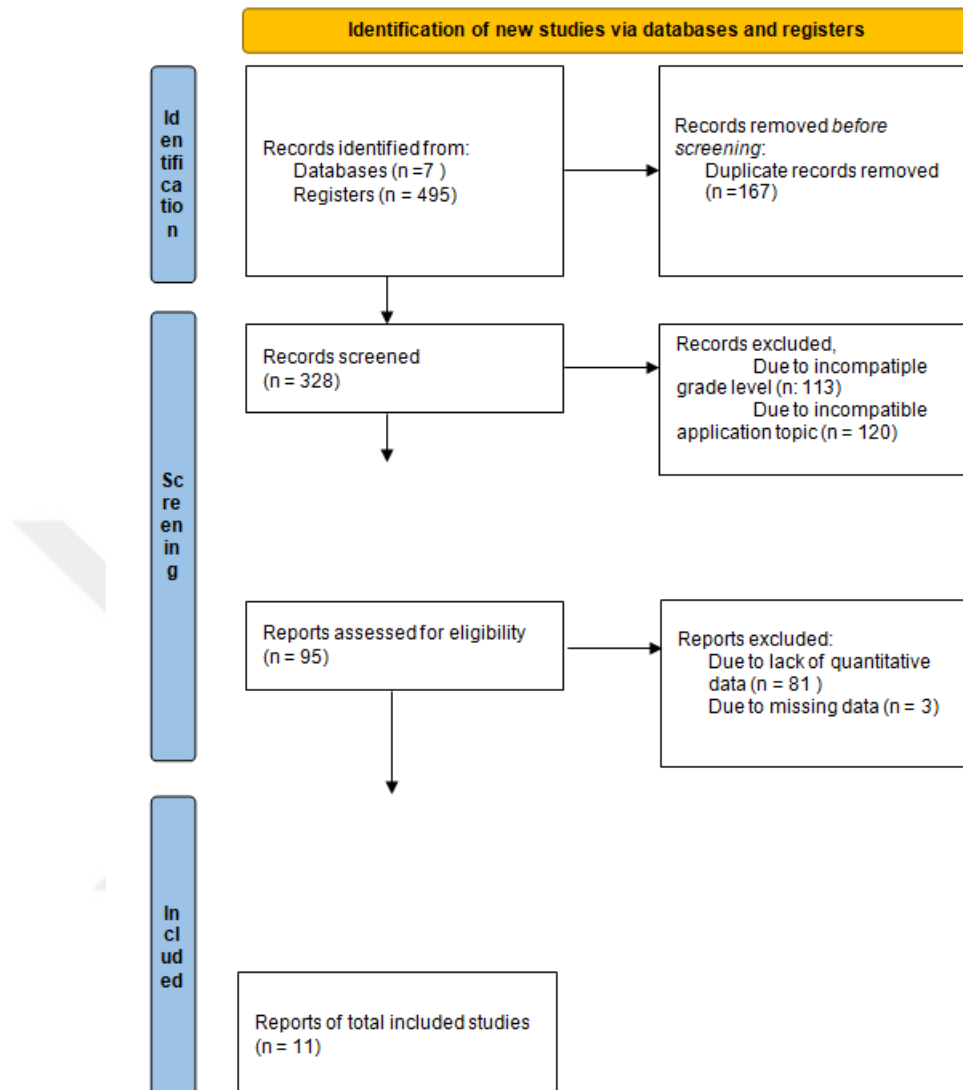


Figure 2.6 Prisma flow diagram

A total of 495 studies were collected from seven distinct databases that were scanned in the manner depicted in the PRISMA Flow Diagram. These 495 papers do not include research published prior to 2011 that were not done in the subject of education.

According to the diagram, identical studies found in different databases were not included in the study and were discarded. Simultaneously, papers derived from the thesis were removed, leaving only the thesis data for the analysis.

When identical studies were eliminated, a total of 495 studies were retrieved from seven separate datasets; 113 of the remaining 328 studies were eliminated because they worked with an age group that was incompatible with the research question, and 120 were eliminated because they investigated an application on a subject that was incompatible with the research question. 81 studies were removed from the remaining 95 because they were qualitative studies in nature, such as action studies, case studies, thematic studies, and case studies. Simultaneously, 3 studies were removed because insufficient data were available to evaluate the effect size. There are 11 that are included in the analysis, in terms of studies conducted in *Turkey*.

The second stage of the literature review aims to reach all the applications of flipped learning between the 4th and 8th grade level science instructions *all around the world*. To reach this goal certain databases are scanned, foreign thesis about the topic are scanned. But the main source of studies are the meta-analysis studies done by various researchers. The researcher tried to reach as many as possible meta-analysis studies. Once reaching the meta-analysis studies, the researcher examined the inclusion and exclusion criteria in each study, and then found the studies that met their own inclusion criteria among the meta-analysis studies.

To get to the relevant papers, the researcher went through the meta-analysis studies on related subjects that were included in the analysis. In some circumstances, an e-mail was sent to the researcher at the time the data was obtained. The researcher was asked for the pretest-posttest arithmetic mean and standard deviation values for both the experimental and control groups. The relevant mailing's screenshot can be found in **Appendix A**.

Citavi software, a reference management application, was also used to systematize and categorize the studies included in the research. The Citavi application's sixth version was employed in this investigation. The software's user interface is shown in the accompanying screenshot presented in appendix

3.3.1 Inclusion Criteria

The most critical stage in performing a meta-analysis is establishing the inclusion and exclusion criteria. Before proceeding to the analytical phase of meta analysis, these criteria are used to identify who may and cannot be included in the research. These criteria help specify which papers should be included in the meta-analysis, resulting in more accurate and reliable conclusions. (Dinçer,2014) The most often utilized criteria for identifying the studies that were retrieved are normally the research type, period, specific keyword, a particular data type, a particular database, and a particular publishing type (Card, 2012). Since meta-analysis deals with experimental process data, experimental studies are preferable (Dinçer, 2014). However, due to the ease of statistical data in correlational studies, these studies can also be included in the meta-analysis. The study's scope was chosen using the inclusion criteria listed in the table below.

Table 3.2 Study selection criteria

Criteria	Inclusion
<i>Publication period</i>	Studies completed between 2012 and 2022
<i>Publication type</i>	Publications that have been published in a peer-reviewed journal on a national or international level, thesis studies master's or doctoral degree. Publications in which search terms appear in the title, abstract, or keywords.
<i>Research design</i>	The studies were conducted with control groups. Control groups should be instructed in a traditional classroom setting, whereas experimental groups should be conducted with the FL applications.
<i>Outcome</i>	Academic achievement or academic success or science achievement
<i>Implementation</i>	FL's impact in the area of science education with the participants grade level range 4th to 8th .
<i>Accessibility</i>	Open access and full text access publications or the author can provide the data needed
<i>Data</i>	The sample size (n), standard deviation (sd), and mean values(x) are all specified for the tested used (pre and post test data or post test only data).

3.3.1 Exclusion Criteria

If a study is eliminated from a meta-analysis, it is because it does not meet the criteria for inclusion. (Card, 2015) As a result, papers that did not meet the inclusion criteria were excluded from the analysis in this study. The following are the exclusion criteria for this meta-analysis study:

1. Studies published outside the date range determined by the researcher,
2. Studies that did not match the age level of the participants with the research question,
3. Studies that did not investigate the FLA in science courses.
4. Studies that did not quantitatively measure academic achievement,
5. Studies that are scanned twice in the databases,
6. Studies that are working with the exactly same participants and the data (derived studies),
7. Studies that are published after last screening date,
8. Studies conducted not in the research areas linked with educational sciences are excluded.

3.3.2 Quality of Included Studies

A study's quality may be determined by a few factors, and the study can be improved by enhancing the following criteria:

1. Maintaining a large sample size
2. Increasing the number of representative samples relevant to the study subject
3. Selection of more appropriate measuring tools to ensure accurate measurements
4. Utilization of random assignment and sampling
5. Checking for bias and trying to reduce bias

6. Keeping the number of the participants as low as those who withdrew from the research and did not respond to the measuring tool questions. (Alp & Şen, 2021)

The researcher scanned until May 15, 2022, as the final screening date, for the second step of the data collection phase. The fact that the literature has a wide variety of applications all across the world has hampered systematic investigation, as not seen by the portion of this study that is limited to Turkey. As a result, the researcher was unable to tell systematically how many studies she obtained from which database and with which searching keywords, unlikely in the first stage. Instead, she attempted to direct her systematic effort through Citavi, a reference and knowledge management tool. It was feasible to conduct a preliminary investigation to see whether the scan data might be included in the analysis in a more factual manner thanks to the aforementioned software. The fact that the literature has a wide variety of applications all across the world has hampered systematic investigation, as not seen by the portion of this study that is limited to Turkey.

3.3.3 Limitations

This research is limited by the studies completed between 2012 and 2022, by the publications that have been published in a peer-reviewed journal on a national or international level, thesis studies master's or doctoral degree. It is also limited by the publications in which search terms appear in the title, abstract, or keywords. This research is limited by the studies were conducted with control groups. Control groups should be instructed in a traditional classroom setting, whereas experimental groups should be conducted with the FL applications on the grade level between 4th to 8th science classrooms.

3.3.4 Coding Method

Quantitative data obtained from scanning the research should be collected systematically and then coded. Although there is no universally accepted method for coding, the critical point is to develop a coding system that encompasses all categorical data in the research and enables the disclosure of information that varies between studies. In order to appropriately understand the results of a meta-analysis, it is necessary to guarantee that the data has been coded correctly from the beginning of the process (Lipsey & Wilson, 2001).

The purpose of this coding method is to design a coding approach that incorporates all relevant data about the studies in order to transform the features of all studies included in the meta-analysis into categorical variables. The researcher conducting the meta-analysis determines the moderator variables and criteria to be utilized in selecting papers for inclusion in the meta-analysis, as well as their coding.

The researcher conducting the meta-analysis determines the moderator variables and criteria to be utilized in selecting studies for inclusion in the meta-analysis, as well as their coding protocol. The researcher's decision to include or exclude studies indicates that the meta-analysis process is not objective. (Kaşaracı, 2013) Along with the criteria used to select the research for inclusion, the study's limits and potential are explicitly noted. Thus, the goal is not objectivity, but a shared subjectivity with the readers that is established within the context of the study's constraints. Furthermore, the researcher who is doing a meta-analysis aims specified subjectivity within the scope of the studies included in the analysis. Each of the criteria and constraints that are clearly disclosed to the reader accomplishes this goal. (Lipsey & Wilson, 2001)

Following the collection of quantitative research on the implementations of the FLA in science lessons, a coding protocol was developed to convert the data from studies that achieved the inclusion requirements into categorical variables, allowing for comparisons between them. In Appendix it is represented the

coding protocol utilized in this study. This format is composed of three components: *Identity of the Study*, *Content of the Study*, *Study Data*.

Identity of the Study part includes information about the research's features, Content of the Study section includes information about the study's moderators, and the Study Data section includes information about the study's statistical characteristics. While the statistical aspects of the study were discussed, the applications included data from both the experimental and control groups. These statistics are utilized to determine the magnitude of each study's influence.

3.3.5 Inter-rater Reliability (IRR)

In meta-analysis research, it is advised to verify the reliability of the coding procedure (Card, 2015). In order to verify internal consistency (reliability) in the classification of the analyzed studies, a second researcher assessed 30% of the documents included in the study and, a consensus was achieved about the codings. When comparing the codings, Miles and Huberman's (2016) metric ($\text{Reliability} = \frac{\text{consensus}}{\text{consensus} + \text{disagreement}} \times 100$) was applied, and the coders' agreement was determined to be 90%. The disagreement between the two researchers centered on the selection of study data for inclusion in the analysis. In several ANCOVA-based investigations, both researchers agreed later that incorporating modified means into the analysis would produce more precise findings.

