International Electronic Journal of Environmental Education
Vol.10, Issue 2, 2020, 44-84
RESEARCH ARTICLE

The Effect of Constructivist Learning Approach and Active Learning on Environmental Education: A Meta-Analysis Study*

Selçuk ARIK**
Tokat Gaziosmanpaşa University, Tokat, TURKEY

Mehmet YILMAZ
Gazi University, Ankara, TÜRKİYE

Abstract

This study conducted a meta-analysis of 57 primary experimental studies which involved 6237 students and investigated the effect of constructivist learning approach and active learning on students' environmental education. The study also analyzed a set of moderator variables, which are considered to influence the results of the primary studies in line with the findings of the meta-analysis. The moderator variables included "year of publication", "language of publication", "type of publication", "country", "educational level", "sample size", "type of measuring instrument in terms of questions and developer", "duration of experimental intervention", "research design", "teacher and researcher effect", and "type of constructivist learning approach and active learning method". The sample consisted of 6237 students and 57 primary experimental studies on environmental academic achievement and environmental attitudes, which were conducted between 2000 and 2015 and met the inclusion and exclusion criteria. A total of 114 effect sizes were obtained from 57 studies. This study used a meta-analysis approach, which is a retrospective study design. The data were analyzed using meta-analysis. The meta-analysis of the data was performed using a random- effects statistical model. Hedges' g was used to measure effect size. Moderator variables were analyzed using the analog to the analysis of variance (ANOVA) based on random-effects and mixed-effects models. The results of the meta-analysis showed that the overall effect size of constructivist learning approach and active learning on environmental education compared to traditional learning is positive and large (Hedges' g= 1.463). According to the results of the moderator analysis, constructivist learning-based and active learning-based environmental education significantly differed in terms of "country", "sample size", "educational level", "type of publication", "type of measuring instrument", "developer of measuring instrument", "language of publication", "teacher effect", and "researcher effect". On the other hand, no significant difference was found in terms of "year of publication", "duration of experimental intervention", "research design", and "type of teaching method used in the experimental group". Taken together, these findings suggest that constructivist learning and active learning can often be used in environmental education. The following variables should be considered in environmental education practices: sample size of the experimental group, educational level of students, measuring instruments employed, and researchers conducting the experiment, and duration of experimental intervention.

Keywords: Environmental education, environmental academic achievement, environmental attitude, constructivist learning approach, active learning, meta-analysis

Introduction

In this day and age when science and technology are prime values, it is of great importance to raise individuals who have "twenty-first-century skills". Twenty-first-century skills include "lifelong learning" (Field, 2001, p. 3), "self-regulated learner", "using knowledge in daily life and in different situations", "self-evaluating" (Zimmerman, 1989, p. 329), "critical thinking" (Ennis, 1985, p. 48), "metacognitive thinking" (Flavell, 1979, p. 909), and "self-regulating" (Shulman, 1987, p. 19-20). Individuals who have such skills can be raised through the use of active learning and constructivist learning approaches whereby knowledge is actively learned

ISSN: 2146-0329
*** The article is a part of the PhD Thesis prepared by Selçuk ARIK under the supervision of Prof. Dr. Mehmet YILMAZ.**
****E-mail: selcuk.arik@gop.edu.tr**

and constructed in the mind and actively used in daily life, and individuals take responsibility for their own learning (Kanlı, 2010; Özmen, 2004; Ün Açıkgöz, 2014, pp. 60-61).

In the constructivist learning approach, individuals construct new knowledge based on their earlier knowledge; thus, knowledge construction is idiosyncratic and teachers (educators) are only guides (Kanlı, 2010; Özmen, 2004; Ün Açıkgöz, 2014, pp. 60-61). In the active learning model, which corresponds to the constructivist learning approach in terms of cognitive learning, individuals take responsibility for their learning process, take decisions about this process and have the opportunity of self-regulation (Ün Açıkgöz, 2014, p. 17). When attributes of people with twenty-first-century skills are compared to qualities acquired through the constructivist learning approach and active learning model, it seems that the constructivist learning approach and active learning model hold a central place in raising individuals with twenty-first-century skills. A considerable number of meta-analysis studies have found that the constructivist learning approach has a “large” effect on student academic achievement. Ayaz and Şekerci (2015) showed that the effect of the constructivist learning approach on students’ academic achievement was “large” (Hedges’ g = 1.40). Likewise, Semerci and Batdı (2015) determined that the constructivist learning approach had a “large” effect on students’ academic achievement (Cohen’s d =1.08). In a meta-analysis study, Ural and Bümen (2016) also reported that the instructional practices of the constructivist learning approach had a “large” effect on science and technology teaching in Turkey (Cohen’s d = 1.00).

Although the constructivist learning approach is based on the same philosophy in terms of its main objectives, different theorists have argued that different processes are effective in learning. Piaget’s theory of cognitive development suggests that learning occurs by interacting with the environment and processing information by means of schemas according to interest and need. In Bruner’s theory of discovery learning, learning is an internal process that involves using intuition and interacting with the environment but giving responses independent from the environment. In the theory of meaningful learning, Ausubel argues that knowledge is learned by a process of meaning-making. Dewey’s theory of learning by doing explains that learning is achieved through real experiences and discovery as a result of interaction with the environment. In social development theory, Vygotsky argues that learning takes place through interaction with the environment, emphasizing the importance of play at this stage (Ün Açıkgöz, 2014, pp. 67-76). Constructivist learning approach and active learning can be applied through different teaching methods and techniques in light of these different theories. Constructivist learning approach can be employed using the following teaching methods and techniques: problem-based learning (PBL), project-based learning, computer-assisted learning (CAL), cooperative learning (CL), the 5E and 7E learning cycles, etc. Active learning model can be applied through various instructional methods and techniques, such as “some techniques based on cooperative learning”, “mind maps”, “teaching through research”, “discovery learning”, and “case method”.

Constructivist learning approach and active learning model are often used in “environmental education” as in many disciplines. The main objectives and principles of environmental education included in the Tbilisi Declaration (1977) can be summarized as follows: “active participation in the solution of environmental problems”, “the ability to take an active role in recognizing environmental problems and offering solutions”, “noticing environmental problems on one’s own”, “critical thinking about environmental problems”, and “gaining first hand experience with practice-based activities” (Balkan Kıyıcı, 2009, p. 177; Tbilisi Declaration, 1977). These basic objectives and principles found in the Tbilisi Declaration are similar to those of the constructivist learning approach and active learning models (Kanlı, 2010; Özmen, 2004; Ün Açıkgöz, 2014). In line with this similarity, it can be said that the use of a constructivist learning approach and active learning models in environmental education plays an important role. Several scientists who have realized the connection between environmental education and constructivist learning approach and active learning models have carried out various experimental and quasi-experimental studies to test the validity of this connection. These (quasi-) experimental studies investigated the effect of various constructivist learning approaches or active learning models on environmental education, such as “outdoor education” (Becker, Lindner, Loynes, & Pedersen Gurholt, 2016; Özdemir, 2010; Remington & Legge, 2017; Rodrigues & Payne, 2017),”garden-based education” (Blair, 2009; Ratcliffe, Merrigan, Rogers, & Goldberg, 2011; Robinson & Zajicek, 2005; Ürey, Çepni, & Kaymakçı, 2015; Ürey, Göksu, & Karaçöp, 2017), “field (nature) trips and camps” (Balkan Kıyıcı & Atabek Yiğit, 2010; Bozdoğan, 2012; Scarce, 1997; DeWitt & Storksdieck, 2008; Riegel & Kindermann, 2016; Topçu & Atabey, 2017), “project-based learning” (Benzer, 2010; Güven, 2011; Koçak, 2008; Oflaz, 2012); “cooperative learning” (Bilgili, 2008; Bülbül, 2007; Cömert, 2011; Solmaz, 2010), “computer- or technology-assisted learning” (Aivazidis, Lazaridou, & Hellden, 2006; Aslan Efe, 2015; Çetin, 2003; Gökmen, 2008), “sustainable environmental education” (Özdemir, 2007; Suárez - Orozco & Suárez - Orozco, 2017; Tapia-Fonllem, Fraijo-Sing, Corral-Verdugo, & Ortiz Valdez, 2017).

Although these studies on environmental education were based on the same approach (constructivist learning approach) or model (active learning model), they used different teaching methods and techniques developed in line with the theories of various theoreticians. Experimental studies in this field of social sciences (education sciences) by nature, may be affected by “sample size”, “quality of the measuring instrument used”, “characteristics (social, cultural, physical, emotional, etc.) of researchers and experimental group students “, “cultural, physical and geographical conditions”, “research design”, etc. (Adler, 2012; Glass, 1976; Kağıtçıbaşı, 2010, pp. 82, 91,97; Merdin, 1996; National Research Council, 2000; Sarıer, 2013; Üstün, 2012). Thus, it is not right to think that the results of these studies would have the same effect on students. Among earlier studies that compared constructivist learning approach and/or active learning with traditional learning methods in terms of environmental academic achievement, some found significant differences in favor of the experimental group (constructivist learning approach and active learning models) (Aivazidis et al., 2006; Cronin-Jones, 2000; Erentay, 2013; Gnanalet & Ramakrishnan, 2010; Hsiao, Lin, Feng, & Li, 2010; Yoldaş, 2009), while others found no difference in favor of the experimental group (Broyles, 2011; Hsu, 2004; Liu, 2004; Skaza, 2010). Similarly, among previous studies that compared constructivist learning approach and/or active learning with traditional methods in terms of environmental attitudes, some reported significant differences in favor of the experimental group (Bilgili, 2008; Bodzin, 2008; Güven, 2011; Nkire, 2014; Sağlamer Yazgan, 2013; Solmaz, 2010), while others reported no difference in favor of the experimental group (Aguilar, Waliczek, & Zajicek, 2008; Aslan Efe, 2015; Burek, 2012; Gökmen, 2008; Oflaz, 2012; Öztürk, 2013).

Scientific knowledge is objective, experimental, repeatable, ever-changing, uncertain, deductive or inductive, generalizable, accumulative, and based on imagination, creativity, observations, and inferences (Abd-El Khalick, Bell, & Lederman, 1998; Arık, 2010). Given the objectivity, experimentality, repeatability, uncertainty, and changeability of scientific knowledge, studies on the impact of constructivist learning approach and active learning models on environmental education should be generalized based on a deductive or inductive approach, taking into account the accumulative nature of scientific knowledge. As noted by Popper (2015, p. 18), science “is like a building erected on piles” above a swamp. These piles are never based on any natural and firm ground; science is a constantly changing, renewing and evolving phenomenon. According to Popper, science is a “deductive” and “falsifiable” phenomenon. In this regard, scientists should always look for new knowledge based on prior knowledge (Popper, 2015, p. 19). To consolidate this phenomenon, research must be carried out based on sound foundations extending from the past to the present. The deeper the roots of a tree and the more branches grow, the stronger and more productive the tree becomes. Likewise, science is strong and successful to the extent that it integrates the past and the future. The development of a tree depends on water, sun, and nutrients, while the development of science depends on scientific knowledge and scientists. Scientists can advance science by establishing close links between the past and the present.

Retrospective research methods (Erkuş, 2017, p. 125) are of major importance in ensuring this tight connection between the past and the present. Retrospective research allows information obtained in the past to be presented in integrity. In brief, retrospective research can display a fuller historical picture of science (Cooper, 2010, p. 4; Erkuş, 2017, p. 125). In this regard, the present study used a retrospective research method. This retrospective study is of importance in presenting the effect of constructivist learning approach and active learning models on environmental education.

Retrospective research can be carried out in five modes: "literature review", "systematic review", "research review", "research synthesis" and "meta-analysis" (Cooper, 2010, p. 4; Erkuş, 2017, p. 125). Meta-analysis, defined as "the analysis of analyses" (Glass, 1976), differs from other retrospective research methods in that it is a quantitative method of systematic analysis (Erkuş, 2017, p.125; Glass, 1982; Konstantopoulus, 2008; Üstün & Eryılmaz, 2014), based on an overall effect size index (Ellis, 2013, s. 4-5; Fan, 2001; Hunter & Schmidt, 2000), aims to generalize research results (Glass, 1982), permits no subjective judgment, reflects the characteristics of studies included in the meta-analysis (Borenstein, Hedges, Higgins, & Rothstein, 2009, p. 262; Rosenthal & DiMatteo, 2001), enables the use of moderator-variable analysis, and is the most recent retrospective research method (Erkuş, 2017, p.125; Üstün & Eryılmaz, 2014).

By means of meta-analysis, all effect sizes obtained from primary research can be synthesized to obtain an "overall effect size" (Glass, 1982; Lipsey & Wilson, 2001; Üstün & Eryılmaz, 2014). This situation is important to fulfill the principle of generalizability underscored by Popper in the philosophy of science. Compared to other retrospective research procedures, meta-analysis allows a statistical generalization of scientific information through "overall effect size" indices (Erkuş, 2017, p. 125; Üstün & Eryılmaz, 2014). In this regard, this meta-analysis study, which investigates the effect of constructivist learning approach or active learning models on environmental education, is valuable in that it enables the generalization of scientific knowledge.

Since meta-analysis studies are based on "overall effect sizes", they do not have problems arising from statistical significance tests. Statistical significance tests are affected by sample size and often insufficient to explain what research results correspond to in everyday life (Ellis, 2013, p. 3). It is often not possible to obtain a statistically significant result by chance. However, it is common to obtain statistically significant but unimportant results or statistically insignificant but important results. Thus, a statistically significant result should not be considered practically significant (Ellis, 2013, pp. 4-5). To explore real-life effects of statistical research results, the focus should be on the concept of "effect size", the use of which is recommended by international institutions such as the American Psychological Association (APA, 2001, p. 25) and the American Educational Studies Association (AESA, 2006, p. 10) (Ellis, 2013, pp. 4-5; Fan, 2001; Hunter, & Schmidt, 2000). Investigating the effect of constructivist learning approach or active learning models on environmental education, this meta-analysis study obtained the effect size results of all primary studies included in the meta-analysis. This meta-analysis study is of special importance in that it presents the real-life effects of primary studies included in the meta-analysis.

Meta-analysis research also allows an analysis of the characteristics of "primary studies" included in the meta-analysis. One of the main objectives of meta-analysis research is to determine homogeneity among studies included in the meta-analysis. Meta-analysis research helps to find out whether all studies included in the meta-analysis have similar effects. If there is heterogeneity among studies, the source of this heterogeneity is explained through possible moderator variables (Üstün & Eryılmaz, 2014). Meta-analysis studies reveal results of heterogeneity and moderator variables (Glass, 1982; Lipsey & Wilson, 2001), thereby contributing to Popper's concept of falsifiability of scientific knowledge. Therefore, meta-analysis studies are of great importance in that they contribute to the falsification of scientific knowledge.

No meta-analysis research has been found that investigated the effect of constructivist learning approach and active learning on environmental education. In addition, Başol, Doğuyurt, and Demir (2016) analyzed meta-analysis studies carried out in Turkey and demonstrated that there is no previous meta-analysis study on environmental education. The international literature involves no study on the effect of constructivist learning approach and active learning on environmental education but several meta-analysis studies on environmental education (Hines, Hungerford, & Tomera, 1987; Zelezny, 1999; Bamberg, & Möser, 2007; Hawcroft, & Milfont, 2010; Osbaldiston, & Schott, 2011; Mifsud, 2012; Hurst, Dittmar, Bond, & Kasser, 2013; Klöckner, 2013). Meta-analysis studies in social sciences can be conducted in four different modes. These can be classified as follows: "meta-analysis of the effectiveness of relations", "exploration of a construct/scale development study", "structural equation", and "meta-analysis of the effectiveness of differences" (Başol et al., 2016). Considering the kinds of previous meta-analysis studies on environmental education, Hines et al. (1987), Bamberg and Möser (2007), Hurst et al. (2013), and Klöckner (2013) carried out a meta-analysis of the effectiveness of relations. Hawcroft and Milfont (2010)'s meta-analysis was an exploration of a construct/scale development study. Zelezny (1999), Osbaldiston and Schott (2011), and Mifsud (2012), like the present study, carried out a meta-analysis of the effectiveness of differences. In her meta-analysis, Zelezny (1999) investigated the impact of educational interventions conducted in classrooms and in non-traditional settings on environmental behavior in a period from 1971 to 96. In their meta-analysis, Osbaldiston and Schott (2011) examined the effectiveness of experimental treatments conducted between 1980 and 2010 on pro-environmental behavior. Mifsud (2012) meta-analyzed environmental knowledge, attitudes and action of young people after compulsory education. These studies differ from the present study in terms of years covered in the meta-analysis, inclusion criteria, the method of meta-analysis used, and dependent, independent or moderator variables. Thus, the present meta-analysis study fills a gap in the literature and displays the big picture of previous findings on the effect of the constructivist learning approach and active learning on environmental education. Accordingly, the main objective of this meta-analysis study was to investigate the effect of constructivist learning approach and active learning on environmental education in comparison with traditional learning methods and to analyze the impact of moderator variables considered to affect this effect. To this end, answers were sought to the following research problems:

1) "What is the overall effect of constructivist learning approach or active learning methods on environmental education compared to traditional learning methods?"
2) "Do moderator variables (year of publication, language of publication, type of publication, country, educational level, sample size, type of measuring instrument in terms of questions and developer, duration of experimental intervention, research design, teacher and researcher effect, and type of constructivist learning approach and active learning method used in the experimental group) have an impact on the overall effect size when the constructivist learning approach or active learning methods are compared with traditional learning methods in terms of environmental education results?"

Methodology

This section includes the following subheadings: research model, literature review, inclusion and exclusion criteria, coding procedures, unit of analysis; dependent, independent and moderated variables; reliability and validity, data analysis, and effect size calculation and effect size index.

Research Model

To explore the effect of constructivist learning approach and active learning on students' environmental academic achievement and environmental attitudes, this study employed a meta-analysis method, which is one of the research methods (Cooper, 2010, p. 4). Meta-analysis, defined as the "analysis of analyses" (Glass, 1976), is a method of organizing and combining the primary data analysis results of previous studies on the same topic from a systematic and quantitative perspective using certain statistical analysis methods to see the bigger picture and make comments about it (Arık, 2017, p. 69). This meta-analysis study followed the following steps: 1) identifying the research topic and problem statement (identifying hypotheses, if any), 2) explaining dependent, independent and moderator variables, 3) reviewing the literature to identify studies to be included in the meta-analysis and organizing the gathered primary studies, 4) establishing inclusion and exclusion criteria, 5) selecting studies to be included in the meta-analysis based on these criteria, 6) coding the studies, assessing their quality, and ensuring coding reliability, 7) combining and statistically analyzing the findings of the studies, and 8) interpreting and presenting research results (Cooper, 2010, p. 13; Creswell, 2005, p. 8; Rosenthal & DiMatteo, 2001; Üstün, 2012, pp. 52-53; Üstün & Eryılmaz, 2014).