3.3.6 Dependent Variables

As defined by Büyüköztürk et al. (2012), the dependent variable is considered as the variable on which the influence of the independent variable is examined, and the dependent variables variables of this research are the changes in the academic achievement of the students in relation to FLA in science lessons. In this study, effect sizes of each studies included in the meta analysis are considered as the dependent variables of the study.

3.3.7 Independent Variables and Study Moderators

The variable that a researcher wants to determine its effect on the dependent variable is called the *independent variable* (Büyüköztürk et al., 2012). The independent variables of this research are the gender of the participants (female-male), the type of study publication (thesis-article), the FLA design, and the scale used in the studies (developed, adapted, ready-made scale).

Study moderators (regulatory variable) are the second-level independent variables that are affected by the study results and used to determine the effect size (Büyüköztürk et al., 2012). Here, random effects model is selected according to the significance level of the comparison within the group (fixed effects model if not significant, random effects model if significant), and whether the moderator is significant according to the significance level of the comparison between groups (Borenstein, et al., 2021). Study moderators are registered according to the coding protocol. Study moderators involved in this research;

1. Application Topic
2. Application Duration
3. Grade level of the Participants
4. Sample Size of the studies
5. Application Region

3.4 Analysis of Data

When combining statistical data from several research, it is necessary to convert the data into an effect size, which is a standard measuring unit for meta analysis. Effect size is a standard metric that is used in studies to quantify the intensity and direction of the link between two variables. Therefore, in this study, first of all, the effect size values of each study are calculated.

3.4.1 Effect Size Indices

The index of effect size is the most crucial variable in a meta-analysis, the pivot around which the entire effort revolves (Card, 2015). The numerous statistical outcomes from the relevant research are transformed into a single quantitative metric, the index of effect, which can then be compared, aggregated, and evaluated across the sampled studies. Numerous considerations must be addressed when defining and coding effect size indices effectively (Durlak & Lipsey, 1991).

The term "effect size" refers to the effect coefficient of each research included in the meta-analysis (Dinçer, 2014). The magnitude of the influence is calculated using the mean and standard deviation values (Robson, 2015). As a result, it is crucial to assess the magnitude of the influence based on the given data. The effect size is a statistical value that indicates the degree to which the sample findings deviate from the null hypothesis's predictions. Additionally, it demonstrates our application's effectiveness regardless of the number of the participants.

3.4.2 Calculation of the Effects Size

The effect size is derived by dividing the difference in means between two groups by their standard deviation. The higher the difference in mean between two groups and the lower the standard deviation, the larger the effect size (Ergene, 1999). The effect size is a commonly used metric for determining the magnitude and direction of a correlation in a study. The effect size of a study provides insight into the significance of its findings (Ergene, 1999). The effect

size is obtained by transforming the arithmetic mean, standard deviation, t, F or r values of the studies into a standard measurement value with certain formulas (Rosenthal, 1991).

In this study, the effect size was calculated using quantitative data from all studies included in the meta-analysis. When computing the effect size, each included study's effect size value was determined independently of the others. Effect sizes were considered as the dependent variables of the study.

The interpretation of the effect sizes of the studies analyzed in this meta-analysis study was made according to Cohen (1977).

(Cohen,1977) interpreted the effect size values as follows:

1. If the effect size value is less than 0.15, the effect is not important,
2. If the effect size value is between 0.15 and 0.40, there is a small effect,
3. If the effect size value is between 0.40 and 0.75, there is a moderate effect,
4. If the effect size value is between 0.75 and 1.10, there is a large effect,
5. If the effect size value is between 1.10 and 1.45, there is a very large effect,
6. If the effect size value is greater than 1.45, there is an excellent effect.

When reporting the effect sizes of particular studies, several metrics such as Cohen's d value, Hedges' g, or Pearson's r are utilized. In this study Cohen's d value is utilized as it is defined as the value of the difference between standardized means. Cohen's d is calculated by dividing the difference between the raw means by the standard deviation.

The standard deviation employed in the formula is calculated differently depending on whether the groups are homogenous or not. When the groups are

homogenous (ie, when the samples for the experimental and control groups are drawn from the same population), the standard deviations of both groups can be considered the same value of standard deviation (See: 2). When samples are obtained from distinct universes, the standard deviation is determined as the square root of the mean of the squares of the standard deviations of the universes from which the experimental and control groups are derived (Cohen, 1988).

The conversion formula used for the effect size:

$$d_{cohen} = \frac{X_e - X_c}{\sigma_p} \quad (3.1)$$

$$\sigma_p = \sigma_e = \sigma_c \quad (3.2)$$

$$\sigma_p = \sqrt{\frac{\sigma_e^2 + \sigma_c^2}{2}} \quad (3.3)$$

The conversion formula used for the pooled standard variance:

$$\sigma_p^2 = (n_e - 1) \sigma_e^2 + (n_c - 1) \sigma_c^2 \quad (3.4)$$

The conversion formula used for the pooled standard deviation:

$$\sigma_p = \sqrt{\frac{(n_e - 1) \sigma_e^2 + (n_c - 1) \sigma_c^2}{(n_e + n_c)}} \quad (3.5)$$

The conversion formula used in the effect size calculations from the t-test:

$$d = \frac{2t}{\sqrt{df}} \quad (3.6)$$

$$df = n_e + n_c - 2 \quad (3.7)$$

The conversion formula used in the effect size calculations from the F test:

$$d = \frac{2\sqrt{F}}{\sqrt{df(error)}} \quad (3.8)$$

$$df = df(error) \quad (3.9)$$

In this study, effect sizes, variances, upper and lower limits of each study were calculated using Comprehensive Meta-Analysis (CMA) Ver.3.

d_{cohen} : Cohen's d value

X_e : Mean value of experimental group

X_c : Mean value of control group

σ_p : Pooled standard deviation

σ_p : Pooled standard deviation

σ_e : Standard deviation value of experimental group

σ_c : Standard deviation value of experimental group

n_e : number of experimental group

n_c : number of control group

σ_p^2 : pooled standard variance

σ_e^2 : experimental group variance

σ_c^2 : control group variance

4 FINDINGS

In this section, the descriptive statistics of the studies included in the research and the findings obtained as a result of testing the hypotheses of the research are given.

The databases EBSCO, ERIC, Proquest, YÖKTEZ, and Ulakbim, JSTOR were scanned, along with the studies published after 2011. Keyword-based Google searches and Google Scholar searches were also conducted. The duration of this screening research was extended through April 15, 2022 for the first stage of data analysis. Until the stated date, the researcher periodically ran keyword searches in order to track academic publications and stay abreast of the latest developments. 495 experimental studies have been reached for the effect of the FLA on the academic success of the students in science implementations between the years 2012 - 2022 in Turkey. The effect sizes of 11 studies that comply with the meta-analysis inclusion criteria specified in this thesis and contain necessary and sufficient information for effect size calculation were analyzed.

For the second stage of data analysis, the researcher examined meta-analysis studies on the applications of the flipped education model from abroad. Each study included in these studies was reviewed individually to ensure that it met the eligibility criteria. A meta-analysis was performed on the studies that met the eligibility criteria. The duration of this screening research was extended through May 15, 2022 for the second stage of data analysis. Any academic paper published after this date is out of the scope of this thesis. To calculate the effect size of the FLA on the academic success of the students in science implementations between the years 2012 - 2022 abroad. The effect sizes of 11 studies that comply with the meta-analysis inclusion criteria specified in this thesis and contain necessary and sufficient information for effect size calculation were analyzed.

In this chapter, the effect size values generated by integrating the descriptive statistics of the studies included in the study and the data related to the sub-problems of the research using the meta-analysis approach are presented. Additionally, the effect sizes of the data pertaining to the study topic and each sub-problem are displayed via a forest plot calculation. By assessing the effect sizes, the Heterogeneity Test was used to estimate the degree of heterogeneity. The Funnel Plot is used to understand and make a general understanding for publication bias, then the researcher wanted to do a further investigation on publication with the use of Begg and Mazumdar Rank Correlation Test.

4.1 Descriptive Statistics of the Studies Included in the Research

The accompanying table contains information such as the original titles of the 22 studies included in the meta-analysis, the names of the researchers, and the disciplines of the applicable courses

Table 4.1 Descriptive statistics of the studies included in the research

Study ID	Study Name	Location of Study	Publication Type	Number of Participants	Application Grade Level	Practitioner Type	Practitioner's Study Field	Discipline	Application Duration
1	Aksoy, 2020	Kastamonu	MT	43	7	T	S	P	4 weeks
2	Camiling , 2017	Philippines	A	24	6	A	IT	NM	6 weeks
3	Çakır, 2017	Amasya	MT	53	7	T	S	P	5 weeks
4	Çetinkaya, 2017	TR	A	45	7	A	IT	P	7 weeks
5	Duffy, 2016	USA	Ph.D T	91	8	T	S	E	12 weeks (semester)
6	Elian &Hamaidi , 2016	Jordan	A	44	4	A	S	B	3 weeks
7	Güven Demir, 2018	Samsun	Ph.D T	60	4	T	S	As	4 weeks
8	Ha et al., 2016	Korea	A	53	6	NM	NM	E	NM
9	Kaya,2021	Antalya	MT	54	6	T	S	B	7 weeks
10	Kithinji, 2016	Kenya	A	103	4	T	IT	C	8 weeks

Table 4.1 cont'd.

11	Lee et al., 2016	Korea	A	90	7	T	S	E	5 weeks
12	Maddox, 2018	USA	Ph.D T	225	8	A	S	E	12 weeks (semester)
13	Mohanty& Parida, 2016	India	A	90	8	NM	NM	E	4 weeks
14	Olakanmi, 2016	Nigeria	A	66	8(13-14 age)	T	S	C	3 weeks(2 h per week)
15	Samavi et al., 2020	Iran	A	40	6	A	S	E	5 weeks(1 h per week)
16	Say&Yıldırım, 2020	Konya	A	63	8	T	S	C	2 weeks
17	Sezer,2016	TR	A	70	6	A	IT	B	2 weeks
18	Solak,2021	Istanbul	MT	38	8	T	S	P	5 lesson hours
19	Söndür,2020	Kayseri	Ph.D T	64	7	T	S	P	8 weeks
20	Yağmur,2019	Ankara	MT	64	7	T	S	P	4 weeks
21	Yanardağ,2021	Diyarbakır	MT	32	8	T	S	E	6 weeks
22	Yousefzadeh& Salimi, 2015	Iran	A	50	7	T	S	NM	8 weeks

T:1462

Note. (MT: Master's Thesis, Ph.D T: Ph.D Thesis, A: Article, P: Physics, C: Chemistry, B: Biology, E: Earth Science, As: Astronomy Ac: Academic, T: Teacher, S: Science, IT: Information Technologies, NM: Not mentioned)

The overall sample size of the 22 studies included in the research is 1462 participants, as shown in the table above. The independent factors of meta-analysis studies were studied in these studies are given. Here is a list of the categorical independent variables used in this study, as well as their descriptive statistics as follows.

Table 4.2 Detailed descriptive statistics of studies included in the analysis

	<i>Frequency</i>	<i>Percentage (%)</i>
<i>Type of Publication</i>		
Article	12	54,54
Master's Thesis	6	27,27
Ph.D Thesis	4	18,18
<i>Total</i>	<i>22</i>	<i>100</i>
<i>Language of the Publication</i>		
Turkish	8	36,36
English	13	59,09
Korean	1	4,54
<i>Total</i>	<i>22</i>	<i>100</i>

Table 4.2 cont'd.