Literature Review

The review of the literature was carried out in two modes: "computer-based (online)" and "manual (using printed publications)". Prior to the literature review, the keywords used in the literature review were determined ("environmental education"; "environmental education" + "pretest" + "posttest"; "environmental education" + "pre-test" + "post-test"; environmental education" + "experimental group" + "control group").

A six-phase literature review was conducted to make a computer-based search. Online databases accessible to the libraries of Gazi and Gaziosmanpaşa universities were used in the first phase ("ERIC", "Science Direct", "Teacher Reference Center", "Scopus", "Social Sciences Citation Index-SSCI", "JSTOR Journals", "Academic OneFile", "Business Source Complete", "Information Science & Technology Abstracts", "Green FILE", "Arts & Humanities Citation Index", "General OneFile", "SciTech Connect", "Directory of Open Access Journals", "Science Citation Index-SCI", "CINAHL Complete", and "Library"). In the second phase, the thesis was searched using the national thesis center of the Council of Higher Education (YÖK) and "ProQuest" databases. In the third phase, four high-impact peer-reviewed international journals ("Journal of Research in Science Teaching", "Science Education", "Environmental Education Research", and "The Journal of Environmental Education") were determined and examined online. In the fourth phase, the bibliography of the studies included in the meta-analysis was checked and the studies that could be included in the meta-analysis were examined online. In the fifth phase, the meta-analysis studies similar to the present study were reviewed and the studies that could be included in the meta-analysis were examined online. In the final sixth phase, various national and international congresses on environmental education and science education were defined (NARST, ESERA, AERA, UFBMEK, and EJER) and online abstracts and full texts were examined.

The central libraries of Gazi, Hacettepe and Gaziosmanpaşa universities were used for the manual literature search. Any work that was unavailable in any of these libraries and inaccessible online was obtained using the interlibrary loan service available to Gaziosmanpaşa University.

Inclusion and Exclusion Criteria

A set of inclusion and exclusion criteria were established to decide which studies found through the literature search would be included in the meta-analysis. The scope and limitations of this meta-analysis study were thus laid down (Borenstein et al., 2009). This meta-analysis study used the following inclusion criteria: year of publication (January 2000 to December 2015), language of publication (English and Turkish), type of publication (published/unpublished and national and international), educational level (students from all levels of formal education), dependent variables (environmental academic achievement and environmental attitudes), independent variables (the use of constructivist learning approach and active learning methods in the experimental group and traditional learning methods in the control group), research design (experimental design), research model (the use of pre-test, post-tests, and control groups), and availability of statistical data needed for effect size calculation (sample sizes, means, standard deviations, and P-value t-value F-value, effect size, etc.). The study used the following exclusion criteria: studies that fall outside the inclusion criteria, theses without access permission, and studies without free access. Additionally, among studies derived from master's theses or doctoral dissertations, the first published (either article or thesis) was included in the meta-analysis and the last published was excluded.

Coding Procedures

A coding sheet was formed for detailed and systematical coding operations. Coding sheets are of utmost importance in ensuring the reliability of meta-analysis (Chen & Chan, 2016; Glass & Smith, 1979; Üstün, 2012, p. 78). This study reviewed various meta-analysis studies to design the coding sheet (Docky, Segers, Bossche, & Gijbels, 2003; Hawcroft, & Milfont, 2010; Hurst et al., 2013; Johnson, Johnson, & Stanne, 2000; Sirin, 2005; Üstün, 2012). A literature review was undertaken to identify moderator variables; the first coding sheet (30 items) was designed. The second coding sheet (41 items) was formed in line with subject matter expert opinions. Then, the coding sheet was piloted. The third coding sheet was formed as a result of the pilot coding. The final sheet was modelled by re-coding in line with expert and researcher opinions. The coding sheet consisted of 46 items and four categories: information on coders, identification information on the studies included in the meta-analysis, general information on the studies, and information on the content of the studies. The form comprised both open-ended and multiple-choice items.

Unit of Analysis

One of the criticisms of meta-analysis is its "lumpy" nature (Glass, 1982, p. 109). Lumpy, also called aggregate, refers to the case "in which multiple results are derived from the same study" included in the meta-analysis. Lumping in a meta-analysis causes bias (Üstün & Eryılmaz, 2014) and errors in reliability due to the use of multiple datasets from the same study (Glass, 1982, p. 109). A unit of analysis can be considered as a unit of analysis in a meta-analysis. A unit of analysis can be each study included in the meta-analysis or each effect size in each study included in the meta-analysis. When each effect size derived from the same dataset is accepted as a unit of analysis or both theses and articles derived from master's theses or doctoral dissertations are included in a meta-analysis, it might cause lumping (Üstün & Eryılmaz, 2014). Thus, this study accepted each study as a unit of analysis. In other words, one effect size was obtained from each study. For studies from which multiple effect sizes were derived, the mean effect size was used. The mean effect size was calculated using the combined sample size, the combined mean, and the combined standard deviation (Borenstein et al., 2009, pp. 221-222). Additionally, among studies derived from master's theses or doctoral dissertations, the first published was included in the meta-analysis. As a result, 114 effect sizes (k = 114) derived from 57 studies (n = 57) included in the meta-analysis were included as 57 units of analysis in such a way that one effect size could be obtained from each study.

Dependent, Independent and Moderator Variables: Intervention Method

The dependent variables of the studies included in this meta-analysis were environmental academic achievement and environmental attitudes. The independent variables included methods based on *"constructivist learning approach"* or "*active learning*" used in the experimental group and "*traditional learning*" methods used in the control group. The study also investigated the impact of moderator variables considered to affect the relationship between the dependent and independent variables. This study analyzed 13 moderator variables. These moderator variables are as follows: *"year of publication"*, *"language of publication"*, *"type of publication"*, *"country"*, *"educational level"*, *"sample size"*, *"type of* *measuring instrument in terms of questions"*, *"type of measuring instrument in terms of developer "*, *"duration of experimental intervention"*, *"research design"*, *"teacher effect"*, *"researcher effect"*, and *"type of constructivist learning approach and active learning method used in the experimental group"*.

Reliability and Validity

Reliability in meta-analysis is concerned with the coding studies included in the meta-analysis (Lipsey & Wilson, 2001, pp. 73-74; Rosenthal, 2009, pp. 44-45 as cited in Üstün & Eryılmaz, 2014). Validity is related to publication bias and quality of studies included in the meta-analysis (Borenstein et al., 2009; Glass, 1982, p. 106).

This study used two different coding procedures with respect to the reliability of meta-analysis: "coder reliability" and "intercoder reliability" (Lipsey & Wilson, 2001, pp. 73-74; Rosenthal, 2009, pp. 44-45 as cited in Üstün & Eryılmaz, 2014). Coder reliability refers to the consistency of a single coder, while intercoder reliability refers to the consistency between different coders (Lipsey & Wilson, 2001, pp. 73-74; Rosenthal, 2009, pp. 44-45 as cited in Üstün & Eryılmaz, 2014). These reliabilities were calculated using the equation of "agreement rate" (agreement rate = number of observations agreed upon / total number of observations) (Orwin & Vevea, 2009, p. 187).

"Forest plot", "funnel plot", "Rosenthal's fail-safe N (FSN)", "Orwin's (1983) fail-safe N", and the "TFM developed by Duval and Tweedie (2000a, 2000b)" were used for the validity of meta-analysis (Greenhouse & Iyengar, 2009, pp. 428-430; Rothstein, Sutton, & Borenstein, 2005; Üstün & Eryılmaz, 2014). Determining the quality of studies included in the meta-analysis is one of the critical validity problems. However, it is not a right approach to determine the quality of studies included in the meta-analysis using various measures and exclude them from the meta-analysis, which may lead to publication bias (Glass, 1982; Lipsey, & Wilson, 2001; Valentine, 2009, p. 130). Thus, this study carried out a systematic review using a Primary Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) diagram (Figure 1), performed a moderator analysis and included all studies that satisfied the inclusion criteria (Littell, Corcoran, & Pilai, 2008).

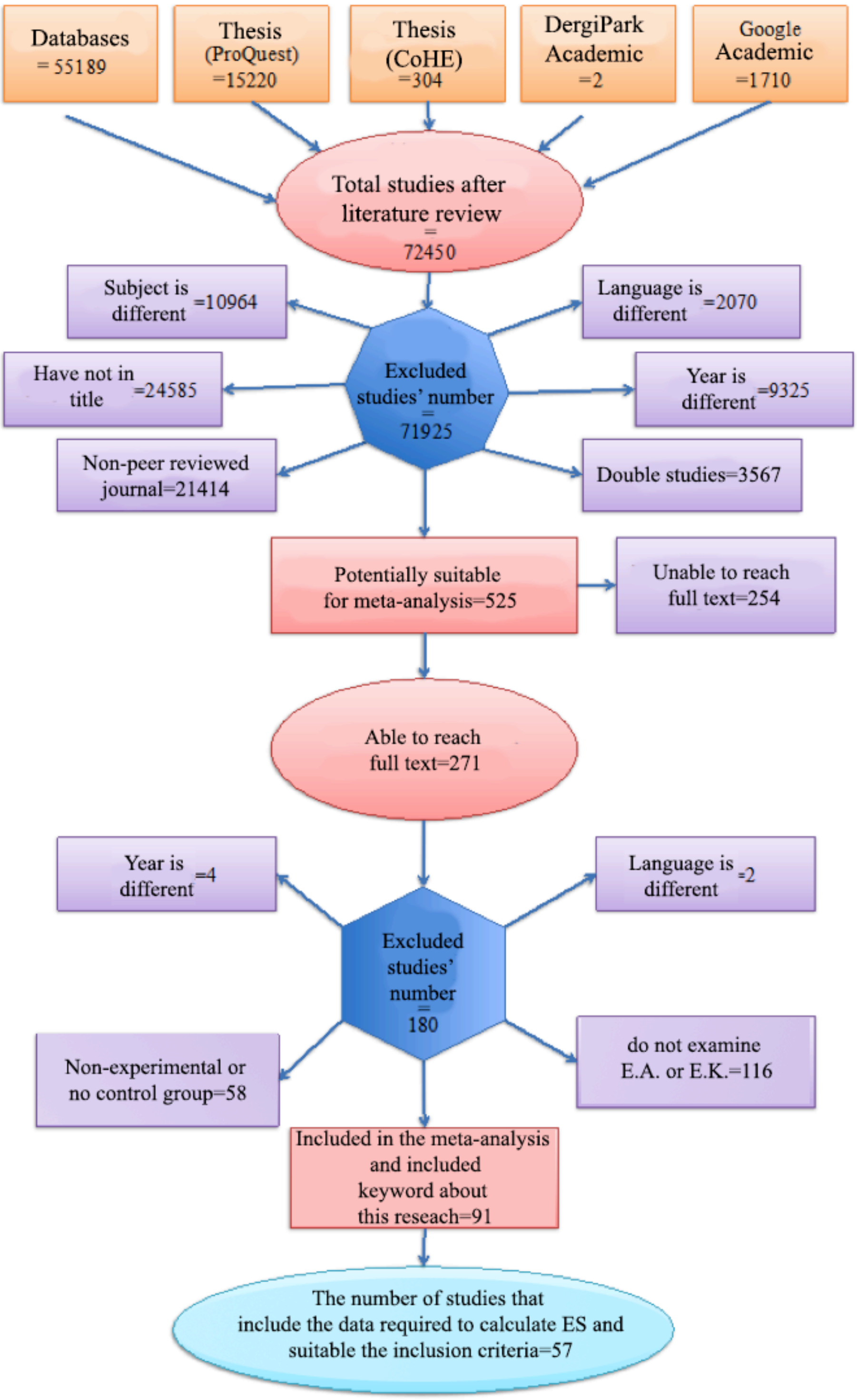


Figure 1. PRISMA flow chart of literature review

Data Analysis

The data were analyzed using "*meta-analysis (meta-analysis as a data analysis method)*", "*heterogeneity analysis*", "*moderator variable analysis*", and "*statistical power* analysis".

Meta-analysis is both a scientific research method (Cooper, 2010, pp. 147-148; Cooper & Hedges, 2009; Hines et al., 1987; Rosenthal & DiMatteo, 2001; Sanchez-Meca & Marin-Martinez, 2010) and a data analysis method (Glass, 1976; Shelby & Vaske, 2008). Meta-analysis considered as a scientific research method in the research model section is considered as a data analysis method in this section. Scientific research can be analyzed using three different methods. These are "*primary analysis*" (the original first-hand analysis of research data), "*secondary analysis*" (the re-analysis of primary data using better statistical techniques or various new questions), and "*meta-analysis*" (the integration of findings from the primary data analysis for the purpose of generalization to a broader sampling; briefly, the analysis of analyses) (Glass, 1976).

The main objective of a meta-analysis is to "determine whether the results of studies included in the meta-analysis are homogenous" and "if there is heterogeneity, to identify moderator variables considered to have an effect on this result" (Hueda-Medina, Sanchez-Meca, Marin-Martinez, & Botella, 2006). Thus, heterogeneity analysis is of critical importance for meta-analysis research. This study used three types of analyses to determine heterogeneity including "Q-statistic and correlation significance test", "τ^2 (tau-squared) estimate", and "I^2statistic".

If the results of studies included in the meta-analysis show a heterogeneous distribution, moderator variables considered to affect the relationship between dependent and independent variables must be investigated (Üstün & Eryılmaz, 2014). Saunders (1956) defined a moderator variable as "a variable that systematically changes the shape and power of the relationship between dependent and independent variables" (Sharma, Durand, & Gur-Arie, 1981). This study carried out the "ANOVA analog based on the Q test" using "*random-effects*" and "*mixed-effects*" models to analyze the variance in subgroups (Üstün & Eryılmaz, 2014). An analogous ANOVA has low power and weakness in statistical analysis tests (Borenstein et al., 2009 as cited in Üstün & Eryılmaz, 2014). Thus, R-squared (R^2), which represents the proportion of variance explained in the moderator analysis, must be calculated. The effect of covariate can be explained by the proportion of variance explained. To this end, the "R^2 index" must be calculated. The R^2 index can be defined as "the ratio of explained variance to total variance" (Borenstein et al., 2009, pp. 179-180).

The main objective of this meta-analysis study was to reject the null hypothesis. The fulfilment of this objective depends on the use of robust statistical analysis methods (Borenstein et al., 2009, p. 257). A statistical power analysis [Power= $(1-\emptyset(c_\propto - \lambda)) + \emptyset(-c_\propto - \lambda)$] was run to determine the statistical power of the research data (Ellis, 2013, p. 52).

Effect size calculation and effect size index

The concept of effect size has assumed an added importance as statistical analysis tests are based on sampling and thus suffer from weakness and low power. Various international organizations such as AERA, APA, and NRC underscore the importance of effect size and emphasize that effect size, which is of pivotal importance for meta-analysis research, should be used along with statistical analysis tests in primary studies (Ellis, 2013, p. 4; Fan, 2001; Hunter, & Schmidt, 2000). Depending on the type of research, effect size can be calculated using two indices called the r family and the d family (Borenstein et al., 2009; Ellis, 2013, p. 6; Rosenthal, 1991, p. 17). This study used the d family index as it compared sub-groups for continuous outcomes. The comparison of continuous outcomes can be measured using the indices "Cohen's d", "Glass *Δ* ", "Response Ratio I" and "Hedges' g". A slight bias may occur when the effect size is calculated using Cohen's d and Glass *Δ*(especially when small-sample studies are included in the meta-analysis). Hedges' g removes such bias through a correction factor called J (Borenstein et al., 2009; Üstün & Eryılmaz, 2014). This study employed Hedges' g to avoid bias since it is the most recent effect size index and small-sample studies were included in the meta-analysis. The effect sizes obtained from the study were evaluated using the classification criteria proposed by Cohen (1988, p. 40) and Cohen, Manion, and Morrison (2007, p. 521). According to Cohen (1988, p. 40), effect size can be interpreted as small, medium and large for the point estimates 0.20, 0.50, and 0.80, respectively. In this classification, values < 0 are interpreted as inverse effect and zero effect and values < 0.20 as trivial. According to the classification proposed by Cohen et al. (2007, p.

521), an effect size from 0 to 0.20 represents a weak effect, from 0.21 to 0.50 a modest effect, from 0.51 to 1.00 a moderate effect, and > 1.00 a strong effect. Effect sizes were calculated using Hedges' g equation (Hedges' g=M_1-M_2/SD^*_{total}). In this equation, M_1represents the mean of the experimental group, M_2represents the mean of the control group, and SD_{pooled} the pooled weighted standard deviations using the correction factor J (Borenstein et al., 2009, p.27; Ellis, 2013, pp. 10-11).

In meta-analysis, two models called "fixed-effects model" and "random- effects model" are used to interpret the mean effect size derived from studies included in the meta-analysis (Borenstein et al., 2009; Cooper, 2010, pp. 190-191; Hedges, 2009, p. 41; Ellis, 2013, p. 129). One of the major mistakes made in the selection of a model is to select a model based on heterogeneity test results. The selection of a model must be based on the nature of the desired inference. If inferences are made about parameters, then a fixed-effects model must be used; if inferences are made about the population, then a random-effects model must be used (Borenstein et al., 2009, p. 84; Hedges & Vevea, 1998; Üstün & Eryılmaz, 2014). Educational research often aims to make inferences about the population and includes possible variables that moderates the relationship between dependent and independent variables. Therefore, this study used a "*random-effects model*" for meta-analysis, taking into consideration the nature of research on environmental education (variables such as culture, language, ethnicity, and experimental setting might affect the relationship between dependent and independent variables).

Data in meta-analysis can be analyzed using a variety of statistical software, such as Comprehensive Meta-Analysis (CMA), MetAnalysis, MetaWin, MIX, MetaEasy, RevMan, and WEasyMA. Bax, Yu, Ikeda, and Moons (2007) compared the aforesaid software in terms of features, results, and usability and found that CMA is superior to other software in terms of features and ease-of-use. Therefore, this study used CMA statistical software version 2.0, since it runs all meta-analysis statistical procedures and is widely used as the most up-to-date software. Additionally, this study used MS Office Excel 2010 and EndNote X6 for the sake of convenience in coding and literature search.

Findings

This study first analyzed the descriptive characteristics of the studies included in the meta-analysis and then the data on the first and second research problems in detail using tables, figures, and plots.

Descriptive characteristics of the studies included in the meta-analysis

Following the review of the literature, 57 studies were included in the meta-analysis in line with the inclusion and exclusion criteria. Table 1 shows descriptive data on the studies included in the meta-analysis.

Table 1.