<i>Study Year</i>		
2013-2014 Academic Year	1	4,54
2014-2015 Academic Year	3	13,63
2015-2016 Academic Year	4	18,18
2016-2017 Academic Year	3	13,63
2017-2018 Academic Year	4	18,18
2018-2019 Academic Year	1	4,54
2019-2020 Academic Year	2	9,09
2020-2021 Academic Year	3	13,63
2021-2022 Academic Year	1	4,54
<i>Total</i>	<i>22</i>	<i>100</i>
<i>Application Region</i>		
India	1	4,54
Iran	2	9,09
Jordan	1	4,54
Kenya	1	4,54
Korea	2	9,09
Nigeria	1	4,54
Philippines	1	4,54
Turkey	11	50,0
The US	2	9,09
<i>Total</i>	<i>22</i>	<i>100</i>

Table 4.2 cont'd.

<i>Has a pilot study been conducted in the research?</i>		
Yes	8	36,36
No	2	9,09
Not spesified	12	54,54
Total	22	100
<i>Research Method</i>		
Qualitative Method		
Quantititavice Method	1	4,54
Mixed Method	21	95,45
Total	22	100
<i>Research Design</i>		
<i>Experimental Study</i>		
<i>Quasi-experimental</i>	22	100
<i>Correlational Study</i>		
<i>Descriptive Study</i>		
Total	22	100

Table 4.2 cont'd.

<i>Practitioner Type</i>		
Academic	6	31,81
Teacher	14	63,63
Teacher Candidate	0	
Not mentioned	2	9,09
<i>Total</i>	<i>22</i>	<i>100</i>
<i>Practitioner's Study Field</i>		
Science	16	72,72
IT	4	18,18
Not mentioned	2	9,09
<i>Total</i>	<i>22</i>	<i>100</i>
<i>Applied Scale Type</i>		
Developed Scale	13	59,09
Adapted Scale		
Ready Scale	5	22,72
Not Specified	4	18,18
<i>Total</i>	<i>22</i>	<i>100</i>

Table 4.2 cont'd.

<i>Reliability Value of the Used Scale in Studies</i>		
0.60 < r < 0.70	2	9,09
0.70 < r ≤ 0.80	3	13,63
r > 0.80	9	40,90
Not Specified	8	36,36
Total	22	100

Since knowing the studies included in the analysis better will enable to better interpret the results of these analysis, information about the studies included in the analysis is given above. The type of publication most frequently included in this meta-analysis study is the article with a rate of 54,54%, followed by the master's thesis with a rate of 27,27% , and the doctoral thesis with a rate of 18,18%.

13 of the 22 studies included in the study were written in English, giving them a rate of 59,09% among all studies. The proportion of 8 studies written in Turkish is 36,36% of all studies. There is 1 study in this study written in Korean. Despite the fact that the researcher does not speak Korean, the document written in Korean was translated into English using Google Translator's document language translation engine, and the necessary information was obtained in this manner.

When the researcher examined the academic years in which flipped education was implemented in science classrooms, the 2015-2016 and 2015-2016 academic years had the highest number of implementations. These academic years, which have a rate of 18.18 % and have received 4 applications per each ,

are followed by 3 studies for the academic years 2014-2015, 2016-2017, and 2020-2021. Each of these years had a participation rate of 13.63 % among other studies included in the meta-analysis. 2 applications for the 2019-2020 academic year applications have been reached. (9.09 %). There is only 1 study in each of the academic years 2013-2014, 2018-2019, and 2021-2022. (4.54 % each) None of the featured studies were implemented during the 2012-2013 academic year.

When the studies included in the meta-analysis are categorized according to their application regions, it is seen that 11 of these studies, (50.0 %) were conducted in Turkey, while the remaining eleven 11 were conducted outside of Turkey. There are 2 research from Iran, Korea, and the United States among the studies that match the inclusion requirements, according to the literature scans. Each of them had a participation rate of 9.09 %. With 1 study, these states are followed by India, Jordan, Kenya, Nigeria, and the Philippines. (4.54 % per each). If we examine the studies conducted in Turkey on a city-by-city basis, we find that 2 of the 11 studies did not provide information about the location of application, while the remaining 9 studies were conducted in Amasya, Ankara, Antalya, Diyarbakır, Istanbul, Karaman, Kastamonu, and Kayseri. One of these cities, Istanbul, yielded 2 studies. 1 study per province mentioned above was included in this meta-analysis study.

Considering the number of participants in the studies included in the analysis, it is seen that this number is generally between 40 and 80. 12 studies are in this sample size range. (54,54%) 5 studies with a sample of less than 40 people and 5 studies with a sample of more than 80 people were also included in this analysis.

Considering the grade levels in which the practices applied in the included studies were conducted, it can be stated that the majority of practices were conducted with 8th-grade students at a rate of 40,90%, while the lowest rate of practice was conducted with 5th-grade students at a rate of 4,54%.

If the studies included in the analysis are categorized according to the application courses, it is seen that the most applied course field is Earth Science

(31,81%) with 7 studies. Astronomy, on the other hand, has been one of the practice courses in 1 study and has the least rate. (4,54%)

When the included studies were grouped according to the duration of the intervention, the research revealed that this period was between 2 and 4 weeks at most. It was included in 8 research and accounts for 36,36% of the study. There are 6 studies in the category of 5-6 weeks according to the intervention duration (27,27%) There are 4 studies in the category of 7-8 weeks according to the intervention duration. (18,18%) There are 2 studies in the category of more than 8 weeks according to the intervention duration. (9,09%) Finally, 2 study's intervention duration is not specified. (9,09)

4.2 Findings Regarding the Effect Size of the Studies Included in the Analysis

The lower and upper limits of the effect size analysis of the studies according to the combined mean effect size (general effect size) , standard error and 95% confidence interval according to the fixed effects model and random effects model are given in Table

Table 4. 3 Effect sizes of studies included in the analysis

Model			Hedges's g			95% Confidence Interval (CI)	
	Study ID	Identity Of the Study	Effect Size	Standart Error	Variance	Lower Limit	Upper Limit
	1	Aksoy, 2020	1,048	0,320	0,102	0,421	1,676
	2	Camiling , 2017	1,119	0,426	0,181	0,284	1,954
	3	Çakır, 2017	0,896	0,284	0,081	0,338	1,453
	4	Çetinkaya, 2017	0,609	0,235	0,055	0,147	1,070
	5	Duffy, 2016	0,386	0,212	0,045	-0,030	0,801
	6	Elian &Hamaidi, 2016	1,514	0,337	0,114	0,853	2,175
	7	Güven Demir, 2018	0,114	0,310	0,096	-0,494	0,722
	8	Ha et al., 2016	0,297	0,272	0,074	-0,236	0,831
	9	Kaya,2021	1,460	0,331	0,110	0,811	2,108
	10	Kithinji, 2016	0,597	0,200	0,040	0,205	0,989
	11	Lee et al., 2016	0,583	0,213	0,046	0,164	1,001
	12	Maddox, 2018	0,780	0,152	0,023	0,483	1,078
	12	Mohanty& Parida, 2016	0,393	0,211	0,045	-0,021	0,807

Table 4.3 cont'd.1

s	14	Olakanmi, 2016	1,702	0,285	0,081	1,144	2,261
	15	Samavi et al., 2020	0,739	0,321	0,103	0,111	1,368
	16	Say&Yıldırım, 2020	0,670	0,256	0,066	0,168	1,172
	17	Sezer,2016	0,715	0,244	0,060	0,237	1,193
	18	Solak,2021	0,506	0,327	0,107	-0,134	1,147
	19	Söndür,2020	0,413	0,303	0,092	-0,182	1,008
	20	Yağmur,2019	0,337	0,270	0,073	-0,193	0,866
	21	Yanardağ,2021	0,503	0,356	0,127	-0,194	1,200
	22	Yousefzadeh& Salimi, 2015	1,458	0,314	0,099	0,842	2,074
Fixed			0,707	0,055	0,003	0,599	0,815
Random			0,735	0,085	0,007	0,569	0,901

$$Q = 46,359 \quad Z_{\text{total}} = 8,679 \quad \text{Variance} = 0,007$$

As seen in the table, the general effect size of flipped learning on students' academic achievement in science lessons was found to be 0,707 according to Fixed Effects Model and 0.735 according to Random Effects Model and these values are statistically significant and they indicates moderate level effect ($p = 0.000$).As (Cohen,1977) interpreted the effect size values as follows:

1. If the effect size value is less than 0.15, the effect is not important,
2. If the effect size value is between 0.15 and 0.40, there is a small effect,
3. If the effect size value is between 0.40 and 0.75, there is a moderate effect,
4. If the effect size value is between 0.75 and 1.10, there is a large effect,
5. If the effect size value is between 1.10 and 1.45, there is a very large effect,
6. If the effect size value is greater than 1.45, there is an excellent effect.

Another interpretation of the effect size value found can be made as follows, FLM increased students' academic achievement in science lessons by 0.735 standard deviations more. The fact that the academic achievement of the students increased in this way is an indication that the FLM is moderately effective on the academic achievement of the students.

When the effect sizes were examined individually, it was found that 1 study had insignificant effect size, 4 studies were small, 9 studies were medium, 3 studies were large, 1 study was very large, and 4 studies had excellent effect sizes. The distribution chart of the effect sizes is given in figure 4.1.

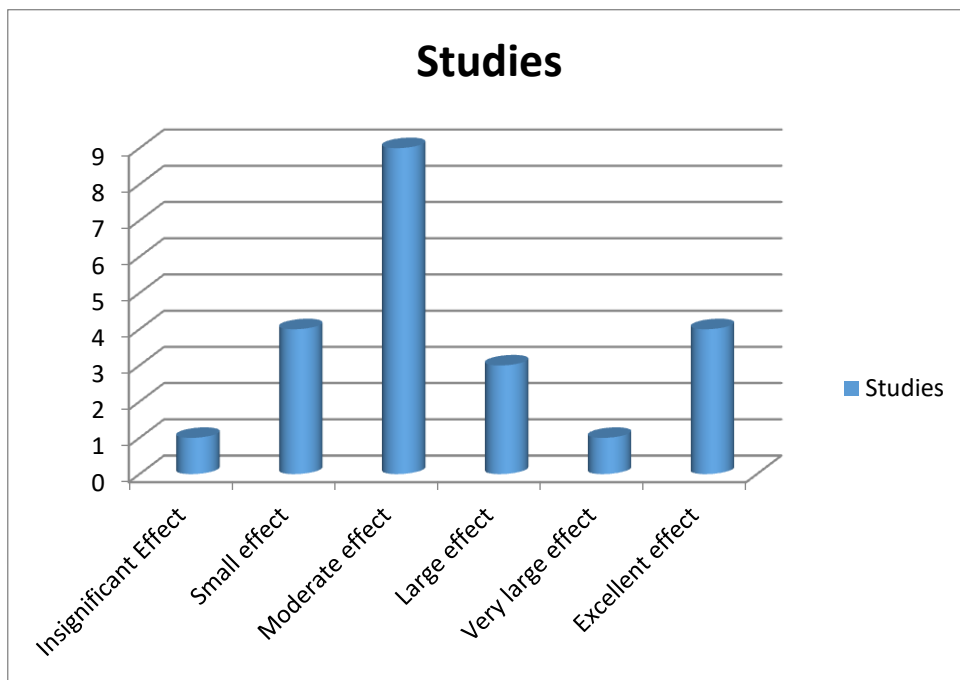


Figure 4.1 Distribution of effect sizes of included studies in the analysis

4.3 Findings Regarding The Hypothesis About Effectiveness of FLM of the Studies

The first null hypothesis of this study is stated as follows:

H_{01} . *"There is no significant change in academic achievement in science lessons in classrooms where the FLM is applied when compared to the traditional classroom layout"*

In order to test this hypothesis, the researcher handled the studies that were carried out in science lessons within the eligibility criteria in the literature review, in the experimental group the FLM and in the control group, the studies that preserved the traditional classroom order. The findings obtained as the result of this examination are given in Table. The hypothesis is denied according to the analysis result. FLM has influence on the academic achievement in science lessons indeed, it has a degree of moderate effect. (0,735)

The forest plot shows the effect sizes in detailed as it is calculated in the fixed effects and random effects model of the studies included in the meta-analysis is given in Figure 4.2.

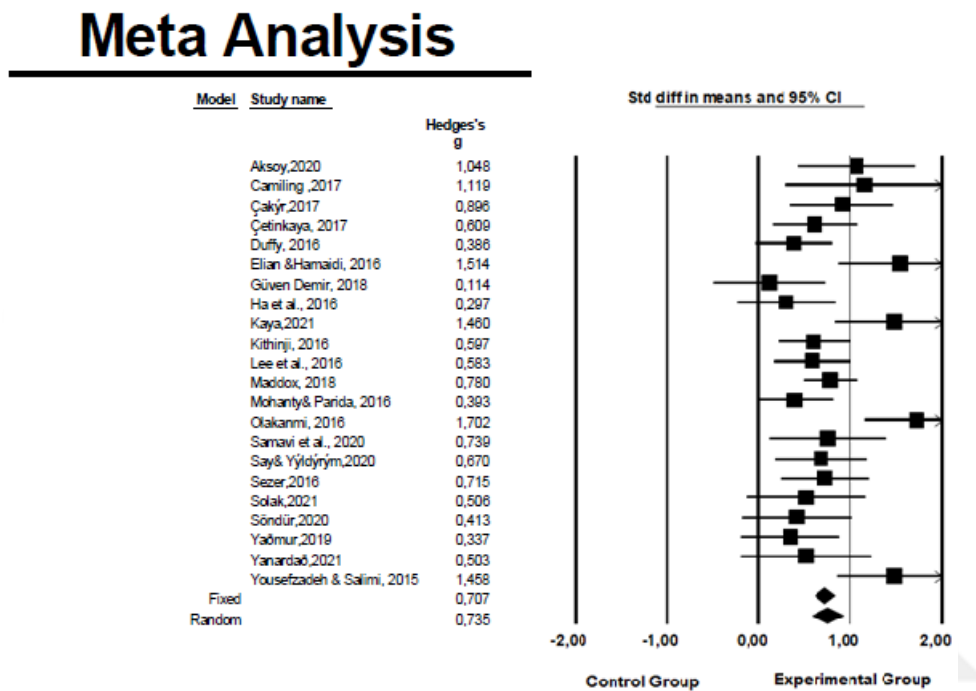


Figure 4.2 Forest plot in the fixed effects and random effects model of studies included in the meta-analysis

The figure 4.2 shows the confidence interval (CI) and effect sizes of each of the studies included in the meta-analysis. Each horizontal line and square in this graph represents a work together. Square shapes represent the individual effect sizes of the studies, and the horizontal lines passing through each square show the confidence interval of the study. The longer the horizontal line means the wider the confidence interval. Arrows in the chart indicate confidence intervals that do not fit in the chart. The diamond shape in the last line of the graph shows the effect size of the selected model (Popay, et al., 2006). In the graph, the effect sizes of both models are indicated.

The line showing the value of 0.00 on the chart is called the 'no effect' line or the ineffectiveness line. (Ried, 2006). For the 22 studies that did not cross this line,

the difference between the experimental and control groups was statistically significant. Looking at this graph, it is seen that the overall effect size is in favor of the experimental groups in the fixed effects and random-effects model. In order to see this effect more clearly, the scale was adjusted between -2 and +2 in the meta-analysis program. This scale made the effect size appear more clearly.

In a very short period of time, meta-analysis applications were usually carried out according to a single data type, the biggest reason for this was that there were modules for combining different types of effect sizes in previous software, and since it is quite difficult to combine based on formulas, but this limitation has been removed in current software. (Dinçer, 2014) Meta-analysis was done by combining more than one data type. 4 of the 22 studies included in the analysis only had post-test data. Therefore, a different data type was selected for these 4 studies when analyzing, the remaining 18 studies had both pretest and posttest data. Therefore, a different data type was selected for these 18 studies. For this purpose, Column for was selected from the insert menu in the CMA V3 program (Comprehensive Meta-Analysis Program 3. Version) and it was chosen to work with different types of data while selecting Effect Size Data. Then more than one data type is selected from the Identify Column for Effect Size, in the Data section. The selected data types are Independent Groups (means, SD's) and Means, SD in each group respectively under Continuous (means) section for this study.

4.4 Heterogeneity Findings

Although effect sizes in individual studies are independent of heterogeneity testing, they are influenced by individual study findings incorporated in heterogeneity testing. The information gained as a consequence of the heterogeneity test plays an important role in the analysis since it is employed in the calculation of the overall effect size and therefore in the model selection (Dinçer, 2014).

While the p value is commonly utilized in statistical results, the Q value is commonly employed in meta-analyses. The Q value is calculated using The Cochran Q significance test is generally more accurate than the p value (Dinçer, 2014). The comparable value in the chi-square (χ^2) table is determined by computing the Q value. The Fixed Effects Model has selected if the Q value is less than the value in the table ($Q < \chi^2$), and the Random Effects Model is preferred if the Q value is larger than the value in the table ($Q > \chi^2$) (Dinçer,2014).

Model	Effect size and 95% confidence interval						Test of null (2-Tail)		Heterogeneity		
	Number Studies	Point estimate	Standard error	Variance	Lower limit	Upper limit	Z-value	P-value	Q-value	df (Q)	P-value
Fixed	22	0,707	0,055	0,003	0,599	0,815	12,811	0,000	46,359	21	0,001
Random effects	22	0,735	0,085	0,007	0,569	0,901	8,679	0,000			

Figure 4.3 Heterogeneity findings

According to the Figure 4.2 Cochran Q significance test, the result of the p-value was calculated as 0.001, and since the p-value is less than 0.05, it can be stated that the studies are heterogeneous. In other words, the heterogeneity test performed was significant. The Q value was determined as 46,359 with 21 degrees of freedom. In the chi-square (χ^2) table, the critical value at 21 degrees of freedom and .05 p- value is 32,671 at the 95 percent level of significance. (Kmietowicz & Yannoulis, 1988). As mentioned before in the model selection section of meta-analysis, diverse research with significant values prefers the random-effects model. (Dinçer, 2014) Furthermore, the Z-value was found to be 8,679 (p=.001). This finding influenced the researcher's choice of the random-effects model, which was employed in the analysis. This conclusion establishes the statistical significance of the impact size value. the Random Effects Model is selected according to the heterogeneity test results.

4.5 Publication Bias Findings

It is advised to investigate whether there is publication bias in the studies included in the meta-analysis at the beginning of the procedure. As mentioned in detail before, meta-analysis studies are subject to criticism when publication bias is not taken into account. Publication bias means, statistically significant studies are more likely to be published than non-statistically significant ones (Rothstein et al., 2006). The first step in avoiding publication bias is to establish objective inclusion criteria. Regardless of whether objective criteria for inclusion are used, it is critical for the study's reliability to assess if the studies included in the analysis generate publication bias. There are several methods for testing publication bias. The funnel plot is the most widely utilized approach in publishing bias analysis. Kendall's statistics and Begg and Mazumdar Rank Correlation provide a more extensive perspective as well.

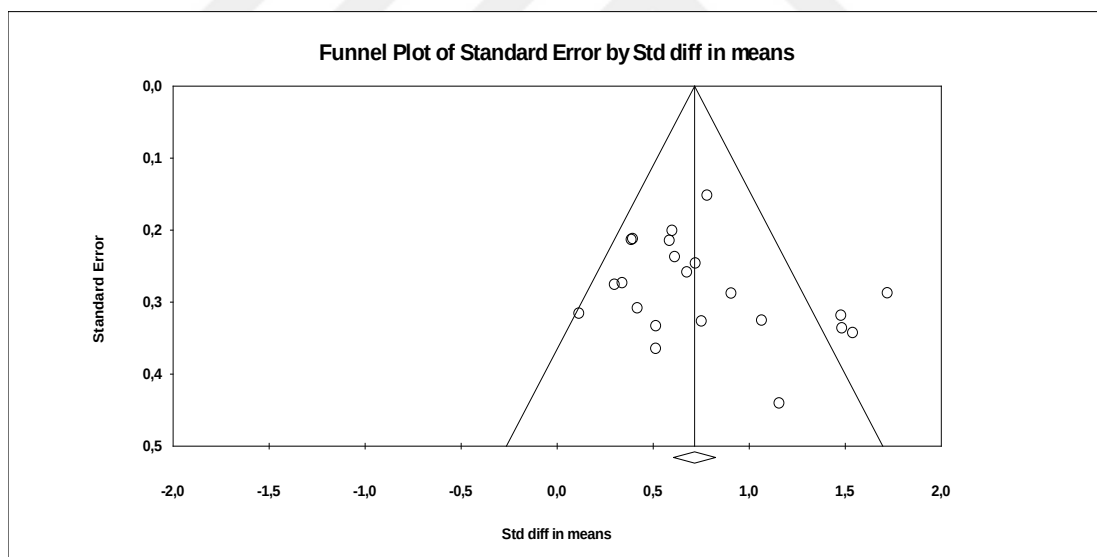


Figure 4.4 The funnel plot of the studies included in the analysis

The 'funnel plot,' which is commonly used in meta-analysis to demonstrate publication bias, is a form of a graph that has the sample size or another metric on the y-axis and the estimated effect size for the research group on the x-axis. The graph is more prevalent in these studies than in bigger ones, possibly due to more heterogeneity between effects in small research. Individual studies are

shown in circles on this graph, while the overall effect is in diamonds. The overall effect size is demonstrated with the diamond shape. The funnel plot shows that the computed effect sizes are asymmetrical and are centered on the overall effect size. This occurrence suggests that there may be publishing bias. The collection of the studies in the center of the funnel, however, is attributable to the relatively medium sample sizes of the analyzed studies. Also the standard error values are respectively medium in the scale. 4 of the studies out of 22 are outside of the funnel.

For studies included in a study to have publication bias, these studies should be collected at the bottom of the graph and only on one side of the combined effect size line (Rothstein et al., 2006). In the analysis made according to this statement, although the findings of publication bias are not in a very serious and distressing situation, other statistics have been continued in order to provide a more detailed and comprehensive understanding.

Another statistic that gives detailed information about publication bias is the Begg and Mazumdar Rank Correlation statistic. In this statistic, the Tau coefficient is expected to be close to 1.00. In this case, it is expected that the two-tailed p-value will not make a significant difference, that is, the p-value will be greater than 0.05

Begg and Mazumdar rank correlation

Kendall's S statistic (P-Q) 63,00000

Kendall's tau without continuity correction

Tau	0,27273
z-value for tau	1,77647
P-value (1-tailed)	0,03783
P-value (2-tailed)	0,07566

Kendall's tau with continuity correction

Tau	0,26840
z-value for tau	1,74827
P-value (1-tailed)	0,04021
P-value (2-tailed)	0,08042

Figure 4.5 Begg Mazumdar rank correlation findings

As seen in the figure 4.5, it is seen that the Tau coefficient is 0.27 and the 2-tailed p value is 0.07. From this result, it is understood that the study does not have publications.