Descriptive data on the studies ıncluded in the meta-analysis

Type of Study	*Subgroup*	*n (%)*	*k (%)*
Year of Publication	2000-2003	3 (5.3%)	7 (6.1%)
	2004-2007	7 (12.3%)	23 (20.2%)
	2008-2011	27 (47.4%)	55 (48.3%)
	2012-2015	20 (35.1%)	29 (25.4%)
Language of Publication	English	27 (47.4%)	61 (53.5%)
	Turkish	30 (52.6%)	53 (46.5%)
Type of	Article	18 (31.6%)	36 (31.6%)

Publication	Doctoral (PhD.) Thesis	15 (26.3%)	36 (31.6%)
	Master's (MA) Thesis	22 (38.6%)	40 (25.4%)
	Other (abstract, full text, poster, etc.)	2 (3.5%)	2 (1.8%)
Country	USA	11 (19.3%)	29 (25.4%)
	Turkey	36 (63.2%)	67 (58.8%)
	Other (Argentina, Bulgaria, India, Canada, Malaysia, Nigeria, Puerto Rico, Taiwan, Thailand, Vietnam, Greece)	10 (17.5%)	18 (15.8%)
Educational Level	Pre-school (Early Childhood)	1 (1.8%)	2 (1.8%)
	Primary School	28 (49.1%)	57 (50.0%)
	Secondary School	8 (14.0%)	12 (10.5%)
	High Education	17 (29.8%)	35 (30.7%)
	Mixed	2 (3.5%)	7 (6.1%)
	Studies That did not Report	1 (1.8%)	1 (0.9%)
Sample Size	<51	10 (17.5%)	15 (13.2%)
	51-100	29 (50.9%)	52 (45.6%)
	101-150	11 (19.3%)	27 (23.7%)
	>150	7 (12.3%)	20 (17.5%)
Type of Questions of the Measurement Instrument	Only Composed of Objective Questions	40 (70.2%)	80 (70.2%)
	Only Composed of Open-ended Questions	1 (1.8%)	3 (2.6%)
	Mixed Questions (Objective and Open-ended questions)	9 (15.8%)	21 (18.4%)
	Studies That did not Report	7 (12.3%)	10 (8.8%)
Developer of Measuring Instrument	Developed by Researcher	25 (43.9%)	49 (43.0%)
	Pre-existing	21 (36.8%)	41 (19.3%)
	Adapted	9 (15.8%)	22 (36.0%)
	Studies That did not Report	2 (3.5%)	2 (1.8%)
Duration of Experimental Intervention	0-4	8 (14.0%)	23 (20.2%)
	4-6	15 (26.3%)	25 (21.9%)
	7-9	6 (10.5%)	11 (9.7%)
	10-12	6 (10.5%)	14 (12.3%)
	13-15	5 (8.8%)	11 (9.7%)
	Over 15	4 (7.0%)	7 (6.1%)
	Other (hour, day, etc.)	6 (10.5%)	7 (6.1%)
	Studies That did not Report	7 (12.3%)	16 (14.0%)
Research Design	True Experimental Design	2 (3.5%)	5 (4.4%)
	Quasi Experimental Design	31 (54.4%)	70 (61.4%)
	Experimental Design (Randomly Assigned Clusters)	24 (42.1%)	39 (34.2%)
Teacher Effect	Different Teachers	12 (21.1%)	35 (30.7%)
	Same Teachers	25 (43.9%)	49 (42.3%)
	Other (distance education, etc.)	4 (7.0%)	6 (5.3%)
	Studies That did not Report	16 (28.1%)	24 (21.1%)
Researcher Effect	Not any of Researcher	16 (28.1%)	38 (33.3%)
	Only One of Researcher	7 (12.3%)	11 (9.7%)
	Only Researcher	19 (33.3%)	36 (31.6%)
	Studies That did not Report	15 (26.3%)	29 (25.4%)
Type of Teaching Method Used in The Experimental Group	Computer -and/or Technology-Assisted Learning Method	7 (12.3%)	15 (13.2%)
	Problem-Based Learning Method	3 (5.3%)	5 (4.4%)
	Project-Based Learning Method	6 (10.5%)	12 (10.5%)
	Cooperative Learning Method	5 (8.8%)	10 (8.8%)
	Outdoor Learning Method	3 (5.3%)	13 (11.4%)
	School Garden / School Yard Learning Method	4 (7.0%)	7 (6.1%)
	Inquiry Based and/or Critical Thinking Learning	3 (5.3%)	6 (5.3%)

	Method		
	Environmental Education Courses and Programs	6 (10.5%)	16 (14.0%)
	Field (Nature) Trips And Camps	6 (10.5%)	11 (9.6%)
	Other	14 (24.6%)	19 (16.7%)
Overall Total		*57 (100%)*	*114(100%)*

As seen in Table 1, most of the studies included in the meta-analysis were carried out "between 2008 and 2015" (2008 to 2011, n = 27, 47%; 2012 to 2015, n = 20, 35%)" The majority of these studies were "graduate theses (master's theses, n = 22, 39%; doctoral dissertations, n = 15, 26%)". The number of research papers published in "Turkish (n = 30, 53%)" and "English (n = 27, 47%)" is nearly equal. The studies mostly surveyed "primary education level (n = 28, 49%)" and "samples of 51-100 persons (n = 29, 51%)". With respect to the measuring instruments used in the studies, nearly half of the measuring instruments were developed by researchers (n = 25, 44%) and the majority were composed of objective questions (n = 40, 70%). The studies carried out the interventions in the experimental and control groups for a maximum of four to six weeks (n = 15, 26%), while some studies did not report the duration (n = 7, 12%). The studies generally used an "experimental design (n = 24, 42%)", while more than half of the studies used a "quasi-experimental design (n = 31, 54%)". In nearly half of the studies included in the meta-analysis, interventions were carried out by the same teacher (n = 25, 44%) in the experimental and control groups. However, a significant portion of the primary studies included in the meta-analysis was composed of studies that provided no information on the teacher conducting interventions in the experimental and control groups "(n = 16, 28%)" and those in which different teachers conducted interventions (n = 12, 21%). When the studies were analyzed according to whether researchers conducted interventions in the experimental and control groups, the majority reported that "researchers conducted interventions in both the experimental and control groups (n = 19, %33)". On the other hand, a significant portion of the primary studies was composed of "studies that did not report (n = 16, %28)" whether researchers took part in interventions and "those reported that researchers took no part in interventions (n = 15, %26)". With respect to the active learning and constructivist learning approaches applied in the experimental group, the most commonly used method was "computer- and technology-assisted learning method (n = 7, 12%)", followed by "project-based learning method (n = 6, %11), "environmental education courses and programs (n = 6, 11%)", and "field (nature) trips and camps (n = 6, 11%)".

The normal distribution curve (Figure 2) and the stem and leaf plot (Figure 3) of a total of 114 effect sizes obtained from 57 studies are presented below.

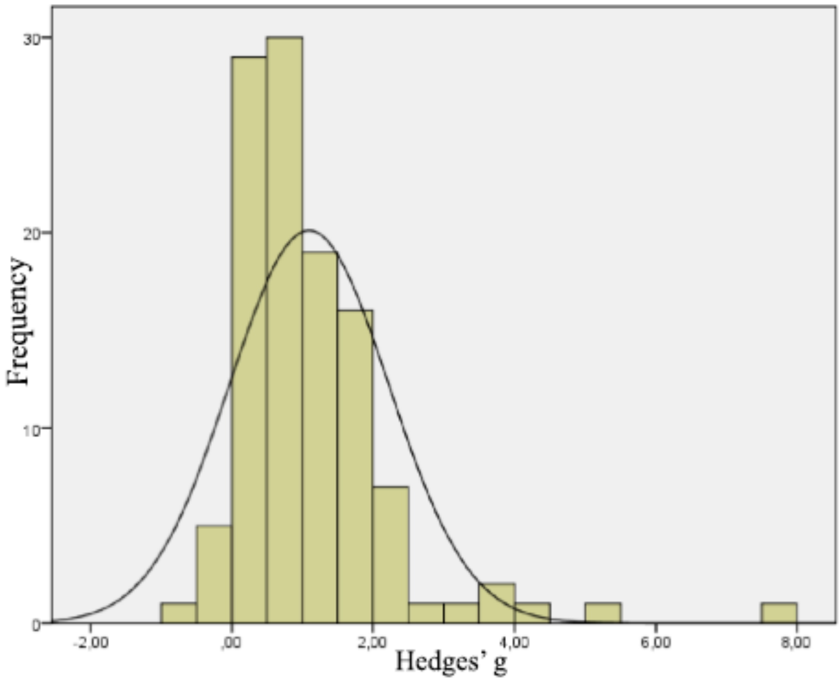


Figure 2. Normal distribution curve histogram for 114 Hedges' g values included in the meta-analysis

Frequency	Stem & Leaf	
1,00	-0 .	7
5,00	-0 .	00113
29,00	0 .	00000001111222222234444444444
30,00	0 .	555555566666667777778888999999
19,00	1 .	0000011111223333344
16,00	1 .	5555556677799999
7,00	2 .	0112344
1,00	2 .	8
1,00	3 .	0
5,00	(>=3,5) Extremes	

Figure 3. Stem and leaf plot related to studies included in meta-analysis

It can be seen from the data in Figure 2, the mean Hedges' g for the studies was 1.014, the mean value 1.094, the standard deviation 1.131, the standard error 0.071, the variance 0.005, the minimum effect size 0.875, and the maximum effect size 1.153. As shown in Figure 3, among 114 effect sizes included in the meta-analysis, 108 (95%) were positive and 6 (5%) are negative. According to the data obtained from the stem and leaf plot, the effect sizes mostly ranged from 0.0 to 0.9 (f=59 (52%)); however, the number of studies with effect sizes of 0.4, 0.0, 0.2, 0.5, and 0.6 was higher than the rest. In line with the data in Figure 2 and Figure 3, the studies included in the meta-analysis had a normal distribution. The total sample size of the studies included in the meta-analysis consisted of 6237 individuals, including 3387 in the experimental group and 2850 in the control group.

Findings on the Effect of Constructivist Learning Approach and Active Learning on Environmental Education

To seek an answer to the first research problem "What is the overall effect of constructivist learning approach or active learning methods on environmental education compared to traditional learning methods?", a systematic analysis was carried out in the following steps: defining the unit of analysis, reliability calculation, publication bias calculation, overall effect size calculation and statistics, power analysis, and heterogeneity analysis.

In order to answer the first research problem, each research was accepted as a unit of analysis. Accordingly, 57 units of analysis were obtained from 57 studies included in the meta-analysis. In studies with more than one effect size, the "mean effect size" was calculated. The mean effect size was calculated using the combined sample size, the combined mean, and the combined standard deviation (Borenstein et al., 2009, pp. 221-222).

With respect to the reliability of the studies included in the meta-analysis, coder reliability and intercoder reliability coefficients were calculated (Lipsey & Wilson, 2001, pp. 73-74; Rosenthal, 2009, pp. 44-45 as cited in Üstün & Eryılmaz, 2014). These reliabilities were calculated using the equation of agreement rate (Orwin & Vevea, 2009, p. 187). Four experts were consulted about the calculation of reliability coefficients. Information about coders is presented in detail in Table 2.

Table 2.

Descriptive statistics about coders

Coder Number	*Gender*	*Job*	*Title*	*Professions*	*Seniority Year*
1	Female	Academics	Doctor	Assessment and evaluation Science education Environmental education Conceptual change and metacognition	10
2	Male	Academics	Doctoral Student	Assessment and evaluation Science education Conceptual change and metacognition	6
3	Female	Teacher	Doctor	Science education Environmental education Problem Based Learning	8
4	Male	Academics	Doctoral Student	Assessment and evaluation Mathematics Education	4

Table 2 shows data on the coders. Accordingly, three coders were female and one was male, three were academics and one was a teacher, two had a doctoral degree and two were doctoral students, three were experts in science education, three in assessment and evaluation, and two in environmental education, and the years of seniority ranged from four to ten years. The mean coder reliability agreement rate was found to be 0.932 and the mean intercoder reliability agreement rate 0.935. These values are greater than the agreement rate of 0.80 suggested by Carletta (1996) and Cohen (1960) and that of.85 suggested by Bayraktar (2001). Therefore, it can be said that the data of this meta-analysis are reliable (Carletta, 1996; Cohen, 1960; Bayraktar, 2001).

Quality of studies and publication bias are two major validity problems in meta-analysis. It might be a solution to this validity problem to determine the quality of studies and exclude poor-quality studies from meta-analysis. However, it is not a right approach to determine the quality of studies included in the meta-analysis using various measures and exclude them from the meta-analysis, which may lead to publication bias (Glass, 1982; Lipsey, & Wilson, 2001; Valentine, 2009, p. 130). Accordingly, all studies that meet the inclusion criteria must be systematically identified and included in the meta-analysis. This study adopted a systematic approach to determine which studies to include in the meta-analysis and thus included studies in the meta-analysis using a PRISMA diagram (Figure 1) (Littell et al., 2008). Forest and funnel plots, Rosenthal's fail-safe N, Orwin's fail-safe N, and Duval and Tweedie's TFM were used to determine the publication bias of the studies included in the meta-analysis (Greenhouse & Iyengar, 2009, pp. 428-430; Rothstein et al., 2005; Üstün & Eryılmaz, 2014). Figure 4 displays the data for the funnel chart.

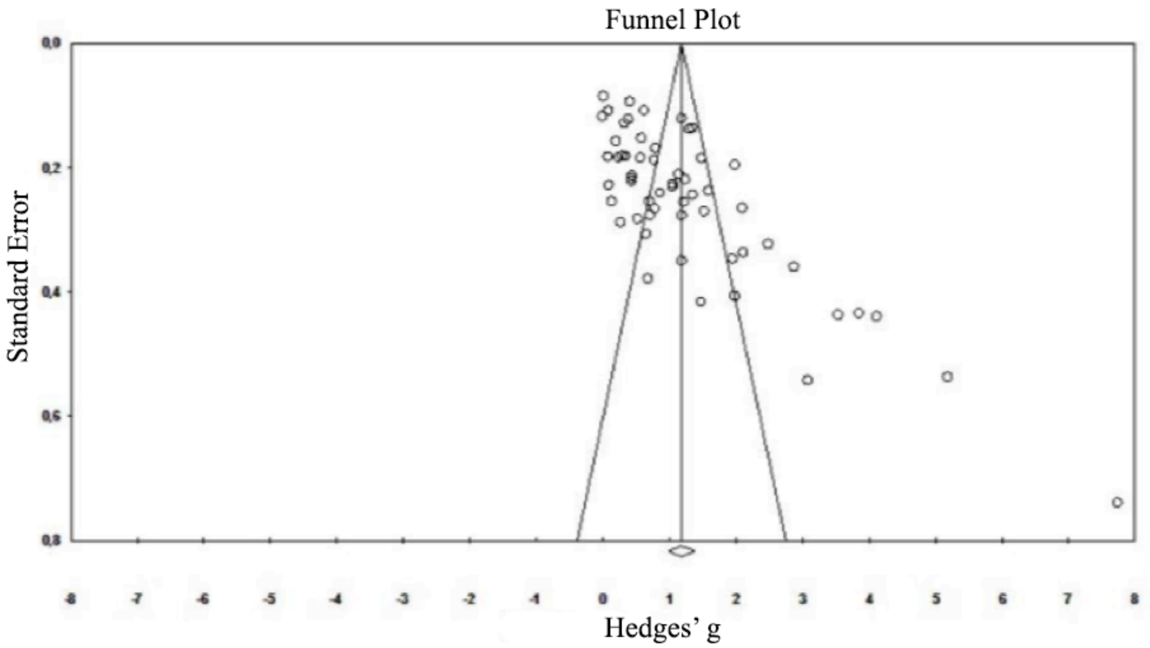


Figure 4. Funnel Plot of studies included in meta-analysis

Figure 4 shows a roughly symmetrical distribution of the studies in the inverted funnel shape. The black squares in the forest plot (Appendix 2) represent the mean effect size for each unit of analysis, the horizontal lines represent the confidence intervals at 95%, and the area of squares represents the weights of studies included in the meta-analysis. The diamond at the bottom of the plot represents the combined effect size of studies. In the forest plot given in Appendix 2, the studies included in the meta-analysis were listed according to their sensitivity based on mean effect sizes. It can be seen from the data in Appendix 2 that there was no significant publication bias for the studies included in the meta-analysis. The followings can be presented as evidence that there is no publication bias: the mean effect sizes of high-sensitivity studies were distributed within a narrower range while the mean effect sizes of low-sensitivity studies were distributed within a wider range, and effect sizes increased with reduced sensitivity. However, the data obtained from the forest and funnel plots are visually analyzed. Thus, the study data must be statistically analyzed. The data were statistically analyzed using "Rosenthal's FSN" (Table 3) and "Orwin's FSN" (Table 4) to show that there was no publication bias in the studies (Greenhouse & Iyengar, 2009, pp. 428-430; Rothstein et al., 2005; Üstün & Eryılmaz, 2014).

Table 3.

Statistical data related to Rosenthal's FSN

	Rosenthal's FSN
Z-value for observed studies	34,15528
p-value for observed studies	0,00000
Alpha	0,05
Tails	2
Z for alpha	1,95996
Number of observed studies	57
FSN	7253

Table 4.

Statistical data related to Orwin's FSN

	Orwin's FSN
Hedges' g observed studies	0,71
Criterion for a 'trial' Hedges' g	0,100
Mean Hedges' g in missing studies	0,000
FSN	351

As shown in Table 3 and Table 4, "Rosenthal's FSN" was 7253 and "Orwin's FSN" was 351 with alpha set at 0.1 for each. These results indicate that if 7253 studies according to "Rosenthal's FSN" and 351 studies according to "Orwin's FSN" were added to the meta-analysis, the meta-analytic mean effect size would be statistically insignificant. If the alpha value was set at 0.05, "Orwin's FSN" would rise to 758. These values are very high compared to the results of 57 studies included in the meta-analysis. The formula N/(5k+10) proposed by Mullen, Muellerleile, and Bryant (2001) can be used to determine how robust FSN is to be far from publication bias. If the value exceeds 1, it indicates that the meta-analysis is sufficiently robust for future studies. According to "Rosenthal's FSN", this value was 7253/(5*57+10)=17.73. This value substantially exceeds 1. Based on the statistical data obtained from "Rosenthal's FSN" and "Orwin's FSN", this meta-analysis seems to be highly robust for possible future studies (Mullen et al., 2001; Borenstein et al., 2009).

Publication bias was finally analyzed using "Duval and Tweedie's trim and fill method (TFM)". The number of missing studies might exist in a meta-analysis was estimated using this method and these possible studies were added to the meta-analysis to estimate the effect of the missing studies on the overall effect size (Üstün & Eryılmaz, 2014). Table 5 shows the case where the adjusted effect sizes with missing studies added using the "TFM" were added to the left of the mean and Table 6 shows the case where they were added to the right.

Table 5.

Adjusted effect size data by "TFM" (missing studies added to the left of the mean)

	Random Effect Model				
	Number of trimmed study	***Hedges' g***	***Lower Limit***	***Upper Limit***	***Q Value***
Observed Effect Size		1.181	0.981	1.382	
Adjusted Effect Size	0	1.181	0.981	1.382	860.856

Table 6.