4.6 Findings Regarding The Hypothesis About Discipline of the Studies

The second null hypothesis of the study is stated as follows:

H₀2. "There is no significant difference between the effect sizes of the publications in the literature on the effects of the courses in which the flipped education model is applied in science education on the academic achievement of students in science, according to the disciplines."

In order to test this hypothesis, the subgroup called discipline is analyzed in the meta-analysis program. The disciplines are categorized as "Physics, Chemistry,

Biology, Earth Science and Astronomy". The findings obtained as the result of this examination are given in Table. 4.4

Table 4.4 Findings regarding the hypothesis about disciplines of the studies

Moderator Variable	95% CI							Heterogeneity		
Discipline	N	ES	SE	Lower Limit	Upper Limit	Z	P	Q	df	p
<i>Astronomy</i>	1	0,114	0,310	-0,494	0,722	0,368	0,713	0,000	0	1,000
<i>Biology</i>	3	1,189	0,170	0,781	1,446	6,561	0,000	5,176	2	0,075
<i>Chemistry</i>	3	0,969	0,138	0,607	1,147	6,358	0,000	10,993	2	0,004
<i>Earth Science</i>	7	0,589	0,084	0,396	0,726	6,665	0,000	4,678	6	0,586
<i>Physics</i>	6	0,623	0,116	0,395	0,850	5,365	0,000	4,422	5	0,490
Total (REM)	20	0,634				12,813	0,000	46,374	21	0,001
			Heterogeneity Within Groups (Q_{wr})					25,679	16	0,059
			Total Heterogeneity Between Groups (Q_b)					20,695	5	0,001

According to the table, the average effect sizes of the disciplines; 0.114 for astronomy, 1.189 for biology, 0.969 for chemistry, 0.589 for earth science, and for physics 0.623 effect sizes calculated. According to this table, a significant difference was found between the mean effect sizes for the application topic moderator. [$(p_b=0,001)<0,05$]. According to this table, significant difference was found between the mean effect sizes for the application topic moderator. Therefore, the second hypothesis is rejected. Therefore, the discipline variable

was determined as a variable that could be the cause of heterogeneity between effect sizes.

The forest plot according to the random effects model of the disciplines moderator is given in the figure 4.6 below.

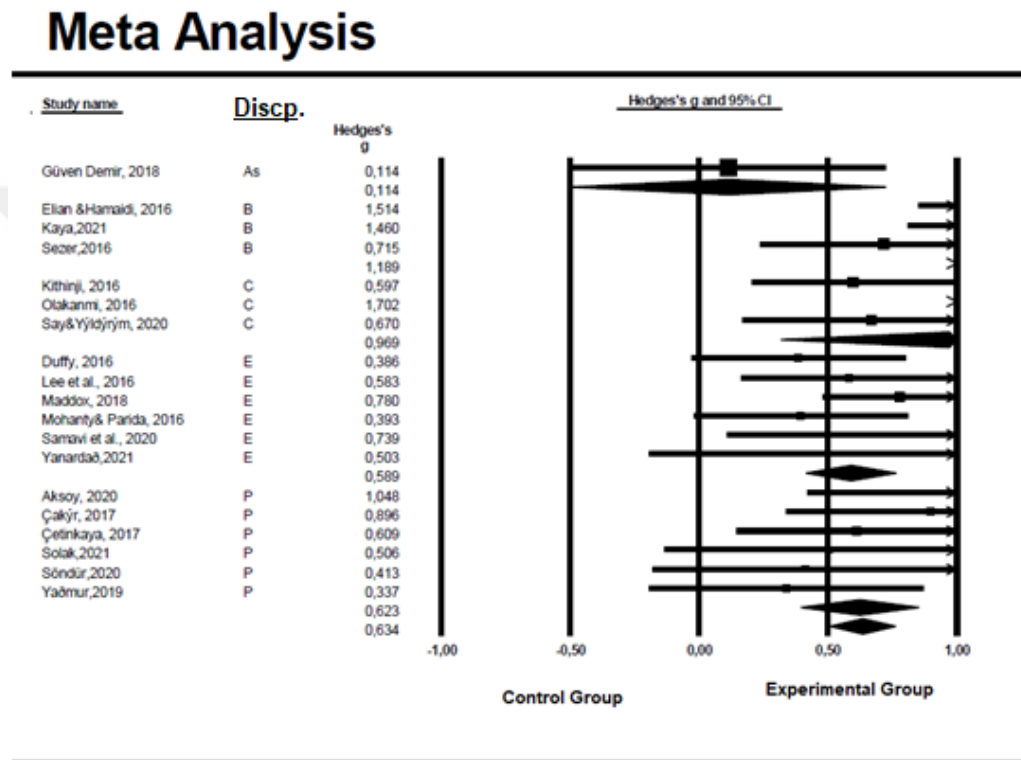


Figure 4.6 Forest plot of regarding the hypothesis about discipline of the studies

When the figure 4.6 is examined, it is seen that the effect size values according to the application topic are in favor of the experimental group and differ from each other. According to this graph, the total effect size of the discipline moderator was found to be 0,634. This value has a moderate effect according to Cohen's (1988) criteria.

4.7 Findings Regarding The Hypothesis About Duration of the Applications of the Studies

The third null hypothesis of the study is stated as follows:

H₀3. There is no significant difference between the effect sizes of the publications in the literature on the effects of the courses in which the flipped education model is applied in science education on the academic achievement of students in science, according to the application duration of the applications.

In order to test this hypothesis, the subgroup called application duration is analyzed in the meta-analysis program. The application durations are categorized as " 2-4 weeks, 5-6 weeks, 7-8 weeks, more than 8 weeks, and the application duration is not mentioned (NM)". The findings obtained as the result of this examination are given in Table 4.5.

Table 4.5 Findings regarding the hypothesis about duration of the applications of the studies

Moderator Variable	95% CI							Heterogeneity		
Application Duration	N	ES	SE	Lower Limit	Upper Limit	Z	P	Q	df	p
<i>2-4 weeks</i>	8	0,794	0,096	0,556	0,930	7,777	0,000	26,689	7	0,000
<i>5-6 weeks</i>	6	0,688	0,122	0,448	0,927	5,624	0,000	2,408	5	0,790
<i>7-8 weeks</i>	4	0,730	0,117	0,570	1,028	6,842	0,000	6,582	3	0,086
<i>X>8 weeks</i>	2	0,611	0,124	0,404	0,888	5,231	0,000	2,281	1	0,131
Total (REM)	20	0,705				12,813	0,000	46,374	21	0,001
			Heterogeneity Within Groups (Q_{wl})					45,771	17	0,000
			Total Heterogeneity Between Groups (Q_b)					0,604	4	0,963

According to the table, the average effect sizes of the application duration; 0,794 for 2-4 weeks, 0,688 for 5-6 weeks, 0,730 for 7-8 weeks and 0,936 for the topics that re not specified and, 0,611 for the duration of more than 8 weeks effect sizes calculated. According to this table, a significant difference was not found between the mean effect sizes for the application duration moderator. [($p_b=0,963$)>0,05]. According to this table, significant difference was found between the mean effect sizes for application duration moderator. Therefore, the third hypothesis is not rejected. Therefore, the application duration variable was not determined as a variable that could be the cause of heterogeneity between effect sizes.

The forest plot according to the random effects model of the subject area moderator is given in the figure 4.7 below

Meta Analysis

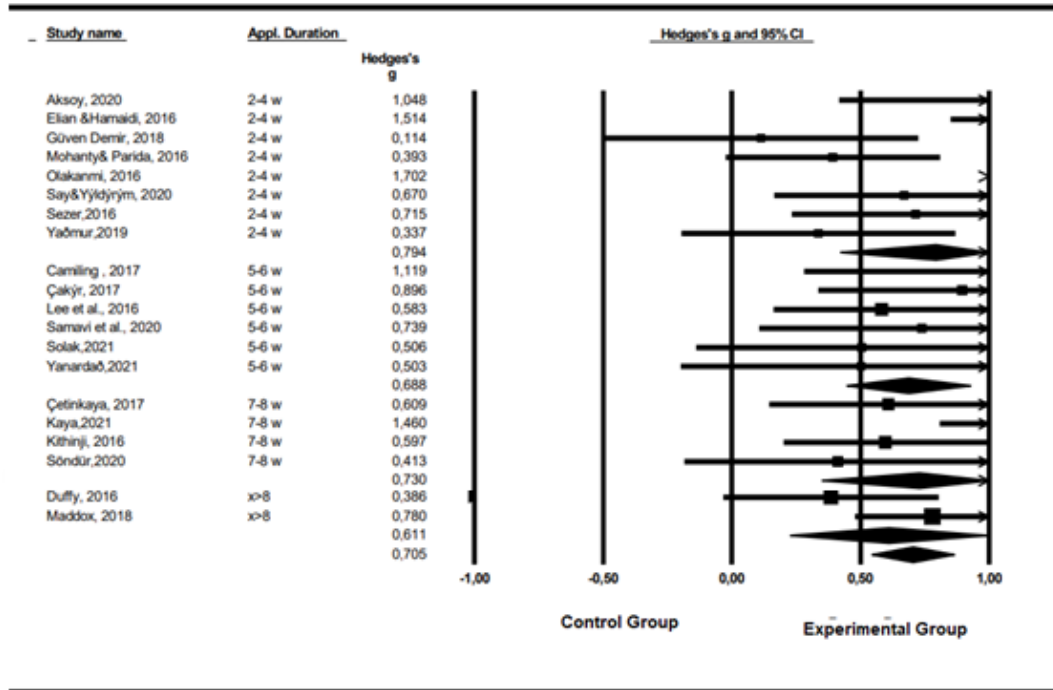


Figure 4.7 Forest plot regarding the hypothesis about duration of the applications of the studies

When the figure 4.7 is examined, it is seen that the effect size values according to the application topic are in favor of the experimental group and differ from each other. According to this graph, the total effect size of the application duration moderator was found to be 0,705 This value has a moderate effect according to Cohen's (1988) criteria.

4.8 Findings Regarding The Hypothesis About Grade Level of The Participations of the Studies

The fourth null hypothesis of the study is stated as follows:

H₀₄. "There is no significant difference between the effect sizes of the publications in the literature on the effects of the courses in which the flipped education model is applied in science education on the academic achievement of students in science, according to the grade levels of the students."

In order to test this hypothesis, the subgroup called grade level is analyzed in the meta-analysis program. The grade levels of the participants are categorized as "4, 5, 6, 7, and 8. Then it is found out that there is no 5th grade level applied in the studies, so this category is eliminated. The findings obtained as the result of this examination are given in Table.4.6



Table 4.6 Findings regarding the hypothesis about grade level of the participations of the studies

Moderator Variable	95% CI							Heterogeneity		
Grade Level	N	ES	SE	Lower Limit	Upper Limit	Z	P	Q	df	p
4	3	0,666	0,150	0,371	0,961	4,428	0,000	9,622	2	0,008
6	5	0,781	0,135	0,516	1,046	5,774	0,000	8,094	4	0,088
7	7	0,712	0,102	0,513	0,911	7,017	0,000	10,628	6	0,101
8	7	0,686	0,087	0,516	0,856	7,901	0,000	17,593	6	0,007
Total (REM)	22	0,707	0,055	0,599	0,815	12,813	0,000	46,374	21	0,001
			Heterogeneity Within Groups (Q_{wi})					45,937	18	0,000
			Total Heterogeneity Between Groups (Q_B)					0,437	3	0,932

According to the table, the average effect sizes of the application duration; 0,666 for 4th grade level, 0,781 for 6th grade level, 0,712 for 7th grade level, 0,686 for 8th grade level students effect sizes calculated. According to this table, a significant difference was not found between the mean effect sizes for the application duration moderator. [$(p_b=0,932)>0,05$]. According to this table, significant difference was found between the mean effect sizes for the grade level moderator. Therefore, the fourth hypothesis is not rejected. Therefore, the grade level variable was not determined as a variable that could be the cause of heterogeneity between effect sizes.