Adjusted effect size data by "TFM" (missing studies added to the right of the mean)

	Random Effect Model				*Q Value*
	Number of trimmed study	*Hedges' g*	*Lower Limit*	*Upper Limit*	
Observed Effect Size		1.181	0.981	1.382	860.856
Adjusted Effect Size	10	1.463	1.198	1.728	2362.828

Given the data in Table 5, no missing data was added to the left of the mean; however, given the data in Table 6, ten missing data were added to the right of the mean. After the missing data were added to the right of the mean, the adjusted effect size (Hedges' g) was found to be 1.463 with a lower limit of 1.198, an upper limit of 1.728 and Q value of 2362.28. The funnel plot of the adjusted effect size is presented in Figure 5.

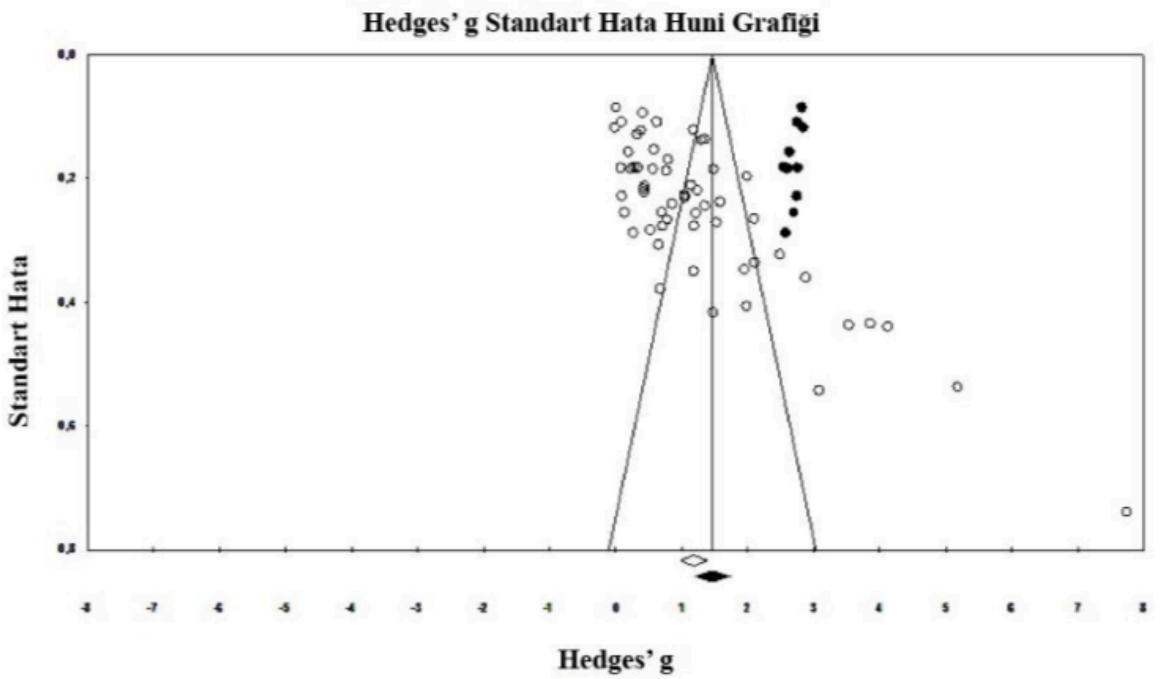


Figure 5. Funnel Plots Related to Adjusted Effect Size of Studies Included in Meta-Analysis

Figure 5 shows that the studies included in the meta-analysis were generally at the center of the inverted funnel, thereby showing a symmetrical distribution. "The adjusted effect size (Hedges' g = 1.463)" and the "overall effect size (Hedges' g = 1.181)" are the same according to the classification proposed by Cohen et al. (2007, p. 521). Both values represent a large effect size. Given the data on both plots, it can be said that there was no publication bias that would affect the bottom of the plot.

Based on the validity and reliability analysis results of the studies included in the meta-analysis, it can be said that there was no problem with validity and reliability in this meta-analysis study. Thus, the overall effect size and the related statistical test results can be analyzed in relation to the first research problem. Table 7 shows statistical data on the overall effect size.

Table 7.

Statistical related to overall effect size

Model	*Descriptive statistics related to studies included in meta-analysis*	*Descriptive statistics related to effect size and 95% confidence interval*					*Null Test*	
	f	k	g	S.E.	Var.	95% confidence interval	Z-value	p-value
Fixed	57	57	0.714	0.025	0.001	0.665-0.763	28.45	0.000
Random	57	57	1.181	0.102	0.010	0.981-1.382	11.54	0.000

As can be seen from Table 7, the overall effect size was "large" (Cohen, 1988) or "strong" (Cohen et al., 2007) at 95% confidence interval (0.981-1.382) for 57 studies (k = 57) included in the meta-analysis according to the random-effects model (k = 57; Hedges' g = 1.181; S = 0.102; S2= 0.010; %95 CI = 0.981-1.382; Z-value = 11.537; p-value = 0.000). The results of the null-hypothesis test showed that the null hypothesis was rejected at$\propto$= 0.05, z = 11.537 (p = 0.000). It can thus be said that all real effect sizes differ significantly from zero. Based on these findings, the constructivist learning approach and/or active learning approach are strongly (largely) effective on environmental education compared to traditional learning methods.

The rejection of the null hypothesis depends on whether robust statistical analysis methods are used. A statistical power analysis was performed to determine the statistical power of the findings obtained from this study (Borenstein et al., 2009, p. 257, Ellis, 2013, p. 52). One of the prime objectives of meta-analysis is to determine the heterogeneity among the studies included in the meta-analysis and to determine the moderator variables considered to cause heterogeneity (Hueda-Medina et al., 2006). Table 8 displays the results of power analysis and heterogeneity analysis.

Table 8.

Findings related to heterogeneity test

Heterogeneity				***Tau- squared (τ^2)***				***Power***	
Q-value	df (Q)	p-value	Iota-squared (ι^2)	Tau-squared (τ^2)	S.E.	S^2	Tau (τ)	Power	B
860,9	56	0.000	93.495	0.526	0.143	0.02	0.725	1.000	0.000

As shown in Table 8, the null hypothesis was rejected at $\alpha = 0.05$ ($p < 0.05$). Thus, all studies shared the common effect size and showed heterogeneity in terms of common effect size. The results of the Q test and I-squared analysis revealed heterogeneity among the studies included in the meta-analysis. The Q value obtained at 56 degrees of freedom (Q = 860.856) was greater than Q(56) = 74.468 given for 56 degrees of freedom at the level of p = 0.05 in the χ^2 distribution table [Q (56) = 860.856 > 74.468]. It can thus be said that the effect size distribution is heterogeneous. I-squared for heterogeneity was 93.495 (ι^2 = 93.495). This represents heterogeneity at 93.495%. Given that this value is over 75%, heterogeneity among the studies included in the meta-analysis seems to be high (Higgins, Thompson, Deeks, & Altman, 2003). In this case, the heterogeneity among the studies must be explained. To this end, the results of the moderator variables must be analyzed and the sources of heterogeneity must be explained (Glass, 1982; Lipsey & Wilson, 2001; Üstün & Eryılmaz, 2014). The power analysis results indicate that the study has high statistical power on the basis of the overall effect size (power = 1). Considering the probability of Type II error, it seems that the probability of failure to detect the effect of the actual application is close to zero (B = 0).

Findings on Whether the Overall Effect Size Differs According to Moderator Variables

This study sought to explain the sources of heterogeneity through 13 moderator variables (year of publication, language of publication, type of publication, country, educational level, sample size, type of questions in measuring instrument, developer of measuring instrument, duration of experimental intervention, research design, teacher effect, researcher effect, and teaching method used in the experimental group). To find out whether the effects of constructivist learning approach and/or active learning on environmental education differed according to moderator variables, a moderator analysis was carried out in relation to the second research problem. Table 9 shows the moderator analysis results.

Table 9.

Summary of results for moderator variable analysis

Moderator Variable	*k*	*Model*	*p Value*	*R^2*	*% of Variance Explained*
Year of Publication	57	Fully Random-Effects Model	0.275	0.157	15.7%
Country			0.044	0.508	50.8%
Sample Size			0.003	0.286	28.6%
Duration of Experimental Intervention			0.065	0.000	0.0%
Educational Level	57	Mixed Effects Model	0.000	0.199	19.9%
Type of Publication			0.000	0.184	18.4%
Type of Measuring Instrument			0.000	0.584	58.4%
Developer of Measuring Instrument			0.000	0.421	42.1%
Language of Publication			0.000	0.508	50.8%
Research Design			0.091	0.000	0.0%
Teacher Effect			0.000	0.128	12.8%
Researcher Effect			0.040	0.000	0.0%
Type of Teaching Method Used in The Experimental Group			0.298	0.000	0.0%

It can be seen from the data in Table 9 that there was no significant difference between the effects of constructivist learning approach, active learning methods and traditional learning methods on environmental education in terms of "year of publication (QB = 3.880; SD = 3; p = 0.275; p > 0.05)", "duration of experimental intervention (QB = 13.290; SD = 7; p = 0.065; p > 0.05)", "research design (QB = 10.905; SD = 6; p = 0.091; p > 0.05)", and "type of teaching method used in the experimental group (p = 0.298; p > 0.05)". On the other hand, a significant difference was found in terms of "country (QB = 6.254; SD = 2; p = 0.044; p < 0.05)", "sample size (QB = 13.811; SD = 3; p = 0.003; p < 0.05)", "educational level (QB = 108.808; SD = 5; p = 0.000; p < 0.05)", "type of publication (QB = 107.870; SD = 3; p = 0.000; p < 0.05)", "type of measuring instrument (QB = 18.545; SD = 3; p = 0.000; p < 0.05)", "developer of measuring instrument (QB = 191.461; SD = 3; p = 0.000; p < 0.05)", "language of publication (QB = 85.965; SD = 1; p = 0.000, p < 0.05)", "teacher effect (QB = 85.990; SD = 3; p = 0.000; p < 0.05)", and "researcher effect (QB = 8.332; SD = 3; p = 0.065; p < 0.05)". With respect to the variance ratios explained by these moderator variables, the moderator variables that had the greatest impact on the overall effect size of are as follows: "type of measuring instrument in terms of questions (58.4%)", "country (50.8%)", "language of publication (50.8%)," "type of measuring instrument in terms of developer (42.1%)", "sample size (28.6%)," "educational level (19.9%), "type of publication (18.4%)", and "teacher effect (12.8%)." Although it significantly differed in terms of overall effect size, the moderator variable "researcher effect (0.0%)" accounted for 0% of the variance. "Duration of experimental intervention (0.00%)", "research design (0.00%)" and "type of type of teaching method used in the experimental group (0.00%)" did not differ significantly in terms of overall effect size and had no effect on variance. However, the moderator variable "year of publication (15.7%)" accounted for 15.7% of the variance although it had no significant effect on the overall effect size.

When the effects of constructivist learning approach and active learning methods on environmental learning were compared to those of traditional learning methods, no significant difference was found in terms of "year of publication" (QB = 3.880; SD = 3; p > 0.05). The ranking of the effect sizes for the moderator variable "year of publication" was as follows: "from 2000 to 2003 (ES = 1.729; k = 3)", "from 2008 to 2011 (ES = 1.251; k = 27)", "from 2012 to 2015 (ES = 1.183; k = 20)", and "from 2004 to 2007 (ES = 0.735; k = 7)".

When the effects of constructivist learning approach and active learning methods on environmental learning were compared to those of traditional learning methods, a significant difference was found in term of "language of publication" (QB = 85.965; SD = 1; p < 0.05). The ranking of the effect sizes for the moderator variable "language of publication" was as follows: "Turkish (ES = 1.066; k = 30)" and "English (ES = 0.560; k = 27)".

When the effects of constructivist learning approach and active learning methods on environmental learning were compared to those of traditional learning methods, a significant difference was also found in term of "type of publication" (QB = 107.870; SD = 3; p < 0.05). The ranking of the effect sizes for the subgroups of the moderator variable "type of publication" was as follows: "other (ES = 2.307; k = 2)", "doctoral dissertation (ES = 0.840; k = 15)", "master's thesis (ES = 0.778; k = 22)", and "article (ES = 0.544; k = 18)".

When the effects of constructivist learning approach and active learning methods on environmental learning were compared to those of traditional learning methods, a significant difference was also found in term of "country" of publication (QB = 6.254; SD = 2; p < 0.05). The ranking of the effect sizes for the subgroups of the moderator variable "country" was as follows: "other (ES = 1.435, k = 10)", "Turkey (ES = 1.245, k = 36)", and "USA (ES = 0.701, k = 11)".

When the effects of constructivist learning approach and active learning methods on environmental learning were compared to those of traditional learning methods, a significant difference was also found in term of "educational level" of the sample (QB = 108.808; SD = 5; p < 0.05). The ranking of the effect sizes for the subgroups of the moderator variable "educational level" was as follows: "not reported (ES = 1.991; k = 1)", "early childhood (ES = 1.350; k = 1)", "higher education (ES = 0.850; k = 17)", "secondary education (ES = 0.835; k = 8)", "primary education (ES = 0.594; k = 28)", and "mixed (ES = 0.259; k = 1)".

When the effects of constructivist learning approach and active learning methods on environmental learning were compared to those of traditional learning methods, a significant difference was also found in term of "sample size" (QB = 13.811; SD = 3; p < 0.05). The ranking of the effect sizes for the subgroups of the moderator variable "sample size" was as follows: “51 to 100 people” (ES = 1.491; k = 29), “< 51 people (ES = 1.203; k = 10)”, “101 to 150 people (ES = 0.831; k = 11)”, and “> 150 people (ES = 0.517; k = 7)”.

When the effects of constructivist learning approach and active learning methods on environmental learning were compared to those of traditional learning methods, a significant difference was also found in term of “type of measuring instrument in terms of questions” (QB = 18.545; SD = 3; $p < 0.05$). The ranking of the effect sizes for the subgroups of the moderator variable “type of measuring instrument in terms of questions” was as follows: “only open-ended questions (ES = 1.988; k = 1)”, “not reported (ES = 0.904; k = 7)”, “mixed (ES = 0.721; k = 9)”, and “only objective questions (ES = 0.670; k = 40)”.

When the effects of constructivist learning approach and active learning methods on environmental learning were compared to those of traditional learning methods, a significant difference was also found in term of “type of measuring instrument in terms of developer” (QB = 191.461; SD = 3; $p < 0.05$). The ranking of the effect sizes for the subgroups of the moderator variable “type of measuring instrument in terms of developer” was as follows: “not reported (ES = 2.370; k = 2)”, “developed by researcher(s) (ES = 1.042; k = 25)”, “pre-existing (ES = 0.489; k = 21)”, and “adapted (ES = 0.468; k = 9)”.

When the effects of constructivist learning approach and active learning methods on environmental learning were compared to those of traditional learning methods, no significant difference was found in terms of “duration of experimental intervention” (QB = 13.290; SD = 7; $p > 0.05$). The ranking of the effect sizes for the subgroups of the moderator variable “duration of experimental intervention” was as follows: “not reported (ES = 1.902; k = 7)”, “7 to 9 weeks (ES = 1.687; k = 6)”, “10 to 12 weeks (ES = 1.507; k = 6)”, “< 4 weeks (ES = 1.240; k = 8)”, “13 to 15 weeks (ES = 1.223; k = 5)”, “>15 weeks (ES = 0.843; k = 4)”, “4 to 6 weeks (ES = 0.803; k = 15)”, and “other (ES = 0.792; k = 6)”.

When the effects of constructivist learning approach and active learning methods on environmental learning were compared to those of traditional learning methods, no significant difference was found in terms of “research design” (QB = 10.905; SD = 6; $p > 0.05$). The ranking of the effect sizes for the subgroups of the moderator variable “research design” was as follows: “experimental design (random assignment) (ES = 1.690; k = 17)”, “experimental design (no information on assignment) (ES = 1.464; k = 4)”, “true experimental design (ES = 1.225; k = 2)”, “quasi-experimental design (random assignment) (ES = 1.037; k = 13)”, “experimental design (non-random assignment) (ES = 0.961; k = 13)”, “quasi-experimental design (no information on assignment) (ES = 0.728; k = 5)”, and “experimental design (non-random assignment) (ES = 0.654; k = 3)”

When the effects of constructivist learning approach and active learning methods on environmental learning were compared to those of traditional learning methods, a significant difference was found in term of “teacher effect” (QB = 85.990; SD = 3; $p < 0.05$). The ranking of the effect sizes for the subgroups of the moderator variable “teacher effect” was as follows: “other (ES = 1.643; k = 4)”, “not reported (ES = 0.759; k = 16)”, “same teacher (ES = 0.758; k = 25)”, and “different teacher (ES = 0.519; k = 12)”.

When the effects of constructivist learning approach and active learning methods on environmental learning were compared to those of traditional learning methods, a significant difference was also found in term of “researcher effect” (QB = 8.332; SD = 3; $p < 0.05$). The ranking of the effect sizes for the subgroups of the moderator variable “researcher effect” was as follows: “only one was researcher (ES = 1.918; k = 7)”, “all were researchers (ES = 1.180; k = 19)”, “not reported (ES = 1.168; k = 15)”, and “none was researcher (ES = 0.896; k = 16)”.

When the effects of constructivist learning approach and active learning methods on environmental learning were compared to those of traditional learning methods, no significant difference was found in terms of “ constructivist learning and active learning” (QB = 10.679; SD = 9; $p > 0.05$). The ranking of the effect sizes for the subgroups of the moderator variable “teaching method” was as follows: “outdoor education (ES = 1.864; k = 3)”, “problem-based learning (ES = 1.652; k = 3)”, “other (ES = 1.593; k = 14)”, “project-based learning (ES =

1.085; k = 6)", "environmental education courses and programs (ES = 1.084; k = 6)", "garden-based education (ES = 1.051; k = 4)", "cooperative learning (ES = 1.014; k = 5)", "computer-assisted learning (ES = 0.910, k = 7)", "field (nature) trips and camps (ES = 0.763; k = 6)", and "inquiry based and/or critical thinking learning (ES = 0.743; k = 3)".

Results and Discusion

This study set out to investigate the effects of constructivist learning approach and active learning on environmental education in comparison with traditional learning methods and combined 114 effect sizes derived from 57 studies to treat each study as a unit of analysis (k = 57). The results of the random-effects meta-analysis showed that constructivist learning approach and/or active learning methods had a large (strong)(Cohen, 1988, p. 40; Cohen et al., 2007, p. 521) and positive effect on environmental education compared to traditional learning methods (k = 57; Hedges' g = 1.463; SH = 0.102; S2= 0.010; CI = 0.981-1.382). No meta-analysis research has been found that investigated the effect of constructivist learning approach and active learning on environmental education. Earlier meta-analysis studies on environmental education have used three different meta-analysis methods. The first is the meta-analysis studies on the effectiveness of relations (Hines et al., 1987; Bamberg & Mömer, 2007; Hurst et al., 2013; Klöckner, 2013), the second is the meta-analysis studies on the effectiveness of scale studies (Hawcroft & Milfont, 2010), and the third is the meta-analysis studies on the effectiveness of differences (Zelezny, 1999; Osbaldiston & Schott, 2011; Mifsud, 2012), which is the case in the present study. With respect to the meta-analysis studies on the effectiveness of differences, the results of Osbaldiston and Schott (2011) are similar to those of the present study, while the results of Zelezny (1999) differ from those of the present study.

Osbaldiston and Schott (2011) studied the effectiveness of experimental treatments conducted between 1980 and 2010 on pro-environmental behavior. The authors aimed to examine how to promote pro-environmental behavior using meta-analysis. Their sample consisted of 87 published reports between 1980 and 2010 (n = 87; k = 243). They found that treatments including "cognitive dissonance", "goal setting", "social modeling", and "prompts" had a very large effect on pro-environmental behavior (Osbaldiston & Schott, 2011). The findings of this study support the present study. However, the two studies differ in year criterion, and dependent and independent variables.

Zelezny (1999) compared the effects of educational interventions in classrooms and those in non-traditional settings on environmental behavior in the period from 1971 to 1996. The research was restricted to studies that were published from 1971 to 1996. The sample consisted of nine published studies that involved classroom interventions and nine that involved interventions in non-traditional settings. The effect sizes were compared according to r-effect size. The effect size was r = .65 for classroom interventions and r = .27 for interventions in non-traditional settings. Accordingly, educational interventions in non-traditional settings were less effective in improving environmental behavior compared to classroom interventions. Additionally, active participation was found to be more likely in classrooms interventions compared to interventions in non-traditional settings. The research reported that the studies included in the meta-analysis used poor research designs and had low research quality (Zelezny, 1999). The results reported by Zelezny differ from the findings of the present study. There might be several possible explanations for this discrepancy. It might be that Zelezny (1999) sampled much earlier studies (1971-1996), the studies included in the meta-analysis used simple experimental designs, the effect size was calculated using the r family, and different dependent variables were used.

Mifsud (2012) meta-analyzed twenty-one studies on environmental knowledge, attitude, and behavior of young people. Although the title of the study suggests that a meta-analysis would be performed, it was rather a systematic review. Thus, no effect size was reported. However, the findings reported by Mifsud (2012) are consistent with the findings of the present study. The studies analyzed by Mifsud (2012) mostly focused on primary and secondary school students but laid much less stress on students aged 16 to 18 years. The findings of these studies showed that young people had a positive attitude towards the environment and environmental issues, and women had a more positive attitude towards the environment than men. The majority of the studies (n = 20) used quantitative research methods, one study used only a qualitative research method, and two studies used both qualitative and quantitative research methods. The quantitative studies mostly used multiple-choice and Likert-type attitude scales. Television, books, newspapers, schools, and groups of friends constituted the main sources of environmental information for the sample of young people. Environmental problems that the sample group often mentioned included "air pollution", "water pollution", "degradation of biodiversity", and "population growth in metropolitan areas".

No previous meta-analysis research has focused on the effect of the constructivist learning approach and active learning on environmental academic achievement and environmental attitudes. However, previous meta-analysis studies investigated the effects of constructivist learning approach or active learning on academic performance in different disciplines (such as mathematics, astronomy, and science) (Schmidt, Van der Molen, Te Winkel, & Wijnen, 2009; Çelik, 2013; Topan, 2013; Batdı, 2014b; Ayaz & Şekerci, 2015; Semerci & Batdı, 2015; Yaşar, Çengelci Köse, Göz, & Gürdoğan Bayır, 2015; Lee, Lee, Gong, Bae, & Choi, 2016; Ural & Bümen, 2016; Bozdemir, Ezberci Çevik, Altunoğlu, & Kurnaz, 2017; Şad, Kış & Demir, 2017) and on attitudes (Ayaz & Şekerci, 2015; Semerci & Batdı, 2015; Toraman & Demir, 2016; Ural & Bümen, 2016). In accordance with the present results, the majority of previous studies reported a "large (strong)" (Cohen, 1988, p. 40) and positive effect size (Çelik, 2013; Topan, 2013; Batdı, 2014b; Ayaz & Şekerci, 2015; Semerci & Batdı, 2015; Yaşar et al., 2015; Ural & Bümen, 2016; Bozdemir et al., 2017; Şad et al., 2017). Çelik (2013) reported that alternative teaching methods had a "large" effect on primary school students' academic performance in mathematics (Cohen's d = 0.887). Topan (2013) observed that student-centered methods had a "large" effect on students' mathematical academic achievement (Hedges' g = 0.892). Batdı (2014b) also found that activity-based learning approaches had a "large" effect on students' academic performance (ES = 2.26). Similarly, Ayaz and Şekerci (2015) determined that the constructivist learning approach had a "large "effect on students' academic performance (Hedges' g = 1.40). Likewise, Semerci and Batdı (2015) reported that the constructivist learning approach had a "large" effect on students' academic performance (Cohen's d = 1.08). Yaşar et al. (2015) also showed that student-centered learning-teaching processes in social studies classes had a "large" effect on students' academic performance (Hedges' g = 1.25). Ural and Bümen (2016) found that constructivist instructional practices used in science and technology teaching in Turkey had a "large" effect on students' science performance (Cohen's d = 1.00). Bozdemir et al. (2017) reported that different teaching approaches used in teaching astronomy subjects had a "large" effect on students' academic performance in astronomy (Hedges' g = 0.816). Şad et al. (2017) also observed that contemporary learning approaches had a "large" effect on students' mathematics academic performance (Cohen's d = 0.93). Contrary to these results, Lee et al. (2016) found that non-traditional learning methods had a "small" effect on critical thinking skills of nursing students (ES = 0.42 and ES = 0.29). Similarly, Schmidt et al. (2009) observed that constructivist learning approaches using problem-based learning had a "weak" effect on medical knowledge of medical students (d = 0.07). However, these studies differ from the present study in terms of both sample groups and the treatment of different dependent variables.

Some previous meta-analysis studies focused on the effect of constructivist learning approach or active learning on student attitudes in different disciplines (science and technology, and mathematics) (Ayaz & Şekerci, 2015; Semerci & Batdı, 2015; Toraman & Demir, 2016; Ural & Bümen, 2016). These studies differ in their findings. Ayaz and Şekerci (2015) observed that the effect of the constructivist learning approach on student attitudes was "moderate" (Hedges' g = 0.755). Similarly, Toraman and Demir (2016) reported a "moderate" effect (ES = 0.728) of constructivist learning approach on student attitudes. Likewise, Ural and Bümen (2016) found that constructivist instructional practices used in science and technology teaching in Turkey had a "moderate" effect on students' science attitudes (Cohen's d = 0.743). In contrast to these findings, Semerci and Batdı (2015) reported a “modest” effect (Cohen’s d = 0.44) of constructivist learning approach on student attitudes. These differences might be explained by the fact that affective characteristics such as motivation, attitude, sensitivity develop at an early age, it takes a long time for them to develop, and they are hard to change (Smith, 1968; Kağıtçıbaşı, 2010, p. 132). Another possible explanation for the difference between the present study and previous meta-analysis studies that investigated affective characteristics might be that the present study investigated a specific discipline, such as environmental education, and involved different moderator variables.

According to the results of the “Q test” run to determine the homogeneity of the studies included in the meta-analysis, the null hypothesis was rejected atα 0.05 ($p = 0.000$; $p < 0.05$; $z = 11.537$) and all the studies included in the meta-analysis shared a common effect size but showed a heterogeneous distribution with respect to the common effect size ($Q(56) = 860.856 > \chi 2$ distribution table $Q(56) = 74.468$) ($Q(56) = 860.856$). The “I-square analysis” results revealed a high level of heterogeneity ($\iota 2>75$)($\iota 2= 93.495$) (Higgins et al., 2003). The sources of heterogeneity was explored by the moderator analysis (Glass, 1982; Lipsey & Wilson, 2001; Üstün & Eryılmaz, 2014).

According to the results of the moderator analysis, a significant difference was found between the effects of constructivist learning approach, active learning methods and traditional learning methods on environmental education in terms of “country (QB = 6.254; SD = 2; p = 0.044; p < 0.05)”, “sample size (QB = 13.811; SD = 3; p = 0.003; p < 0.05)”, “educational level (QB = 108.808; SD = 5; p = 0.000; p < 0.05)”, “type of publication (QB = 107.870; SD = 3; p = 0.000; p < 0.05)”, “type of measuring instrument (QB =18.545; SD = 3; p = 0.000; p < 0.05)”, “developer of measuring instrument (QB = 191.461; SD = 3; p = 0.000; p < 0.05)”, “language of publication (QB = 85.965; SD = 1; p = 0.000, p < 0.05)”, “teacher effect (QB = 85.990; SD = 3; p = 0.000; p < 0.05)”, and “researcher effect (QB = 8.332; SD = 3; p = 0.065; p < 0.05)”. However, there was no significant difference in terms of “year of publication (QB = 3.880; SD = 3; p = 0.275; p > 0.05)”, “duration of experimental intervention (QB = 13.290; SD = 7; p = 0.065; p > 0.05)”, “research design(QB = 10.905; SD = 6; p = 0.091; p > 0.05)”, and “type of teaching method used in the experimental group (p = 0.298; p > 0.05)”.

Previous studies have analyzed the effect of some of these moderator variables. The findings of the present study corroborate some of the earlier findings but differ from some other. In their meta-analysis studies, Üstün (2012), Kyndt, Raes, Lismont, Timmers, Cascallar, and Dochy (2013), and Gözüyeşil and Dikici (2014) found the overall effect size significantly differed according to the moderator variable “country”, which is consistent with the present results. In agreement with the present results, Şad et al. (2017) showed that the overall effect size significantly differed according to the moderator variable “sample size”. The present result that the overall effect size significantly differed according to the moderator variable “educational level” matches the results observed in earlier studies (Özdemirli, 2011; Batdı, 2014a; Batdı (2015), Capar & Tarim, 2015; Akdemir & Karakuş, 2016; Ayaz & Söylemez, 2016; Başar, Aşkın, & Gelbal, 2016; Üstünel, 2016). The present result that the overall effect size significantly differed according to the moderator variable “type of publication” also confirms earlier results (Üstün, 2012; Ayaz, 2015c; Kanadlı, Ünal, & Karakuş, 2015; Karakuş & Öztürk, 2016; Karakuş & Yalçın, 2016; Lazonder & Harmsen, 2016). Consistent with the present study, Üstün (2012) observed that the overall effect size significantly differed according to the moderator variable “type of measuring instrument in terms of developer”. In agreement with the present study, Öner Armağan (2011) found that the overall effect size significantly differed according to the moderator variable “researcher effect”. No previous study has reported that the overall effect size significantly differed according to the moderator variable “type of measuring instrument in terms of questions. No previous study has supported or rejected the impact of the moderator variable “language of publication” on the overall effect size. Consistent with the present study, earlier studies observed that the overall effect size did not significantly differ according to the moderator variable “year of publication” (Şahin, 2005; Shin & Kim, 2013; Şen & Yılmaz, 2013; Batdı, 2015; Toraman & Demir, 2016; Başol & Erbay, 2017). Again consistent with the present results, earlier studies reported that the overall effect size did not significantly differ according to the moderator variable "duration of experimental intervention"(Ayaz, 2015c; Capar & Tarim, 2015; Dağyar & Demirel, 2015; Kaplan, Duran, & Baş, 2015; Cantürk Günhan, 2016; Lazonder & Harmsen, 2016; Şad et al., 2017). In agreement with the present study, earlier studies reported that the overall effect size did not significantly differ according to the moderator variable "research design"(Shin & Kim, 2013; Belland, Walker, Whitney Olsen,& Leary, 2015; Jeong, Hmelo-Silver, Jo, & Shin, 2016; Lazonder & Harmsen, 2016). Consistent with the present study, Çelik (2013) observed that the overall effect size did not significantly differ according to the moderator variable "type of teaching method used in the experimental group". In contrast to the results of this research, previous studies reported that the overall effect size did not differ by the moderator variables "sample size" (Şen & Yılmaz, 2013; Gözüyeşil & Dikici, 2014; Ayaz, 2015a; Ayaz, 2015b; Dağyar & Demirel, 2015; Ayaz & Söylemez, 2016; Cantürk Günhan, 2016), "educational level" (Shin & Kim, 2013; Gözüyeşil & Dikici, 2014; Ayaz, 2015c; Yurt & Polat, 2015; Toraman & Demir, 2016; Başol & Erbay, 2017), "type of publication" (Ayaz & Söylemez, 2015; Yurt & Polat, 2015; Ayaz, Şekerci & Oral, 2016; Karakuş & Yalçın, 2016; Lazonder & Harmsen, 2016; Toraman & Demir, 2016), "type of measuring instrument in terms of questions" (Öner Armağan, 2011; Üstün, 2012), "developer of measuring instrument" (Öner Armağan, 2011), and "teacher effect" (Üstün, 2012).

Suggestions

The findings of this study provide valuable insights for future research. The following recommendations can be offered to all educators who study and are involved in environmental education, constructivist learning, and active learning processes:

- "Constructivist learning approach" and "active learning" have a large effect on environmental education compared to "traditional learning". Therefore, these methods and techniques should be frequently used in environmental education classes, projects, and activities.
- The findings on the moderator variables determined to be effective in this study should be taken into account when using these methods.
- The sample size of application classes should be 50 and below and the duration of application should be 7 to 12 weeks.
- Meticulous attention should be devoted to environmental education in early childhood, during when it is most effective. Measuring instruments consisting of both open-ended and objective questions should be used to measure the cognitive and affective aspects related to the environment.
- Outdoor education and problem-based learning methods that have proven to be more effective compared to other methods should be used more often to promote students' environmental knowledge and attitudes.

▪ ▪ ▪

References

Abd-El-Khalick, F., Bell, R., & Lederman, N. (1998). The nature of science and instructional practice: Making the unnatural natural. *Science Education, 82*, 417- 436.

Adler, A. (2012). *Bireysel psikoloji.* (C. Çelebi, çev.) Ankara: Altınpost.

Aguilar, O. M., Waliczek, T. M., & Zajicek, J. M. (2008). Growing environmental stewards: The overall effect of a school garden program on environmental attitudes and environmental locus of control of different demografic group of elementary school children. *HortTechnology, 18* (2), 243-249.

Aivazidis, C., Lazaridou, M., & Hellden, G. F. (2006). A comparaison between a traditional and an online environmental program. *The Journal of Environmental Education, 37* (4), 45-54.

Akdemir, H. & Karakuş, M. (2016). Yaratıcı drama yönteminin akademik başarı üzerine etkisi: Bir meta-analiz çalışması. *International Journal of Active Learning, 1*(2), 55-67.

Arık, S. (2010). *Geniş etkili güncel olayların öğretmen adaylarının bilimin doğası hakkındaki görüşlerine etkisi.* Yüksek lisans tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, İlköğretim Anabilim Dalı Fen Bilgisi Öğretmenliği Bilim Dalı, Ankara.

Arık, S. (2017). *Yapılandırmacı öğrenme yaklaşımı ve aktif öğrenmenin çevre eğitimi üzerine etkisinin sistematik incelenmesi ve meta-analizi.* Doktora tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Matematik ve Fen Bilimleri Eğitimi Anabilim Dalı Fen Bilgisi Eğitimi Bilim Dalı, Ankara.

Aslan Efe, H. (2015). Animasyon destekli çevre eğitiminin akademik başarıya, akılda kalıcılığa ve çevreye yönelik tutuma etkisi. *Bilgisayar ve Eğitim Araştırmaları Dergisi, 3* (5), 130-143.

Ayaz, M. F. (2015a). 5E öğrenme modelinin öğrencilerin derslere yönelik tutumlarına etkisi: Bir meta-analiz çalışması. *Elektronik Eğitim Bilimleri Dergisi, 4*(7), 29-50.

Ayaz, M. F. (2015b). Probleme dayalı öğrenme yaklaşımının öğrencilerin fen derslerindeki akademik başarılarına etkisi: Bir meta-analiz çalışması. *Electronic Turkish Studies, 10*(3), 139-160.

Ayaz, M. F. (2015c). Probleme dayalı öğrenme yaklaşımının öğrencilerin fen derslerine yönelik tutumlarına etkisi: Bir meta-analiz çalışması. *Uşak Üniversitesi Sosyal Bilimler Dergisi, 8* (4), 51-76.

Ayaz, M. F., & Şekerci, H. (2015). Yapılandırmacı öğrenme yaklaşımının akademik başarıya ve tutuma etkisi: Bir meta-analiz çalışması. *Hasan Ali Yücel Eğitim Fakültesi Dergisi, 12* (2), 27-44.

Ayaz, M., & Söylemez, M. (2016). The effect of project-based learning approach on students' attitudes towards science lesson: A meta-analysis study. *Adıyaman University Journal of Educational Sciences, 6*(1), 112-137.

Ayaz, M., Şekercı, H., & Oral, B. (2016). The effect of using of instructional technology to elementary school students' academic achievement: A meta-analysis study. *Journal of The Faculty of Education, 17*(1), 35-54.

Balkan Kıyıcı, F. (2009). Eğitim fakülteleri için genel çevre bilimi. V. Sevinç (Ed.) içinde, *Çevre eğitimi.* Ankara: Maya Akademi.

Balkan Kıyıcı, F., & Atabek Yiğit, E. (2010). Sınıf duvarlarının ötesinde fen eğitimi: Rüzgar santraline teknik gezi. *International Online Journal of Educational Sciences, 2*(1), 225-243.

Bamberg, S., & Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behavior. *Journal of Environmental Psychology, 27*, 14-25.

Başar, T., Aşkın, G. & Gelbal, S. (2016). Tam öğrenme yaklaşımının öğrencilerin akademik başarıları üzerindeki etkisi: Bir meta-analiz çalışması. *Eğitimde ve Psikolojide Ölçme ve Değerlendirme Dergisi, 7*(2), 355-371.

Başol, G. & Erbay, Ş. (2017). Portfolyo kullanımının akademik başarıya etkisi: Bir meta analiz çalışması. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi (H. U. Journal of Education), 32*(2), 396-412.

Başol, G., Doğuyurt, M., & Demir, S. (2016). Türkiye örnekleminde meta analiz çalışmalarının içerik analizi ve metodolojik değerlendirilmesi. *International Journal of Human Sciences, 13*(1), 714-745.

Batdı, V. (2014a). Kavram haritası tekniği ile geleneksel öğrenme yönteminin kullanılmasının öğrencilerin başarıları, bilgilerinin kalıcılığı ve tutumlarına etkisi: Bir meta-analiz çalışması. *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi,* (42), 93-102.

Batdı, V. (2014b). Etkinlik temelli öğrenme yaklaşımının akademik başarıya etkisi (Meta-analitik ve tematik bir çalışma). *e-International Journal of Educational Research, 5* (3), 39-55.