The forest plot according to the random effects model of the subject area moderator is given in the figure below.

Meta Analysis

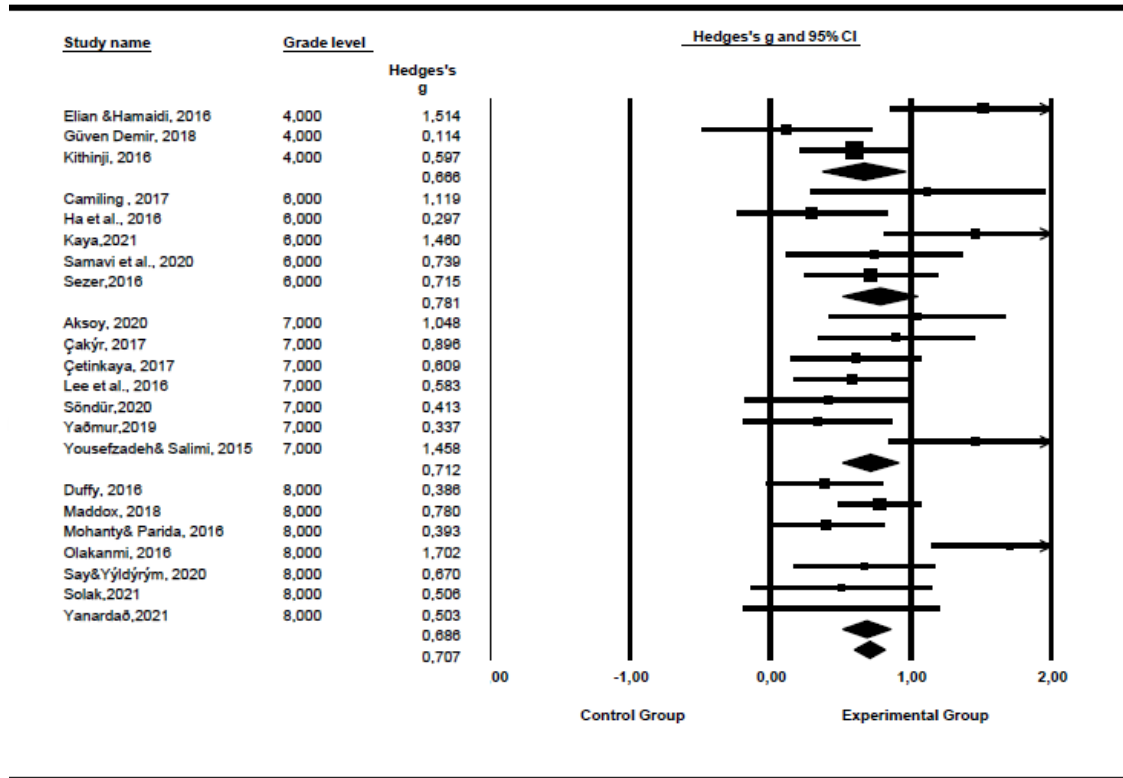


Figure 4.8 Forest plot regarding the hypothesis about grade level of the participations of the studies

When the figure 4.8 is examined, it is seen that the effect size values according to the application topic are in favor of the experimental group and differ from each other. According to this graph, the total effect size of the application duration moderator was found to be 0,707 This value has a moderate effect according to Cohen's (1988) criteria.

4.9 Findings Regarding The Hypothesis About Sample Size of The Participations of the Studies

The fifth null hypothesis of the study is stated as follows:

H₀₅. "There is no significant difference between the effect sizes of the publications in the literature on the effects of the courses in which the flipped education model is applied in science education on the academic achievement of students in science, according to the sample sizes."

In order to test this hypothesis, the subgroup called sample size is analyzed in the meta-analysis program. The sample sizes of the participants are categorized as " $n < 40$, $40 \leq n < 80$, $n \geq 80$ ". The findings obtained as the result of this examination are given in Table.4.7.

Table 4.7 Findings regarding the hypothesis about sample size of the participations of the studies

Moderator Variable	95% CI							Heterogeneity		
Sample Size	N	ES	SE	Lower Limit	Upper Limit	Z	P	Q	df	p
$20 < x \leq 40$	3	0,943	0,189	0,73	1,313	5,001	0,000	0,395	2	0,821
$40 < x \leq 50$	5	1,016	0,129	0,711	1,218	7,461	0,000	8,827	4	0,066
$50 < x \leq 60$	4	0,680	0,148	0,361	0,943	4,395	0,000	11,392	3	0,010
$60 < x \leq 70$	5	0,755	0,107	0,391	0,810	5,615	0,000	30,908	4	0,000
$70 < x \leq 110$	4	0,274	0,0903	0,091	0,453	2,940	0,003	3,363	3	0,339
$220 < x$	1	0,735	0,130	0,480	0,990	5,650	0,000	0,000	0	1,000
Total (REM)	22	0,589	0,050	0,511	0,707	12,127	0,000	79,895	21	0,000
			Heterogeneity Within Groups (Q_{wl})					54,887	16	0,000
			Total Heterogeneity Between Groups (Q_B)					25,009	5	0,000

According to the table, the average effect sizes of the sample size; 0,943 for $20 < x \leq 40$, 1,016 for $40 < x \leq 50$, 0,680 for $50 < x \leq 60$ sample size, 0,755 for $60 < x \leq 70$ and 0,735 for $x > 220$. According to this table, a significant difference was found between the mean effect sizes for the application duration moderator. [$(p_b = 0,000) < 0,05$]. According to this table, significant difference was found between the mean effect sizes for the sample size moderator. Therefore, the fifth

null hypothesis is rejected. Therefore, the sample size variable is determined as a variable that could be the cause of heterogeneity between effect sizes.

The forest plot according to the random effects model of the sample size moderator is given in the figure 4.9 below.

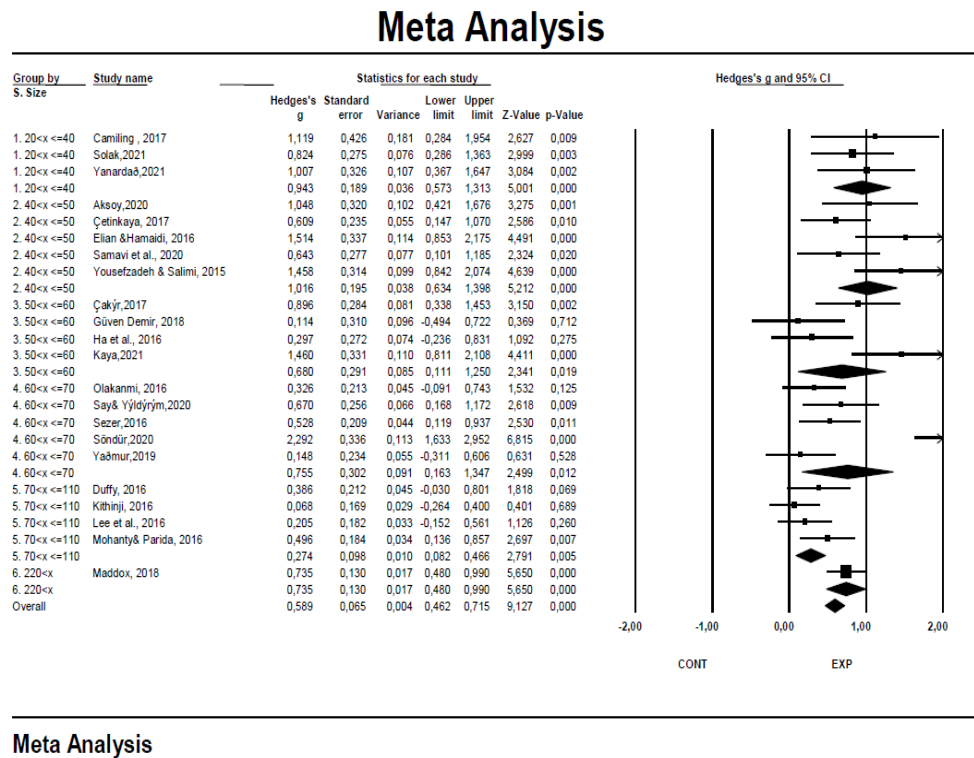


Figure 4.9 Forest plot regarding the hypothesis about sample size of the participations of the studies

When the figure 4.9 is examined, it is seen that the effect size values according to the sample size are in favor of the experimental group and differ from each other. According to this graph, the total effect size of the application duration moderator was found to be 0,661 This value has a moderate effect according to Cohen's (1988) criteria.

4.10 Findings Regarding The Hypothesis About Application of the Region of The Studies

The sixth null hypothesis of the study is stated as follows:

H₀₆. "There is no significant difference between the effect sizes of the publications in the literature on the effects of the courses in which the flipped education model is applied in science education on the academic achievement of students in science, according to the application region." In order to test this hypothesis, the subgroup called applicaiton region is analyzed in the meta-analysis program. The sample sizes of the participants are categorized as "TR as Turkey based studies, F as Foreign based studies" The findings obtained as the result of this examination are given in Table.4.7.

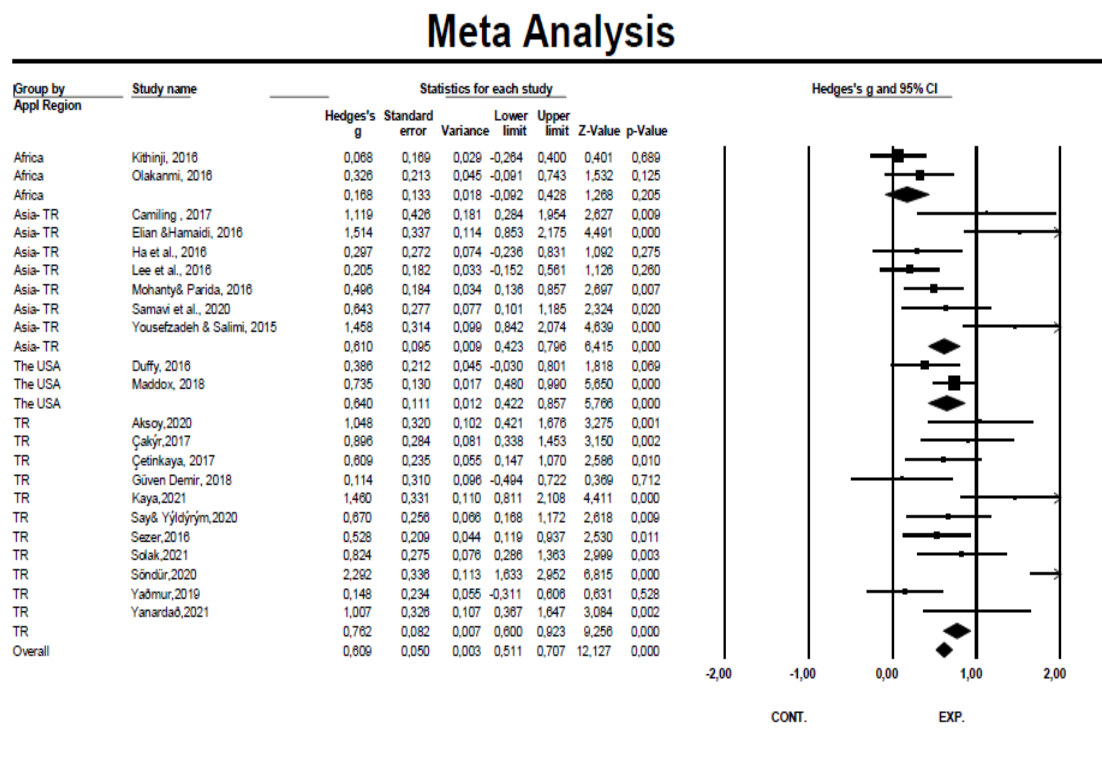
Table 4.7 Findings regarding the hypothesis about application of the region of the studies