Batdı, V. (2015). A meta-analytic study concerning the effect of computer-based teaching on academic success in Turkey. *Educational Sciences: Theory and Practice, 15* (5), 1271-1286.

Bax, L., Yu, L.-M., Ikeda, N., & Moons, K. (2007). A systematic comparison of software dedicated to meta-analysis of causal studies. *BMC Medical Research Methodology, 7* (40), 1-9.

Bayraktar, S. (2001). A meta-analysis of the effectiveness of computer-assisted instruction in science education. *Journal of Research on Technology in Education, 34* (2), 173- 188.

Becker, P., Lindner, M., Loynes, C., & Pedersen Gurholt, K. (2016). *Human nature relations through the lens' of three European outdoor education traditions: A case study of a masters programme.* 7th International Outdoor Education Research Conference, (s. 82). Cape Breton Island.

Belland, B., Walker, A., Whitney Olsen, M., & Leary, H. (2015). A pilot meta-analysis of computer-based scaffolding in STEM education. *Journal of Educational Technology & Society, 18* (1), 183-197.

Benzer, E. (2010). *Proje tabanlı öğrenme yaklaşımıyla hazırlanan çevre eğitimi dersinin fen bilgisi öğretmen adaylarının çevre okuryazarlığına etkisi.* Doktora Tezi, Marmara Üniversitesi Eğitim Bilimleri Enstitüsü, İlköğretim Anabilim Dalı Fen Bilgisi Öğretmenliği Bilim Dalı, İstanbul.

Bilgili, S. (2008). *İlköğretim 7. sınıf fen ve teknoloji dersinde çevre konularının öğretiminde, yapılandırmacı yaklaşıma dayalı işbirlikli öğrenmenin öğrencilerin erişine etkisi.* Yüksek Lisans Tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, İlköğretim Anabilim Dalı Fen Bilgisi Öğretmenliği Bilim Dalı, Ankara.

Blair, D. (2009). The child in the garden: An evaluative review of the benefits of school gardening. *The Journal of Environmental Education, 40* (2), 15-38.

Bodzin, A. (2008). Integrating instructional technologies in a local watershed investigation with urban elementary learners. *The Journal of Environmental Education, 39* (2), 47-58.

Borenstein, M., Hedges, L., Higgins, J., & Rothstein, H. (2009). *Introduction to meta-analysis*. New jersey: Wiley.

Bozdemir, H., Ezberci Çevik, E., Altunoğlu, B. & Kurnaz, M. (2017). Astronomi konularının öğretiminde kullanılan farklı yöntemlerin akademik başarıya etkisi: Bir meta analiz çalışması. *Alan Eğitimi Araştırmaları Dergisi (ALEG), 3* (1), 12-24.

Bozdoğan, A. (2012). Eğitim amaçlı gezilerin planlanmasına ilişkin fen bilgisi öğretmen adaylarının uygulamaları: Altı farklı alan gezisinin değerlendirilmesi. *Kuram ve Uygulamada Eğitim Bilimleri, 12* (2), 1050-1072.

Broyles, I. (2011). *Distributed cognition minicourse: An instructional intervention to improve the effectiveness of one-day environmental education camps.* Doctor of philosophy, Capella University, Minneapolis, MN.

Burek, K. (2012). *The impact of socioscientific issues based curriculum involving environmental outdoor education for fourth grade students.* Doctor of philosophy, University of South Florida College of Education, Science Education Department of Secondary Education, Florida.

Bülbül, Y. (2007). *Ortaöğretim çevre ve insan dersinde işbirlikli öğrenme yönteminin çevreye yönelik tutumlara ve erişiye etkisi.* Yüksek lisans tezi, Çanakkale Onsekiz Mart Üniversitesi Sosyal Bilimler Enstitüsü, Ortaöğretim Sosyal Alanlar Eğitimi Anabilim Dalı Coğrafya Eğitimi Bilim Dalı, Çanakkale.

Cantürk Günhan, B. (2016). Türkiye'de uygulanan drama temelli eğitimin matematik başarısına etkisi: Bir Meta-Analiz çalışması. *International Online Journal of Educational Sciences, 8* (2), 145-162.

Capar, G., & Tarim, K. (2015). Efficacy of the cooperative learning method on mathematics achievement and attitude: A meta-analysis research. *Educational Sciences: Theory & Practice (EDAM), 15*(2), 553-559.

Carletta, J. (1996). Assessing agreement on classification tasks: The kappa statistic. *Computational Linguistics, 22*(2), 249-254.

Chen, M., & Chan, K. (2016). Effects of parenting programs on child maltreatment prevention a meta-analysis. *Trauma, Violence, & Abuse, 17* (1), 88-104.
Cohen, J. (1960). A coefficient of agreement for nominal scale. *Educational and Psychological Measurement*, 20, 37-46.
Cohen, J. (1988). *Statistical power analysis for the behavioral sciences. Second Edition.* USA: Lawrence Erlbaum Associates.
Cohen, L., Manion, L., & Morrison, K. (2007). *Research in education. Sixth Edition.* USA: Routhledge.
Cooper, H. (2010). *Research synthesis and meta-analysis a step-by-step approach.* USA: Sage Publishing.
Cooper, H., & Hedges, L. (2009). Research Synthesis as a Scientific Process. H. Cooper, L. V. Hedges, & J. C. Valentine (Eds.) içinde, *Second edition the handbook of research synthesis and meta-analysis* (s. 3-16). New York: Russell Sage Foundation.
Cömert, H. (2011). *Çevre sorunları ve etkileri konusundaki işbirlikli öğrenme etkinliklerinin öğrencilerin bilgi, tutum ve davranışlarına etkisi.* Yüksek lisans tezi, İstanbul Üniversitesi Fen Bilimleri Enstitüsü, İlköğretim Anabilm Dalı Fen Bilgisi Eğitimi Programı, İstanbul.
Creswell, J. (2005). *Educational research: Planning, conducting and evaluating quantitative and qualitative research (2nd edition).* New Jersey: Pearson.
Cronin-Jones, L. (2000). The effectiveness of schoolyards as sites for elementary science instruction. *School Science and Mathematics, 100* (4), 203-211.
Çelik, S. (2013). *İlköğretim matematik derslerinde kullanılan alternatif öğretim yöntemlerinin akademik başarıya etkisi: Bir meta-analiz çalışması.* Yüksek lisans tezi, Eskişehir Osmangazi Üniversitesi Eğitim Bilimleri Enstitüsü, İlköğretim Anabilim Dalı İlköğretim Matematik Öğretmenliği Bilim Dalı, Eskişehir.
Çetin, G. (2003). *The effect of conceptual change instruction on understanding of ecology concepts.* Doctor of philosophy, The Middle East Technical University , Department of Secondary Science and Mathematics Education, Ankara.
Dağyar, M. & Demirel, M. (2015). Probleme dayalı öğrenmenin akademik başarıya etkisi: Bir meta-analiz çalışması. *Eğitim ve Bilim, 40* (181), 139-174.
DeWitt, J., & Storksdieck, M. (2008). A short review of school field trips: Key findings from the past and implications for the future. *Visitor Studies, 11* (2), 181-197.
Dochy, F., Segers, M., Bossche, P., & Gijbels, D. (2003). Effects of problem-based learning: A meta-analysis. *Learning and Instruction,* 13, 533-568.
Ellis, P. (2013). *The essential guide to effect sizes: Statistical power, meta-analysis, and the interpretation of research results.* New York: Cambridge University Press.
Ennis, R. H. (1985). A Logical basis for measuring critical thinking skills. *Educational Leadership, 43* (2), 44-48.
Erentay, N. (2013). *Okul dışı doğa uygulamalarının beşinci sınıf öğrencilerinin fene ilişkin bilgi, bilimsel süreç becerileri ve çevreye yönelik tutumlarına etkisi.* Yüksek lisans tezi, Akdeniz Üniversitesi Eğitim Bilimleri Enstitüsü, Antalya.
Erkuş, A. (2017). *Davranış bilimleri için bilimsel araştırma süreci (5. Baskı).* Ankara: Seçkin.
Fan, X. (2001). Statistical significance and effect size in education research: Two sides of a coin. *The Journal of Educational Research, 94* (5), 275-282.
Field, J. (2001). Lifelong education. *International Journal of Lifelong Education, 20* (1-2), 3-15.
Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new are of cognitive - development inquiry. *American Psychologist, 34* (10), 906-911.
Glass, G. (1982). Meta-analysis: An approach to the synthesis of research results. *Journal of Research in Science Teaching, 19*(2), 93-112.
Glass, G. V. (1976). Primary, secondary, and meta-analysis of research. *Educational Researcher, 5* (10), 3-8.
Glass, G., & Smith, M. (1979). Meta-analysis of research on class size and achievement. *Educational Evaluation and Policy Analysis, 1* (1), 2-16.
Gnanalet, S., & Ramakrishnan, K. (2010). *Effectiveness of multimedia programme in teaching Environmental education-a study.* International Conference on e-resources

in Higher Education: Issues, Developments, Opportunities and Challenges. Tamilnadu.
Gökmen, A. (2008). *Bilgisayar destekli çevre eğitiminin öğretmen adaylarının madde döngüleri konusundaki başarılarına etkisi.* Yüksek lisans tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ortaöğretim Fen ve Matematik Alanları Eğitimi Anabilim Dalı Biyoloji Eğitimi Bilim Dalı, Ankara.
Gözüyeşil, E., & Dikici, A. (2014). Beyin temelli öğrenmenin akademik başarıya etkisi: Bir meta-analiz çalışması. *Kuram ve Uygulamada Eğitim Bilimleri, 14* (2), 629-648.
Greenhouse, J. B., & Iyengar, S. (2009). Sensitivity analysis and diagnostics. H. Cooper, L. V. Hedges, & J. C. Valentine (Eds.) içinde, *Second edition the handbook of research synthesis and meta-analysis* (s. 417-433). New York: Russell Sage Foundation.
Güven, E. (2011). *Çevre eğitiminde tahmin-gözlem-açıklama destekli proje tabanlı öğrenme yönteminin farklı değişkenler üzerine etkisi ve yönteme ilişkin öğrenci görüşleri.* Doktora tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, İlköğretim Anabilim Dalı Fen Bilgisi Öğretmenliği Bilim Dalı, Ankara.
Hawcroft, L., & Milfont, T. (2010). The use (and abuse) of the new environmental paradigm scale over the last 30 years: A meta-analysis. *Journal of Environmental Psychology*, 30, 143-158.
Hedges, L. V. (2009). Statistical considerations. H. Cooper, L. V. Hedges, & J. C. Valentine (Eds.). *Second edition the handbook of research synthesis and meta-analysis* içinde, (pp. 37-47). New York: Russell Sage Foundation.
Hedges, L., & Vevea, J. (1998). Fixed and random effects models in meta-analysis. *Psychological Methods, 3* (4), 486.
Higgins, J., Thompson, S., Deeks, J., & Altman, D. (2003). Measuring inconsistency in meta-analyses. *British Medical Journal, 327* (7414), 557-560.
Hines, J. M., Hungerford, H. R., & Tomera, A. N. (1987). Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. *The Journal of Environmental Education, 18* (2), 1-8.
Hsiao, H.-S., Lin, C.-C., Feng, R.-T., & Li, K. (2010). Location based services for outdoor ecological learning system: design and implementation. *Educational Technology & Society, 13* (4), 98-111.
Hsu, S.-J. (2004). The effect of an environmental education program on responsible environmental behavior and associated environmental literacy variables in Taiwanese college students. *The Journal of Environmental Education, 35* (2), 37-48.
Hueda-Medina, T., Sanchez-Meca, J., Marin-Martinez, F., & Botella, J. (2006). Assessing heterogeneity in meta-anlaysis: Q statistic or I^2 index? *Center for Health, Intervention, and Prevention (CHIP),* 19, 1-37.
Hunter, J. E., & Schmidt, F. L. (2000). Fixed effects vs. random effects meta-analysis models: Implications for cumulative research knowledge. *International Journal of Selection and Assessment, 8* (4), 275-292.
Hurst, M., Dittmar, H., Bond, R., & Kasser, T. (2013). The relation between materialistic values and environmental attitudes and behaviors: A meta-analysis. *Journal of Environmental Psychology, 36*, 257-269.
Jeong, H., Hmelo-Silver, C. E., Jo, K., & Shin, M. (2016). *CSCL in STEM education: Preliminary findings from a meta-analysis.* System Sciences (HICSS) 49th Hawaii International Conference, (s. 11-20). Hawaii.
Johnson, D., Johnson, R., & Stanne, M. (2000). *Cooperative learning methods: A meta-analysis. Exhibit B.* 02 12, 2016 tarihinde https://pdfs.semanticscholar.org/93e9/97fd0e883cf7cceb3b1b612096c27aa40f90.pdf sayfasından erişilmiştir.
Kağıtçıbaşı, Ç. (2010). *Günümüzde insan ve insanlar sosyal psikolojiye giriş.* İstanbul: Evrim.
Kanadlı, S., Ünal, K. & Karakuş, F. (2015). Kuantum öğrenme modelinin akademik başarıya etkisi: Bir meta-analiz çalışması. *Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 12* (32), 136-157.
Kanlı, U. (2010). Yapılandırmacı kuramın ışığında öğrenme halkası'nın kökleri ve evrimi: Örnek bir etkinlik. *Eğitim ve Bilim (Education and Science), 34* (151), 44-64.

Kaplan, A., Duran, M., & Baş, G. (2015). Matematik dersinde çoklu zekâ kuramına dayalı öğretimin akademik başarıya etkisi: Bir meta-analiz çalışması. *Mersin Üniversitesi Eğitim Fakültesi Dergisi, 11* (3), 814-831.

Karakuş, M. & Öztürk, H. Ġ. (2016). Türkiye'de uygulanan işbirliğine dayalı öğrenme yönteminin fen bilimleri öğretiminde akademik başarı ve derse karşı tutumlar üzerindeki etkisini incelemeye yönelik bir meta-analiz çalışması. *International Journal of Active Learning (IJAL), 1* (1), 1-28.

Karakuş, M. & Yalçın, O. (2016). Fen eğitiminde argümantasyon temelli öğrenmenin akademik başarıya ve bilimsel süreç becerilerine etkisi: Bir meta-analiz çalışması. *Anadolu Üniversitesi Sosyal Bilimler Dergisi, 16* (4), 1-20.

Klöckner, C. (2013). A comprehensive model of the psychology of environmental behaviour - a meta-analysis. *Global Environmental Change, 23* (5), 1028-1038.

Koçak, İ. (2008). *Proje tabanlı öğrenme modelinin kimya eğitimi öğrencilerinin alkanlar konusunu anlamaları ile kimya ve çevreye karşı tutumlarına olan etkisinin değerlendirilmesi.* Yüksek lisans tezi, Gazi Üniversitesi, Kimya Eğitimi Anabilim Dalı, Ankara.

Konstantopoulos, S. (2008). An Introduction to meta-analysis. J. Osborne (Eds.) içinde, *Best practices in quantitative methods* (s. 177-196). USA: Sage.

Kyndt, E., Raes, E., Lismont, B., Timmers, F., Cascallar, E., & Dochy, F. (2013). A meta-analysis of the effects of face-to-face cooperative learning. Do recent studies falsify or verify earlier findings? *Educational Research Review*, 10, 133-149.

Lazonder, A., & Harmsen, R. (2016). Meta-analysis of inquiry-based learning: Effects of guidance. *Review of Educational Research, 86* (3), 681-718.

Lee, J., Lee, Y., Gong, S., Bae, J., & Choi, M. (2016). A meta-analysis of the effects of non-traditional teaching methods on the critical thinking abilities of nursing students. *BMC Medical Education, 16* (240), 1-9.

Lipsey, M. W., & Wilson, D. B. (2001). *Practical meta-analysis.* Thousand Oak, London, New Delhi: Sage.

Littell, J., Corcoran, J., & Pillai, V. (2008). *Systematic reviews and meta-analysis.* New York: Oxford University Press.

Liu, S.-T. (2004). *Effectiveness of an intergenerational approach for enchancing knowledge and improving attitudes toward the environment.* Doctor of philosophy, The Pennsylvania State University, Department of Agricultural and Extension Education, Pennsylvania.

Merdin, S. (1996). *Tanrıya koşan fizik.* İstanbul: Timaş.

Mifsud, M. (2012). A meta-analysis of global youth environmental knowledge, attitude and behavior studies. *US-China Education Review, B* (3), 259-277.

Mullen, B., Muellerleile, P., & Bryant, B. (2001). Cumulative meta-analysis: A consideration of indicators of sufficiency and stability. *Personality and Social Psychology Bulletin, 27* (11), 1450-1462.

National Research Council (NRC) (2000). *Inquiry and the national science education standards: A guide for teaching and learning.* Washington, DC: National Academy.

Nkire, F. (2014). *Participatory environmental education programme and learners' attitude towards the environment in Nigeria.* South Africa International Conference on Education (SAICE) (s. 320-329). Pretoria: African Academic Research Forum.

Oflaz, V. (2012). *Proje tabanlı çevre eğitiminin öğretmen adaylarının çevre bilincine ve epistemolojik inançlarına etkisi.* Yüksek lisans tezi, Pamukkale Üniversitesi Fen Bilimleri Enstitüsü, İlköğretim Anabilim Dalı Fen Bilgisi Eğitimi Programı, Denizli.

Orwin, R., & Vevea, J. (2009). Evaluating coding decisions. H. Cooper, L. V. Hedges, & J. C. Valentine (Eds.), *The handbook of research synthesis and meta-analysis (Second edition)* içinde, (s. 177- 203). New York: Russell Sage.

Osbaldiston, R., & Schott, J. P. (2011). Environmental sustainability and behavioral science: Meta-analysis of proenvironmental behavior experiments. *Environment and Behavior, XX* (X), 1-43.

Öner Armağan, F. (2011). *Kavramsal değişim metinlerinin etkililiği: Meta analiz çalışması.* Doktora tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, İlköğretim Anabilim Dalı Fen Bilgisi Eğitimi Bilim Dalı, Ankara.
Özdemir, O. (2007). Yeni bir çevre eğitimi perspektifi: "Sürdürülebilir gelişme amaçlı eğitim". *Eğitim ve Bilim, 32* (145), 23-38.
Özdemir, O. (2010). Doğa deneyimine dayalı çevre eğitiminin ilköğretim öğrencilerinin çevrelerine yönelik algı ve davranışlarına etkisi. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi , 27*, 125-138.
Özdemirli, G. (2011). *İşbirlikli öğrenme yönteminin öğrencinin matematik başarısı ve matematiğe ilişkin tutumu üzerindeki etkililiği: Bir meta-analiz çalışması.* Yüksek lisans tezi, Çukurova Üniversitesi Sosyal Bilimler Enstitüsü, İlköğretim Anabilim Dalı, Adana.
Özmen, H. (2004). Fen öğretiminde öğrenme teorileri ve teknoloji destekli yapılandırmacı (constructivist) öğrenme. *The Turkish Online Journal of Educational Technology - TOJET, 3* (1), 100-111.
Öztürk, E. (2013). *Uluslar arası bir çevre eğitim projesinin fen ve teknoloji öğretmen adaylarının çevre bilincine etkisi.* Doktora tezi, Hacettepe Üniversitesi Eğitim Bilimleri Enstitüsü, İlköğretim Anabilim Dalı, Ankara.
Popper, K. (2015). *Bilimsel araştırmanın mantığı.* (İ. Aka, & İ. Turan, Çev.) İstanbul: YKY (Yapı kredi yayınları).
Ratcliffe, M., Merrigan, K., Rogers, B., & Goldberg, J. (2011). The effects of school garden experiences on middle school-aged students' knowledge, attitudes, and behaviors associated with vegetable consumption. *Health Promotion Practice, 12* (1), 36-43.
Remington, T., & Legge, M. (2017). Outdoor education in rural primary schools in New Zealand: A narrative inquiry. *Journal of Adventure Education and Outdoor Learning, 17* (1), 55-66.
Riegel, U., & Kindermann, K. (2016). Why leave the classroom? How field trips to the church affect cognitive learning outcomes. *Learning and Instruction, 41*, 106-114.
Robinson, C., & Zajicek, J. (2005). Growing minds: The effects of a one-year school garden program on six constructs of life skills of elementary school children. *HortTechnology, 15* (3), 453-457.
Rodrigues, C., & Payne, P. (2017). Environmentalization of the physical education curriculum in Brazilian universities: Culturally comparative lessons from critical outdoor education in Australia. *Journal of Adventure Education and Outdoor Learning, 17* (1), 18-37.
Rosenthal, R. (1991). *Meta-analytic procedures for social research.* London: Sage.
Rosenthal, R., & DiMatteo, M. R. (2001). Meta-analysis: Recent developments in quantitative methods for literature reviews. *Annual Reviews Psychology, 52* (1), 59-82.
Rothstein, H. R., Sutton, A. J., & Borenstein, M. (2005). *Publication bias in meta-analysis - prevention, assessment and adjustments.* (H. R. Rothstein, A. J. Sutton, & M. Borenstein, Eds.) West Sussex, England: John Wiley & Sons.
Sağlamer Yazgan, B. (2013). *Araştırmaya dayalı sınıf dışı laboratuar etkinliklerinin öğrencilerin araştırma-sorgulama becerilerine ve çevreye karşı tutumlarına etkisi.* Doktora tezi, Marmara Üniversitesi Eğitim Bilimleri Enstitüsü, İlköğretim Anabilim Dalı Fen Bilgisi Öğretmenliği Bilim Dalı, İstanbul.
Sanchez-Meca, J., & Marin- Martinez, F. (2010). Meta-analysis in psychological research. *International Journal of Psychological Research, 3* (1), 150-162.
Sarıer, Y. (2013). *Eğitim kurumu müdürlerinin liderliği ile okul çıktıları arasındaki ilişkilerin meta-analiz yöntemiyle incelenmesi.* Doktora tezi, Eskişehir Osmangazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Eskişehir.
Scarce, R. (1997). Field trips as short-term experiential education. *Teaching Sociology, 25*(3), 219-226.
Schmidt, H. G., Van der Molen, H. T., Te Winkel, W. W., & Wijnen, W. H. (2009). Constructivist, problem-based learning does work: A meta-analysis of curricular comparisons involving a single medical school. *Educational Psychologist, 44* (4), 227-249.

Semerci, Ç., & Batdı, V. (2015). A meta-analysis of constructivist learning approach on learners' academic achievements, retention and attitudes. *Journal of Education and Training Studies, 3* (2), 171-180.

Sharma, S., Durand, R., & Gur-Arie, O. (1981). Identification and analysis of moderator variables. *Journal of Marketing Research*, 291-300.

Shelby, L. B., & Vaske, J. J. (2008). Understanding meta-analysis: A review of the methodological literature . *Leisure Sciences, 30* (2), 96-110.

Shin, I.-S., & Kim, J.-H. (2013). The effect of problem-based learning in nursing education: A meta-analysis. *Advances in Health Sciences Education, 18*(5), 1103- 1120.

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57* (1), 1-23.

Sirin, S. (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of Educational Research, 75*(3), 417-453.

Skaza, H. (2010). *Assessing the effect of simulation models on systems learning in an introductory environmental science course.* Master of science, University of Nevada, Department of Environmental Studies School of Environmental of Public Affairs, Las Vegas.

Smith , M. B. (1968). Attitude change. D. L. Sills (Eds.) içinde, *International encyclopedia of the social sciences* (Cilt 1, s. 458-467). USA: The Macmillan Company & The Free Press.

Solmaz, G. (2010). *İşbirlikli öğrenme yoluyla kavramsal anlamaya yönelik öğretimin öğrencilerin çevre kavramlarını anlamalarına ve çevre farkındalıklarına etkisi: 7. sınıf "insan ve çevre" ünitesi örneği.* Yüksek lisans tezi, Dokuz Eylül Üniversitesi Eğitim Bilimleri Enstitüsü, İlköğretim Anabilim Dalı Fen Bilgisi Öğretmenliği Programı, İzmir.

Suárez-Orozco, M., & Suárez-Orozco, C. (2017). The Sustainable Planet: Towards an Education for Sustainability. A. Battro, L. Pierre, M. Sorondo, & J. Braun (Eds.) içinde, *Children and Sustainable Development* (s. 93-99). New York: Springer International Publishing.

Şad, S. N., Kış, A., & Demir, M. (2017). A Meta-analysis of the effect of contemporary learning approaches on students' mathematics achievement. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi (H. U. Journal of Education), 32* (1), 209-227.

Şahin, M. (2005). *İnternet tabanlı uzaktan eğitimin etkililiği: Bir meta analiz çalışması.* Yüksek lisans tezi, Çukurova Üniversitesi Sosyal Bilimler Enstitüsü, Bilgisayar ve Öğretim Teknolojileri Eğitimi Anabilim Dalı, Adana.

Şen, Ş., & Yılmaz, A. (2013). İşbirlikçi öğrenmenin kavramsal değişim üzerindeki etkisi: Bir meta analiz çalışması . *Karaelmas Journal of Educational Sciences, 1*, 21-32.

Tapia-Fonllem, C., Fraijo-Sing, B., Corral-Verdugo, V., & Ortiz Valdez, A. (2017). Education for sustainable development in higher education institutions: Its influence on the pro-sustainability orientation of Mexican students. *SAGE Open, 7* (1), 1-15.

Tiflis Bildirgesi. (1977). *Environmental education: Creating an environment to educate about the environment*. (United Nations Education, Scientific, and Cultural Organization (UNESCO) in cooperation with the U.N. Environment Programme (UNEP)) Mart 22, 2016 tarihinde Tbilisi Declaration (1977): https://www.gdrc.org/uem/ee/tbilisi.html adresinden alındı.

Topan, B. (2013). *Matematik öğretiminde öğrenci merkezli yöntemlerin akademik başarı ve derse yönelik tutum üzerindeki etkililiği: Bir meta-analiz çalışması.* Yüksek lisans tezi, Kocaeli Üniversitesi Fen Bilimleri Enstitüsü, İlköğretim Anabilim Dalı, Kocaeli.

Topçu, M., & Atabey, N. (2017). Sosyobilimsel konu içerikli alan gezilerinin ilköğretim öğrencilerinin argümantasyon nitelikleri üzerine etkisi. *Bartın Üniversitesi Eğitim Fakültesi Dergisi, 6* (1), 68-84.

Toraman, Ç., & Demir, E. (2016). The effect of constructivism on attitudes towards lessons: A meta-analysis study. *Eurasian Journal of Educational Research, 16* (62), 115-142.

Ural, G., & Bümen, N. (2016). Türkiye'de fen ve teknoloji öğretiminde yapılandırmacılığın öğretimsel uygulamaları üzerine bir meta-analiz. *Eğitim ve Bilim, 41* (185), 51-82.

Ün Açıkgöz, K. (2014). *Aktif öğrenme.* İzmir: Biliş.

Ürey, M., Çepni, S., & Kaymakçı, S. (2015). Fen temelli ve disiplinlerarası okul bahçesi programının bazı sosyal bilgiler öğretim programı kazanımları üzerine etkisinin değerlendirilmesi. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi, 28* (1), 7-29.

Ürey, M., Göksu, V., & Karaçöp, A. (2017). Serbest etkinlik çalışmaları dersi kapsamında geliştirilen okul bahçesi programına yönelik öğretmen görüşleri. *İlköğretim Online, 16* (1), 1-14.

Üstün, U. (2012). *To what extent is problem-based learning effective as compared to traditional teaching in science education? A Meta-Analysis study.* Phd. thesis, Middle East Technical University Secondary Science and Mathematics Education, Ankara.

Üstün, U., & Eryılmaz, A. (2014). Etkili araştırma sentezleri yapabilmek için bir araştırma yöntemi: Meta-analiz. *Eğitim ve Bilim*, 39, 1-32.

Üstünel, M. F. (2016). *Ödevin akademik başarıya etkisi: Bir meta analiz çalışması.* Yüksek lisans tezi, Akdeniz Üniversitesi Eğitim Bilimleri Enstitüsü, Eğitim Bilimleri Anabilim Dalı Eğitimde Ölçme Değerlendirme Yüksek Lisans Programı, Antalya.

Valentine, J. C. (2009). Judging the qualityof primary research. H. Cooper, L. Hedges, & J. Valentine (Eds.) *Second edition the handbook of research synthesis and meta-analysis* içinde (pp. 129-146). New York: Russell Sage Foundation.

Yaşar, Ş., Çengelci Köse, T., Göz, N. L., & Gürdoğan Bayır, Ö. (2015). Sosyal bilgiler dersinde öğrenci merkezli öğretme-öğrenme süreçlerinin etkililiği: Bir meta analiz çalışması. *Anadolu Journal of Educational Sciences International, 5* (1), 38-56.

Yoldaş, C. (2009). *Çevre bilimi dersinin sınıf öğretmeni adaylarının eleştirel düşünme becerileri, erişileri ve tutumlarına etkisi*. Doktora tezi, Dokuz Eylül Eğitim Bilimleri Enstitüsü , İzmir.

Yurt, E., & Polat, S. (2015). The effectiveness of multiple intelligence applications on academic achievement: a meta-analysis. *Journal of Social Studies Education Research, 6* (1), 84-122.

Zelezny, L. (1999). Educational interventions that improve environmental behaviors: A meta-analysis. *The Journal of Environmental Education, 31* (1), 5-14.

Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology, 81* (3), 329-339.

Appendices

Appendix 1. Primary Studies Included in Meta-Analysis

Aguilar, O. M., Waliczek, T. M., & Zajicek, J. M. (2008). Growing environmental stewards: The overall effect of a school garden program on environmental attitudes and environmental locus of control of different demografic group of elementary school children. *HortTechnology, 18* (2), 243-249.

Aivazidis, C., Lazaridou, M., & Hellden, G. F. (2006). A comparaison between a traditional and an online environmental program. *The Journal of Environmental Education, 37* (4), 45-54.

Akçöltekin, A. (2013). *9. sınıf öğrencilerine insanların çevreye zararları konusunun ayrılıp birleşme tekniği (JIGSAW) ile öğretimi.* Doktora tezi, Atatürk Üniversitesi Eğitim Bilimleri Enstitüsü, Erzurum.

Akdaş, E. (2014). *İlköğretim yedinci sınıf fen ve teknoloji dersi insan ve çevre ünitesinde yaşam temelli öğrenme modelinin kullanımının akademik başarı, tutum ve kalıcılık üzerine etkisi.* Yüksek lisans tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Akkurt, N. D. (2007). *Aktif öğrenme tekniklerinin lise 1. sınıf öğrencilerinin ekoloji ve çevre kirliliği konusunu öğrenme başarılarına ve çevreye yönelik tutumlarına etkisi.* Yüksek lisans tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Akkuzulu, D. (2011). *Yedinci sınıf öğrencilerinin fen ve teknoloji dersi çevre ve insan ünitesinde yansıtıcı fen günlükleri tutmasının başarı ve tutuma etkisi.* Yüksek lisans tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Alagöz, B. (2009). *Sosyal bilgiler öğretmen adaylarında çevre bilincinin geliştirilmesinde probleme dayalı öğrenme yönteminin etkisi.* Doktora tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Artun, H. & Özsevgeç, T. (2015). Çevre eğitimi modüler öğretim programının akademik başarı üzerindeki etkisi. *Hasan Ali Yücel Eğitim Fakültesi Dergisi, 12-1* (23), 9-22.

Aslan Efe, H. (2015). Animasyon destekli çevre eğitiminin akademik başarıya, akılda kalıcılığa ve çevreye yönelik tutuma etkisi. *Bilgisayar ve Eğitim Araştırmaları Dergisi, 3* (5), 130-143.

Aslan Efe, H., Yucel , S., Baran, M., & Oner Sunkur, M. (2012). Influence of animation-supported project-based instruction method on environmental literacy and self-efficacy in environmental education. *Asia-Pacific Forum on Science Learning and Teaching, 13* (2).

Aydemir, G. (2010). *Sosyal bilgiler öğretiminde örnek olay yönteminin öğrencilerin çevre bilincine ve çevreye yönelik tutumlarına etkisi.* Yüksek lisans tezi, Marmara Üniversitesi Eğitim Bilimleri Enstitüsü, İstanbul.

Benzer, E. (2010). *Proje tabanlı öğrenme yaklaşımıyla hazırlanan çevre eğitimi dersinin fen bilgisi öğretmen adaylarının çevre okuryazarlığına etkisi.* Doktora tezi, Marmara Üniversitesi Eğitim Bilimleri Enstitüsü, İstanbul.

Bertiz, H. (2010). *Dramanın çevre bilinci oluşturmadaki rolü ve etkililiği.* Doktora tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Bilgili, S. (2008). *İlköğretim 7. sınıf fen ve teknoloji dersinde çevre konularının öğretiminde, yapılandırmacı yaklaşıma dayalı işbirlikli öğrenmenin öğrencilerin erişine etkisi.* Yüksek lisans tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Bodzin, A. (2008). Integrating instructional technologies in a local watershed investigation with urban elementary learners. *The Journal of Environmental Education, 39* (2), 47-58.

Broyles, I. (2011). *Distributed cognition minicourse: An instructional intervention to improve the effectiveness of one-day environmental education camps.* Doctor of philosopy, Capella University, Minneapolis, MN.

Burek, K. (2012). *The impact of socioscientific issues based curriculum involving environmental outdoor education for fourth grade students.* Doctor of philosophy, University of South Florida College of Education, Science Education Department of Secondary Education, Florida.

Bülbül, Y. (2007). *Ortaöğretim çevre ve insan dersinde işbirlikli öğrenme yönteminin çevreye yönelik tutumlara ve erişiye etkisi.* Yüksek lisans tezi, Çanakkale Onsekiz Mart Üniversitesi Sosyal Bilimler Enstitüsü, Çanakkale.

Conaway, J. (2006). *Mississippi river program: A mixed-method examination of the effects of a place-based curriculum on the environmental knowledge and awareness of Montessori adolescents.* Master of science, Minnesota State University, Mankato Mankato, Minnesota.

Cömert, H. (2011). *Çevre sorunları ve etkileri konusundaki işbirlikli öğrenme etkinliklerinin öğrencilerin bilgi, tutum ve davranışlarına etkisi.* Yüksek lisans tezi, İstanbul Üniversitesi Fen Bilimleri Enstitüsü, İstanbul.

Cronin-Jones, L. (2000). The effectiveness of schoolyards as sites for elementary science instruction. *School Science and Mathematics, 100* (4), 203-211.

Çetin, G. (2003). *The effect of conceptual change instruction on understanding of ecology concepts.* Doctor of Philosophy, The Middle East Technical University, Department of Secondary Science and Mathematics Education, Ankara.

Çimen, O. (2013). *Dönüşümsel öğrenme kuramına dayalı çevre eğitiminin biyoloji öğretmen adaylarının çevre sorunlarına yönelik algısına etkisi.* Doktora tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Dillard, J. (2006). *The evaluation and revision of an online course entitled "applied environmental education program evaluation".* Master of science, University of Wisconsin, College of Natural Resources, Steves Point, Wisconsin.

Duerden, M., & Witt, P. (2010). The impact of direct and indirect experiences on the development of environmental knowledge, attitudes, and behavior. *Journal of Environmental Psychology, 30* (4), 379-392.

Dursun, C., Durkan, N., & Erökten, S. (2015). The effect of problem based learning method on the environmental awarness of 7th graders ("human and environment" unit example). *International Journal of Education and Research, 3* (5), 275-288.

Erentay, N. (2013). *Okul dışı doğa uygulamalarının beşinci sınıf öğrencilerinin fene ilişkin bilgi, bilimsel süreç becerileri ve çevreye yönelik tutumlarına etkisi.* Yüksek lisans tezi, Akdeniz Üniversitesi Eğitim Bilimleri Enstitüsü, Antalya.

Gnanalet, S., & Ramakrishnan, K. (2010). *Effectiveness of multimedia programme in teaching Environmental education – a study.* International Conference on e-resources in Higher Education: Issues, Developments, Opportunities and Challenges. Tamilnadu.

Gökler, F. (2012). *Doğal ortamlarda yürütülen çevre eğitiminin, ortaöğretim 9. sınıf öğrencilerinin akademik başarılarına etkisi: Ovacık örneği.* Yüksek lisans tezi, Dokuz Eylül Üniversitesi Eğitim Bilimleri Enstitüsü, İzmir.

Gökmen, A. (2008). *Bilgisayar destekli çevre eğitiminin öğretmen adaylarının madde döngüleri konusundaki başarılarına etkisi.* Yüksek lisans tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Gülay Ogelman, H. & Durkan, N. (2014). Toprakla buluşan çocuklar: Küçük çocuklar için toprak eğitimi projesinin etkililiği. *Uluslararası Sosyal Araştırmalar Dergisi, 7*(31), 632-638.

Güven, E. (2011). *Çevre eğitiminde tahmin-gözlem-açıklama destekli proje tabanlı öğrenme yönteminin farklı değişkenler üzerine etkisi ve yönteme ilişkin öğrenci görüşleri.* Doktora tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Güven, E. (2012). *Disiplinler arası yaklaşıma dayalı çevre eğitiminin ilköğretim 4. sınıf öğrencilerinin çevreye yönelik tutumlarına ve davranışlarına etkisinin incelenmesi.* Yüksek lisans tezi, Erciyes Üniversitesi Eğitim Bilimleri Enstitüsü, Kayseri.

Hsiao, H.-S., Lin, C.-C., Feng, R.-T., & Li, K. (2010). Location based services for outdoor ecological learning system: design and implementation. *Educational Technology & Society, 13* (4), 98-111.

Hsu, S.-J. (2004). The effect of an environmental education program on responsible environmental behavior and associated environmental literacy variables in Taiwanese college students. *The Journal of Environmental Education, 35* (2), 37- 48.