Moderator Variable	95% CI							Heterogeneity		
Application Region	N	ES	SE	Lower Limit	Upper Limit	Z	P	Q	df	p
Africa	2	0,168	0,133	-0,092	0,428	1,0268	0,205	0,902	1	0,342
Asia (-TR)	7	0,610	0,095	0,423	0,796	6,415	0,000	22,572	6	0,001
The USA	2	0,640	0,111	0,422	0,857	5,766	0,000	1,970	1	0,160
TR	11	0,762	0,082	0,600	0,923	9,256	0,000	39,854	10	0,000
Total (REM)	22	0,609	0,050	0,511	0,707	12,127	0,000	79,895	21	0,000
			Heterogeneity Within Groups (Q_W)					65,298	18	0,000
			Total Heterogeneity Between Groups (Q_B)					14,598	3	0,002

According to the table 4.7 , the average effect sizes of the application regionis 0,609; 0,168 for Africa, 0,610 for Asia (minus Turkey), 0,640 for the USA, 0,762 for the studies from Turkey.According to this table, a significant difference was not found between the mean effect sizes for the application duration moderator. [(p_b=**0,002**)<0,05]. According to this table, significant difference was found between the mean effect sizes for the application region moderator. Therefore, the sixth null hypothesis is rejected. Therefore, the sample size variable is

determined as a variable that could be the cause of heterogeneity between effect sizes.

The forest plot according to the random effects model of the application region moderator is given in the figure 4.10 below.



Meta Analysis

Figure 4.10 Forest plot regarding the hypothesis about application of the region of the studies

When the figure 4.10 is examined, it is seen that the effect size values according to the application region are in favor of the experimental group and differ from each other. According to this graph, the total effect size of the application duration moderator was found to be 0,714. This value has a moderate effect according to Cohen's (1988) criteria.

RESULTS AND DISCUSSION

In this study, the impact of FLM implementation in science education on academic success was aimed to examine, and a literature analysis was done using keywords chosen for this specific reason. In the initial phase of the data gathering process, it was intended to locate all research on FLA in Turkey; thus, all relevant databases were thoroughly reviewed. After then, 11 studies that satisfied the inclusion criteria were included. In total, 495 studies were identified, and 11 of them met the inclusion criteria and were thus included in the analysis. In the second phase, the meta-analysis studies completed in foreign countries were evaluated, and based on the results of meta-analysis studies, the research was expanded to include studies with acceptable age ranges and disciplines of study in scientific courses. In this manner, 11 more studies were accessed. In other words, 22 meta-analyses of studies were included in total. Two-step data collection yielded a total of 1462 participants in 22 investigations.

Examining the publication type of the studies included in the meta-analysis reveals that the majority of the research are articles, with master's theses and doctorate dissertations being included in the study. In addition, when the languages of the published research are analyzed, it is shown that the majority of studies are written in English. The academic years with the highest applications are 2015-2016 and 2017-2018, based on the years in which the studies were conducted. In terms of the nations where the studies were conducted, eleven were conducted in Turkey and 11 were conducted in countries other than Turkey. Iran, Korea, and the United States have the highest frequency of application among these nations.

Amasya, Ankara, Antalya, Diyarbakır, Istanbul, Karaman, Kastamonu, and Kayseri, in alphabetical order, are the cities where research conducted in Turkey are implemented in. Two studies were undertaken in Turkey is not specified in terms of applied city.

In order to get insight into the quality of the studies included in the study, the researcher investigated whether the scales employed in these investigations were developed, adapted, or ready scales. As its importance is emphasized in literature. (Alp & Şen, 2021) Simultaneously, the reliability values of the employed scales were examined and provided in the results section as descriptive statistics. According to these results, 13 (59,09 %) of the 22 studies included in the analysis were developed scales and a reliability value above 0.80 was encountered in 9 (40,90%) of them, which shows that the scale is reliable.

The included studies were merged using the meta-analysis technique. Directions and magnitudes of the effects were computed. According to the fixed-effects model, the total effect size of these investigations was calculated to be 0.707%. The heterogeneity test indicates, however, that the effect size distribution is diverse. Therefore, the random-effects model was chosen over the fixed-effects model for this investigation. The total effect size of the studies included in the meta-analysis was determined to be 0.735% using the random-effects model. According to Cohen's (1988) criteria, this is a somewhat favorable effect. This demonstrates that academic success rises when utilizing flipped learning applications in science classrooms as opposed to the traditional methods. In addition, the lack of a research with a negative impact size in this study is evidence of its efficacy, and the outcome of the meta-analysis study is compatible with the relevant literature.

In this study, publication bias was evaluated before beginning the meta-analysis procedure. The funnel plot was assessed for publication bias, and Kendall statistics and the Begg Mazumdar Rank Correlation test were used to describe the findings of publication bias, since the studies in the studied graph were not symmetrical, suggesting the likelihood of publishing bias. As a consequence of these detailed tests, it was determined that publication bias did not exist.

The significance of the heterogeneity test done in this study suggests that the variation in effect size among the studies included in the meta-analysis should be investigated. To conduct this review, moderator variables were analyzed. In this

study, the moderator variables are application topic, the application duration, the grade level of the participants, the sample sizes, the application region, the publication type, the practitioner type, and the practitioner's field of study.

The studies included in the research quantify the difference in academic success between FLA and traditional instructions in science classrooms. The fact that the effect size derived from a meta-analysis of 22 research in this context was 0.73 implies that FLA have a moderate impact on academic achievement in science lessons. The finding of the research is convenient with the studies from the literature, for example Duffy (2016) found out in his experimental and control group study, Duffy conducted an experiment in which he applied both pretest and posttest, and as a result of this experiment, there was no significant difference between pretest and posttest in the control group, but he found that there was a significant difference in the experimental group in which the FLM was applied.

Examining the effect sizes of the analyzed studies one by one reveals that the research with the smallest impact has an effect size value of 0,297. Among the research included in the analysis, the study with the biggest impact size had an effect size of 1,460. These impact sizes are, respectively, small and excellent according to Cohen. (Cohen,1977). To understand the reason of this effect size difference, the studies can be examined independently. When dealing with studies in the field of educational sciences, it is important to remember that certain studies must be studied on their own merits independently. (Alvarez, 2011) Furthermore, because this thesis is founded on the applications of the flipped education model, the flipped education model is closely tied to the student's unique learning. This literature result also suggests that each study, as well as its overall effect, should be analyzed individually.

While doing moderator analyzes for this thesis one of the moderator variable is separated into six subgroups when the application topic is investigated. Among these groups, the application topic with the greatest effect size is Biology.(ES= 1,189) 3 studies with biology application topics are included in the research.

The topic with the greatest effect size is Earth Science ($N=7$), and its effect size is 0,589. Similarly, the impact size for the studies with the application topic of Physics studies has 0,623 effect size. With an effect size of 0,114, Astronomy, the discipline with the fewest research ($N=1$), has the smallest effect size. The variation in the effect size values of the application subjects can be attributed to the difference between the application subjects. Examining the application subjects of the biology course, which have the highest effect size value, reveals that FLA is utilized to provide students with knowledge about structures too tiny to be viewed with the naked eye. From this perspective, we may say that these courses provide effective instruction. Similarly, the use of FLA in the astronomy courses were secured by instructing students on the collision processes of objects too massive for their eyes to see, within the context of FLM. Due to the fact that the working procedures of structures too small and too large to be seen with the naked eye are covered in both courses, it is expected that both will have a high effect value; however, the fact that astronomy has a relatively low effect size value than biology may pose some implementation challenges for the astronomy-related study. When examining the forest graph, it is evident that the research closest to the zero point is the astronomy-related study, while the study farthest from the zero point is the study with the largest effect size. The squared studies in this graph represent the impact sizes of the individual research, while the diamonds represent the total effect size of the studies. Due to the fact that each substudy group was evaluated by separating it into subgroups, the overall effect size was estimated independently for astronomy, biology, chemistry, earth sciences, and physics. It can be observed from the table that biology has the largest overall effect size.

The application durations are categorized as " 2-4 weeks, 5-6 weeks, 7-8 weeks, more than 8 weeks" There are 8 studies with the application duration. According to the moderator analysis, the length of the 8 studies ranges between 2 and 4 weeks, and their effect size is 0,794, indicating a large effect size under Cohen's classification (1988). 6 of the studies included in the analysis lasted 5 to 6 weeks. These studies have an effect size of 0,688. With this score, Cohen's

categorization has a moderate level of influence. Just one of the studies included in the analysis is not provided information on the length of the application. The study's effect size was 0,867. In other words, Cohen's categorization has a very large effect size (1988). Two studies with an effect size of 0,6111 had the smallest effect size when looking at the longest time spans. Even if it's not entirely evident, it's possible to infer that the extent of the effect shrinks with increasing application time. A closer look at the research is needed in order to discover exactly what this relationship is based on. Otherwise, the effect size diminishes as the application duration grows, making it impossible to make a firm diagnosis. When the researcher looked closely at two studies that lasted for more than eight weeks, she discovered that they were inside the purview of a Ph.D. dissertation. 12 weeks was the application duration in each of these studies, which were longer than 8 weeks. These long-term applications, which encompass the entire academic year, have made the researcher doubt the efficacy of flipped instruction in science lessons. Since it is exceedingly implausible that a practitioner may use FLM in science lessons for the duration of an academic semester, this finding has most certainly been seen. To put it another way, implementing all of a semester's scientific lessons in a FLM may provide ineffective outcomes. (Duffy,2016) Similarly, it can be interpreted that the attention levels of the students may have decreased in the applications lasting more than 8 weeks and therefore the effect size value of the applications may have decreased.

Each study's effect on the academic achievements of the students in grades 4, 6, 7, and 8 were computed separately after the participants in the studies included in the analysis were analyzed by class level. Students in grade 6 had the largest effect size, which was assessed to be 0,781. At the same time, 7 studies each from 7th and 8th grade students were reached as the most studied studies. 0,712 and 0,686, respectively, were the effect sizes of these two classes. The lack of data on 5th graders in the studies analyzed is a major flaw in this research. As it was inefficient number of studies in the literature (Özdemir, 2016) in terms of

grade level especially when it comes to lower grade participants like elementary and middle school. This finding of the research is convenient with the literature.

There are six sorts of subgroups in the analysis of study sample sizes with the moderator analysis. Sample sizes between 20 and 40 participants, between 40 and 50 participants, between 50 and 60, between 60 and 70 participants, between 70 and 110 participants, and studies with at least 220 persons are all included as subgroups. We observe that the effect size values decreased with the increase in the number of participants especially after the sample size of 70, it can be said that it is inversely proportional according to the findings of this thesis. Sample sizes indeed, implies the learning environment during the class hour and it also give the idea about the classroom environment while applying FLM in the classrooms. The increase in the number of learners may appear as a handicap in the FLM, which considers the creation of an active learning environment as a natural result. (FLN, 2016) Furthermore, research in the literature has indicated that when class size grows, it becomes more difficult to execute personalized learning activities in the classroom. (Öztürk, 2017) Classroom activities are prioritized in the flipped education model. Students are expected to participate in these activities. Increased in-class involvement, brainstorming, and fostering conversation spaces in the classroom are activities that allow them to be engaged. (FLN, 2016) In addition, students collaborate on a project and participate in activities during class hours. It is difficult to carry out the tasks indicated above in overcrowded classes.

A total of 22 studies, 11 from Turkey and 11 from foreign nations were examined for moderator variable results according to the application region. There was a 0,762 effect size observed for research done in Turkey and a 0,168 for the studies from Africa and, 0,610 for the studies from Asian countries except Turkey, finally the USA based studies has 0,640 effect size value. Individual variances in the applications or procedures utilized may be to account for the discrepancies in the effect size values calculated. The international outputs of this thesis are based on the study evaluating the effect sizes of FLA in Turkey and throughout the world. From this perspective, it is critical to study these

research one by one. The methods and procedures utilized in international research and the methods and techniques used in Turkish studies may have resulted in different effect sizes. According to these values the most effective applications are done in Turkey amongst the studies reached. Also according to the meta-analysis result, Africa based studies has the least effect size values. This result may stemmed from

5.1 Suggestions

The suggestions that the researcher can offer within the scope of the research and analysis are as follows:

There is more than one terminology for the flipped learning concept as it is indicated in the literature review part of this study in detail. Examples of the nomenclature confusions seen in the literature include "flipped education" (Talbert, 2012), "inversed classrooms" (Boyras& Ocak, 2014), "classroom flip" (Baker, 2000), and "reversed classrooms" (Sever, 2014). The term "education" in these contexts typically denotes a classroom in which the instructor plays a significant role, placing the emphasis squarely on imparting knowledge rather than acquiring it. In addition, definitions that include the term "classroom" emphasize instruction that takes place solely in a formal educational setting. In terms of the flipped learning model, neither of these propositions is accurate. Learning takes precedence over teaching in the flipped learning model, and students can apply what they've learned in both traditional classroom settings and those that make use of technological tools. Although the above-mentioned nomenclature ambiguity leads the model to be misunderstood and misapplied, also it creates some confusion in the literature. Researchers might benefit from a standardization of notation.

This thesis, which is a meta-analysis of studies related to the flipped learning model implemented in science classrooms, is constrained by the moderators chosen. There might be several moderators involved in the task to be done in this area of study.

This research investigates the impact of implementations of the flipped learning model on academic achievement in science classes. Other effects besides this one were omitted from the analysis. Examining the impact of teaching strategies based on the flipped learning model on various dependent variables may be conducted using meta-analyses method. These dependent factors include, among others, attitude, motivation, and endurance. The researcher should perform a thorough literature search to identify these factors.

It has been seen that there are studies that use missing or wrong keywords in the literature review. Since keywords are of great importance when collecting data for meta-analysis studies, keywords that fully meet the purpose of the study can be suggested within the studies.

Among the research included in this study, it was discovered that there were studies with inadequate descriptive statistics, which is a negative aspect for meta-analysis investigations. In order to avoid this negative, descriptive statistics acquired from research included in meta-analysis studies might be standardized and added to each relevant study.

Meta-analysis studies are the studies that show the effect sizes of the studies on the connected issue by merging studies with the same research objectives. In order to integrate more meta-analysis research in the literature, introductory and instructive Seminars on meta-analysis might be held.

As a consequence of this research, a moderate impact size on academic success was identified in science classes in which flipped learning model was employed, compared to science lessons taught with the traditional teaching techniques. In light of this finding, it may be concluded that the flipped learning approach has a favorable impact on students' science achievement. Teachers might be given seminars on the flipped learning model, and then encouraged to put their newfound theoretical understanding into practice in their science classes.

As a result of the meta-analysis study, there was a significant difference between the application subjects. These subjects can be analyzed independently.

As a result of this meta-analysis study, it was observed that the effect size of the application decreased as the duration of the application increased. A more detailed look at the studies included in the analysis regarding the cause of this effect, and an independent study could be conducted on it.

As a consequence of this meta-analysis study, a comparison was conducted between the studies applied in Turkey and outside of Turkey. As a result of this comparison, it was discovered that the research examined had varying effect sizes within these two categories. The explanation for the disparity in effect sizes between these two application regions may be figured out by looking at research that go into great depth about the application procedures.

In this study, it was revealed that studies done by academics had higher effect sizes than studies conducted by teachers. The explanation for this high influence can be studied independently.

In order to carry out a meta-analysis study, descriptive statistics need to be examined in detail and it is important that the full texts of the theses are accessible at the same time. Researchers can be encouraged to give open access to their theses through YÖKTEZ

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A

EMAILING WITH RESEARCHER



ben 24 May

alici: mark.camiling v



I hope this e-mail finds you well, my name is Merve from Turkey. I am a research assistant and writing my thesis about flipped learning applications all around the world on the elementary school science teaching level and I came across your study called "The Flipped Classroom: Teaching the Basic Science Process Skills to High- Performing 2nd Grade Students of Miriam College Lower School" Do I have any chance to reach your standard deviation and mean values for both pre and post-test for experimental and control groups?
Best

...



Mark Kenneth Camiling 25 May

alici: ben v



Dear Ms. Merve,

Good day! Thank you very much for reading my paper and reaching me. I appreciate your inquiry. Please find the requested information in the picture below.

Legend:

ExpPre: Pre-test of the Experimental Group

ExpPost: Post-test of the Experimental Group

ConPre: Pre-test of the Control Group

ConPost: Post-test of the Control Group

Variable	Obs	Mean	Std. dev.	Min	Max
ExpPre	12	16.58333	7.229464	7	27

. sum ExpPost

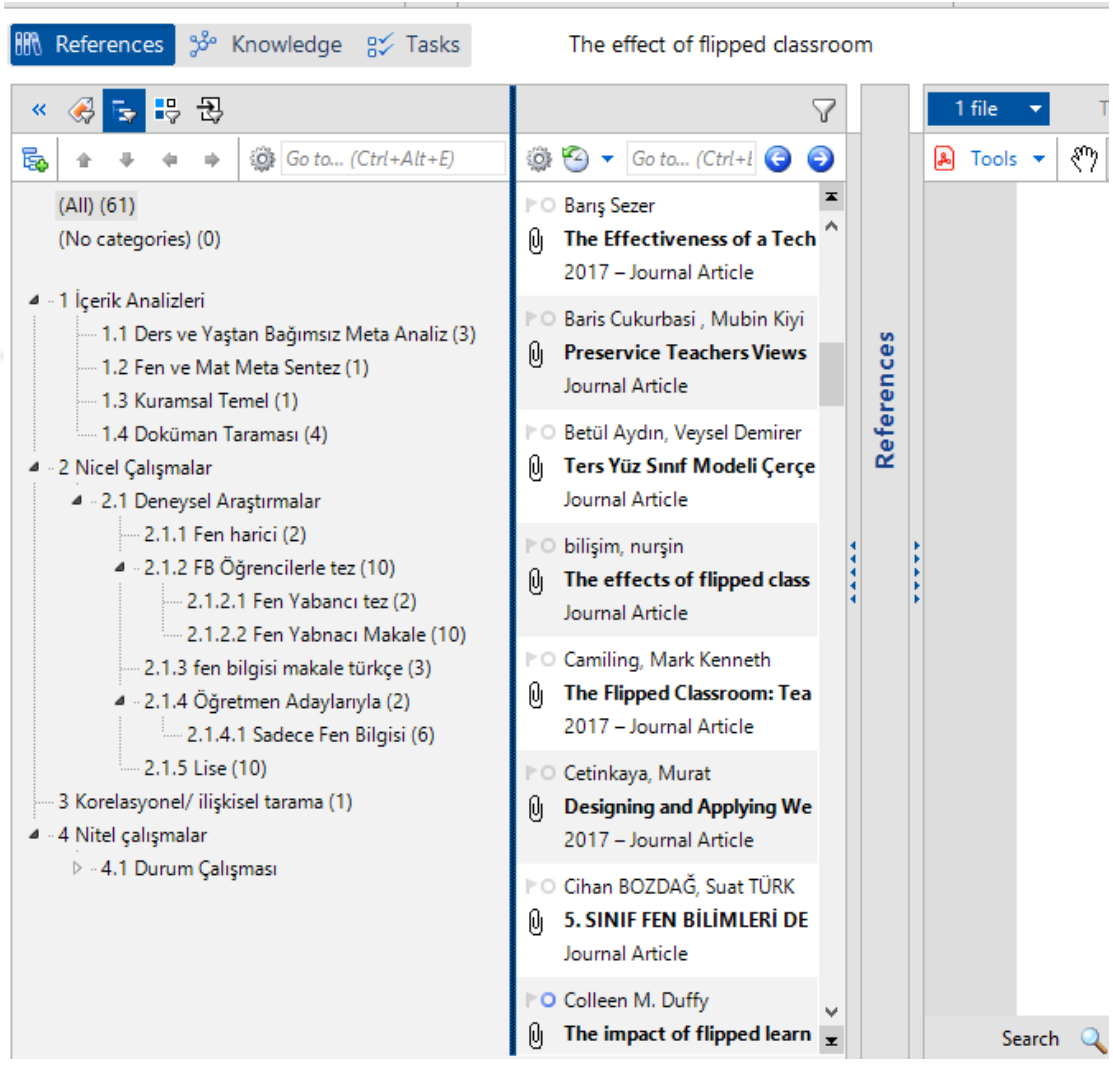
Variable	Obs	Mean	Std. dev.	Min	Max
ExpPost	12	24.58333	4.96274	15	29

. sum ConPre

Variable	Obs	Mean	Std. dev.	Min	Max
ConPre	12	18.16667	6.786858	8	24

B

CITAVI REFERENCE PROGRAM INTERFACE



C

CODING PROTOCOL

I. Identity of the Study

Study number - Year of the Study:			
Title of the Study:			
Writer/s:			
Study Pattern:			
Publication Type:	Article	Master's Thesis	Ph.D
Thesis			
Publication Status:	Published	Unpublished	
Publication Language :	Turkish	English	

II. Content of the Study

Number of the Participants:	F () M ()
Grade level of the participants:	4th Grade() 5th Grade () 6th Grade () 7th Grade () 8th Grade()
Materials Used:	
Application Region (city):	
Application Period (week):	
Topic of the Application:	
Applied Scale:	Developed Scale Adapted Scale Ready- Scale
(Explanation:)	
Is the scale used in the study valid and reliable?	Yes No
(If no, what is reliability value?)	

III. Study Data

Title of the Study Applicator				
Academic	Teacher	Teacher	Candidate	
Applicator's Field of Study				
Pre-Primary School	Science	Math.	Social	IT
Is there a pretest applied to the experimental and control groups? Yes () No()				

IV. Findings of the Study

Pre-test Standart Devition Value		Pre-test Mean Value		Pre-test N of Participants		Post-test Standart Devition Value		Post-test Mean Value		Post- test	N of Parti.
Exp. Gr.	Cont. Gr	Exp. Gr	Cont. Gr.	Exp. Gr.	Cont. Gr.	Exp. Gr.	Cont. Group	Exp. Group	Cont. Group	Exp. Group	Cont. Group

PUBLICATIONS FROM THE THESIS

Conference Papers

1. Yavuz, M. & Coştu B. (Mayıs, 2022) Ters yüz eğitim modelinin fen bilgisi derslerinde akademik başarıya etkisi,meta analiz çalışması. *ICONTE 13th International Congress on New Trends in Education*, Turkey