İşeri Gökmen, S. (2008). *Effects of problem based learning on students' attitude through local vs. non local environmental problems.* Master of science, Middle East Technical University The Graduate School of Social Sciences, Ankara.

Koçak, G. (2008). *Proje tabanlı öğrenme modelinin kimya eğitimi öğrencilerinin alkanlar konusunu anlamaları ile kimya ve çevreye karşı tutumlarına olan etkisinin değerlendirilmesi.* Yüksek lisans tezi, Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara.

Kostova, Z. (2013). Project-based ecology learning in vocational training. *Journal of Environmental Science and Engineering Technology*, 1, 10-22.

Larson, L., Green , G., & Castleberry , S. (2008). *The impact of a summer education program on the environmental attitudes and awareness of minority children.* Proceedings of the 2008 Northeastern Recreation Research Symposium, (s. 1-7). Newtown Square, PA.

Liu, S.-T. (2004). *Effectiveness of an intergenerational approach for enchancing knowledge and improving attitudes toward the environment.* Doctor of philosophy, The Pennsylvania State University, Department of Agricultural and Extension Education, Pennsylvania.

Mutlu, M. (2013). Effect of using roundhouse diagrams on preservice teachers' understanding of ecosystem. *Journal of Baltic Science Education, 12* (2), 205-218.

Nkire, F. (2014). *Participatory environmental education programme and learners' attitude towards the environment in Nigeria.* South Africa International Conference on Education (SAICE) (s. 320-329). Pretoria: African Academic Research Forum.

Oflaz, V. (2012). *Proje tabanlı çevre eğitiminin öğretmen adaylarının çevre bilincine ve epistemolojik inançlarına etkisi.* Yüksek lisans tezi, Pamukkale Üniversitesi Fen Bilimleri Enstitüsü, Denizli.

Othman, R., Harun, R., Muda, A., Rashid, N., & Othman, F. (2011). Environmental education through mural painting activities as to enhance secondary school students‟ knowledge and awareness on environment. *World Applied Sciences Journal, 14(Exploring Pathways to Sustainable Living in Malaysia: Solving the Current Environmental Issues),* 101-106. https://www.scopus.com/record/display.uri?eid=2-s2.0- 84864931854&origin=inward&txGid=ac7edd6ad4da330b2f1f0ecb64ed39d9 sayfasından erişilmiştir.

Özgel, Z. (2015). *Doğa kampı destekli eğitmin öğrencilerin çevre sorunlarına yönelik tutum, farkındalık ve davranışlarına etkisi.* Yüksek lisans tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Özsoy, S. (2010). *Effects of eco-school application on elementary school students' environmental literacy levels.* Doctor of philosophy, The Graduate School of Social Sciences Middle East Technical University, Ankara.

Öztürk, E. (2013). *Uluslar arası bir çevre eğitim projesinin fen ve teknoloji öğretmen adaylarının çevre bilincine etkisi.* Doktora tezi, Hacettepe Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Punyain, K. (2008). *A development of the constructivist thematic science program at Chiangmai Zoo.* Doctor of education, Srinakharinwirot University, Science Education, Krung Thep Maha Nakhon.

Sağlamer Yazgan, B. (2013). *Araştırmaya dayalı sınıf dışı laboratuar etkinliklerinin öğrencilerin araştırma-sorgulama becerilerine ve çevreye karşı tutumlarına etkisi.* Doktora tezi, Marmara Üniversitesi Eğitim Bilimleri Enstitüsü, İstanbul.

Schneller, A. J., Schofield, C., Frank, J., Hollister, E., & Mamuszka, L. (2015). A case study of indoor garden-based learning with hydroponics and aquaponics: Evaluating pro-environmental knowledge, perception and behavior change. *Applied Environmental Education & Communication, 14* (4), 256-265.

Skaza, H. (2010). *Assessing the effect of simulation models on systems learning in an introductory environmental science course.* Master of science, University of Nevada, Department of Environmental Studies School of Environmental of Public Affairs, Las Vegas.

Solmaz, G. (2010). *İşbirlikli öğrenme yoluyla kavramsal anlamaya yönelik öğretimin öğrencilerin çevre kavramlarını anlamalarına ve çevre farkındalıklarına etkisi: 7. sınıf "insan ve çevre" ünitesi örneği.* Yüksek lisans tezi, Dokuz Eylül Üniversitesi Eğitim Bilimleri Enstitüsü, İzmir.

Taff, M. A., Aziz, A., Haron, R. N., Raysid, N. M., & Yasim, M. M. (2010). Residential outdoor education and environmental attitudes: An examination in a Malaysian University. *Journal of Outdoor Recreation, Education, and Leadership, 2* (3), 198- 216.

Tahiroğlu, M., Yıldırım, T., & Çetin, T. (2010). Değer eğitimi yöntemlerine uygun geliştirilen çevre eğitimi etkinliğinin, ilköğretim 7. sınıf öğrencilerinin çevreye ilişkin tutumlarına etkisi. *Selçuk Üniversitesi Ahmet Keleşoğlu Eğitim Fakültesi Dergisi*, 30, 231-248.

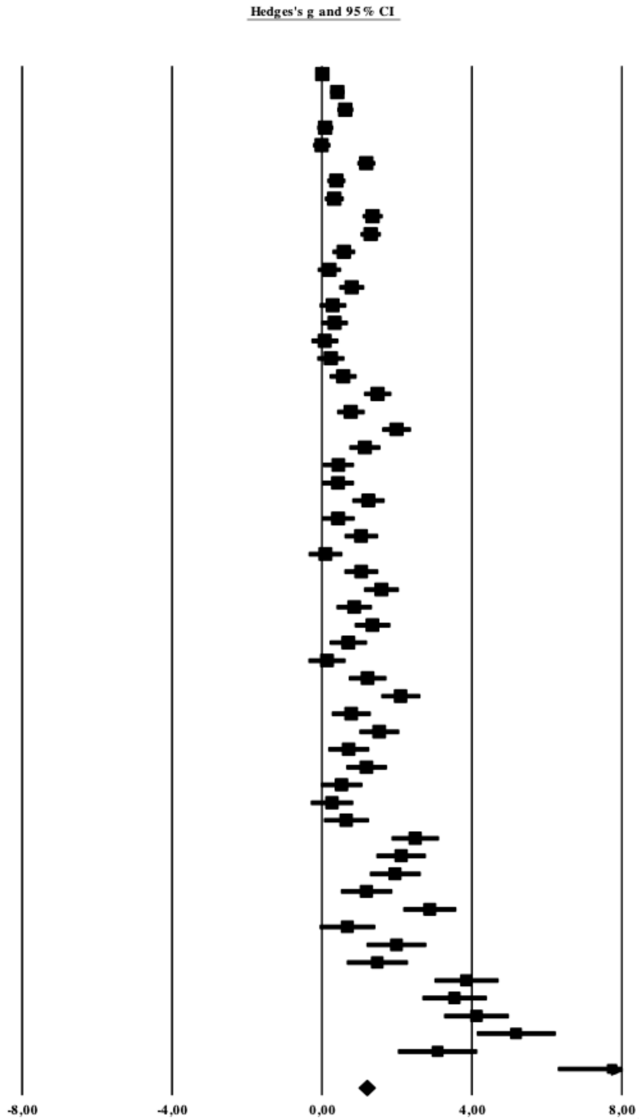
Yalım, N. (2003*). İlköğretim dördüncü sınıf fen bilgisi dersinin yaratıcı drama yöntemi ile öğretiminin öğrencilerin akademik başarılarına etkisi.* Yüksek lisans tezi, Eskişehir Anadolu Üniversitesi Eğitim Bilimleri Enstitüsü, Eskişehir.

Yılmaz, T. (2013). *Kavram karikatürleriyle desteklenmiş bilimsel hikayelerin öğrencilerin akademik başarıları, tutumları ve motivasyonları üzerine etkisi.* Yüksek lisans tezi, Celal Bayar Üniversitesi Fen Bilimleri Enstitüsü, Manisa.

Yoldaş, C. (2009). *Çevre bilimi dersinin sınıf öğretmeni adaylarının eleştirel düşünme becerileri, erişileri ve tutumlarına etkisi.* Doktora tezi, Dokuz Eylül Eğitim Bilimleri Enstitüsü, İzmir.

Appendix 2. Forest Plot for 57 studies included in meta-analysis

Study name	Outcome	Subgroup within study	Statistics for each study						
			Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Aguilar vd. (2008)	Attitude	School Garden / School Yard Learning Method	0.011	0.086	0.007	-0.156	0.179	0.134	0.894
Skaza (2010)	Achievement	Computer, Technology Web Based Learning Method	0.412	0.095	0.009	0.227	0.597	4.361	0.000
Cronin-Jones (2000)	Attitude	School Garden / School Yard Learning Method	0.623	0.109	0.012	0.410	0.836	5.720	0.000
Duerden & Witt (2010)	Achievement	Field (Nature) Trips And Camps	0.087	0.109	0.012	-0.127	0.301	0.792	0.428
Aivazidis (2006)	Attitude	Computer, Technology Web Based Learning Method	-0.008	0.118	0.014	-0.240	0.224	-0.065	0.948
Ozsoy (2010)	Achievement	Environmental Education Courses and Programs	1.183	0.122	0.015	0.944	1.421	9.717	0.000
Liu (2004)	Achievement	Outdoor Learning Method	0.386	0.123	0.015	0.145	0.627	3.140	0.002
Hsu (2004)	Achievement	Environmental Education Courses and Programs	0.329	0.129	0.017	0.076	0.582	2,546	0.011
Ogelman (2014)	Achievement	Environmental Education Courses and Programs	1.350	0.137	0.019	1.081	1.619	9.846	0.000
Othman (2011)	Achievement	Other	1.301	0.138	0.019	1.030	1.572	9.403	0.000
Taff vd. (2010)	Attitude	Field (Nature) Trips And Camps	0.584	0.153	0.024	0.283	0.885	3.807	0.000
Kostova (2013)	Achievement	Project-Based Learning Method	0.199	0.158	0.025	-0.110	0.508	1.262	0.207
Larson (2008)	Achievement	Field (Nature) Trips And Camps	0.793	0.169	0.029	0.461	1.125	4.682	0.000
İseri Gokmen (2008)	Attitude	Problem-Based Learning Method	0.291	0.182	0.033	-0.065	0.647	1.602	0.109
Aydemir (2010)	Attitude	Other	0.341	0.183	0.033	-0.018	0.699	1.864	0.062
Broyles (2011)	Achievement	Computer, Technology Web Based Learning Method	0.080	0.183	0.034	-0.279	0.439	0.436	0.663
Erentay (2013)	Attitude	Outdoor Learning Method	0.237	0.184	0.034	-0.124	0.598	1.285	0.199
Gokler (2012)	Achievement	Field (Nature) Trips And Camps	0.568	0.185	0.034	0.205	0.930	3.067	0.002
Dillard (2006)	Achievement	Environmental Education Courses and Programs	1.484	0.185	0.034	1.121	1.848	8.007	0.000
Punyain (2008)	Attitude	Field (Nature) Trips And Camps	0.772	0.188	0.035	0.403	1.141	4.104	0.000
Nkire (2014)	Attitude	Environmental Education Courses and Programs	1.991	0.196	0.039	1.606	2.376	10.133	0.000
Akcoltekin (2013)	Achievement	Cooperative Learning Method	1.146	0.211	0.045	0.731	1.560	5.420	0.000
Saglamer Yazgan (2013)	Attitude	Inquiry Based and/or Critical Thinking Learning Method	0.441	0.213	0.045	0.024	0.859	2.074	0.038
Guven (2012)	Attitude	Other	0.431	0.218	0.047	0.005	0.857	1.981	0.048
Bilgili (2008)	Attitude	Cooperative Learning Method	1.238	0,220	0.048	0.808	1.669	5.636	0.000
Cetin (2003)	Achievement	Computer, Technology Web Based Learning Method	0.433	0.222	0.049	-0.002	0.869	1.949	0.051
Aslan Efe (2015)	Achievement	Computer, Technology Web Based Learning Method	1.049	0.227	0.052	0.604	1.494	4.619	0.000
Aslan Efe (2012)	Attitude	Project-Based Learning Method	0.092	0.229	0.052	-0.357	0.540	0.400	0.689
Dursun (2015)	Attitude	Problem-Based Learning Method	1.051	0.231	0.053	0.598	1.504	4.547	0.000
Guven (2011)	Attitude	Project-Based Learning Method	1.587	0.238	0.057	1.120	2.054	6.666	0.000
Benzer (2010)	Attitude	Project-Based Learning Method	0.863	0.241	0.058	0.389	1.336	3.572	0.000
Comert (2011)	Attitude	Cooperative Learning Method	1.351	0.244	0.060	0.872	1.829	5.527	0.000
Akkurt (2007)	Attitude	Other	0.703	0.255	0.065	0.204	1.202	2.760	0.006
Ozturk (2013)	Attitude	Environmental Education Courses and Programs	0.137	0.255	0.065	-0.363	0.637	0.535	0.592
Gokmen (2008)	Achievement	Computer, Technology Web Based Learning Method	1.218	0.256	0.066	0.716	1.721	4.755	0.000
Mutlu (2013)	Achievement	Other	2,101	0.266	0.071	1.581	2.622	7.911	0.000
Solmaz (2010)	Achievement	Cooperative Learning Method	0.782	0.267	0.071	0.259	1.305	2.931	0.003
Yoldas (2009)	Attitude	Inquiry Based and/or Critical Thinking Learning Method	1.528	0.271	0.074	0.996	2.059	5.631	0.000
Akkuzulu (2011)	Achievement	Other	0.714	0.277	0.077	0.171	1.256	2.577	0.010
Artun & Ozsevgec (2015)	Achievement	Other	1.188	0.277	0.077	0.645	1.731	4.290	0.000
Bulbul (2007)	Attitude	Cooperative Learning Method	0.527	0.283	0.080	-0.028	1.083	1.862	0.063
Burek (2012)	Achievement	Inquiry Based and/or Critical Thinking Learning Method	0.268	0.288	0.083	-0.297	0.833	0.930	0.352
Akdas (2014)	Achievement	Other	0.650	0.308	0.095	0.047	1.252	2.112	0.035
Bertiz (2010)	Achievement	Other	2.490	0.323	0.105	1.856	3,124	7.698	0.000
Yilmaz (2013)	Achievement	Other	2.114	0.337	0.113	1.454	2.773	6.279	0.000
Ozgel (2015)	Attitude	Field (Nature) Trips And Camps	1.955	0.347	0.120	1.275	2.635	5.634	0.000
Bodzin (2008)	Attitude	School Garden / School Yard Learning Method	1.188	0.350	0.123	0.502	1.875	3.393	0.001
Tahiroglu (2010)	Attitude	Other	2.877	0.360	0.130	2.171	3.583	7.988	0.000
Kocak (2008)	Attitude	Project-Based Learning Method	0.678	0.379	0.144	-0.065	1.420	1.789	0.074
Conaway (2006)	Achievement	Other	1.988	0.407	0.166	1.190	2.786	4.885	0.000
Cimen (2013)	Attitude	Other	1.476	0.417	0.174	0.660	2.293	3.543	0.000
Gnanalet & Ramakrishnan (2010)	Achievement	Computer, Technology Web Based Learning Method	3.856	0.435	0.189	3.005	4.708	8.873	0.000
Oflaz (2012)	Attitude	Project-Based Learning Method	3.540	0.438	0.191	2.682	4.397	8.089	0.000
Alagoz (2009)	Achievement	Problem-Based Learning Method	4.122	0.440	0.194	3.259	4.984	9.363	0.000
Yalim (2003)	Achievement	Other	5.183	0.537	0.289	4.130	6.237	9.645	0.000
Schneller (2015)	Achievement	School Garden / School Yard Learning Method	3.086	0.543	0.295	2.022	4.150	5.685	0.000
Hsiao, Lin, Feng & Li (2010)	Achievement	Outdoor Learning Method	7.743	0.739	0.547	6.295	9.192	10.474	0.000
			1.181	0.102	0.010	0.981	1.382	11.537	0.000



International Electronic Journal of Environmental Education
Vol., Issue , 20XX, X-XX
RESEARCH ARTICLE

Yapılandırmacı Öğrenme Yaklaşımı ve Aktif Öğrenmenin Çevre Eğitimi Üzerine Etkisi: Bir Meta-Analiz Çalışması

Selçuk ARIK
Tokat Gaziosmanpaşa Üniversitesi, Tokat, TüRKİYE

Mehmet YILMAZ
Gazi Üniversitesi, Ankara, TÜRKİYE

Received:; Accepted:

Özet

Bu araştırmada, yapılandırmacı öğrenme yaklaşımı ve aktif öğrenmenin öğrencilerin çevre eğitimi üzerine etkisini inceleyen 6237 öğrenciyi kapsayan 57 birincil deneysel çalışmanın meta-analizi yapılmıştır. Ayrıca meta-analizinden elde edilen bulgular kapsamında, birincil araştırma sonuçlarına etki ettiği düşünülen moderatör değişkenlerin analizi yapılmıştır. Araştırmanın moderatör değişkenleri ise şunlardır; Yayın yılı, yayın dili, yayın türü, ülke, öğrenim düzeyi, örneklem büyüklüğü, ölçme aracının soruları bakımından ve geliştiren bakımından türü, deneysel uygulama süresi, araştırma deseni, öğretmen ve araştırmacı etkisi ile yapılandırmacı öğrenme yaklaşımı ve aktif öğrenme yöntemlerinin türüdür. Araştırmanın çalışma grubunu, 2000-2015 yılları arasında yapılmış, çevre akademik başarısı ve çevreye yönelik tutumla ilgili, araştırmanın dahil edilme ve hariç tutulma kriterlerine uygun 57 birincil deneysel çalışma ve bu çalışmalar kapsamındaki toplam 6237 öğrenci oluşturmuştur. Bu 57 çalışmadan toplam 114 etki büyüklüğü elde edilmiştir. Araştırmada, geriye dönük bilimsel araştırma yöntemlerinden bir tanesi olan meta-analiz yöntemi kullanılmıştır. Araştırmanın verileri meta-analiz yöntemi aracılığıyla incelenmiştir. Verilerin meta-analizi, rastgele etkiler modeline dayalı olarak gerçekleştirilmiştir. Etki büyüklüğü Hedges'ın g etki büyüklüğü formülüne göre hesaplanmıştır. Moderatör değişkenlerin analizinde ise Analog ANOVA istatistiksel analizi yapılmıştır. Bu analizde ise rastgele etkiler ve karma etkiler modelleri kullanılmıştır. Meta-analizi sonucunda, yapılandırmacı öğrenme yaklaşımı ve aktif öğrenmenin geleneksel öğrenmeye kıyasla çevre eğitimi üzerine genel etki büyüklüğünün "pozitif ve geniş (Hedges' g=1,463)" düzeyde olduğu belirlenmiştir. Moderatör analizi sonuçları incelendiğinde ise yapılandırmacı öğrenme yaklaşımı ve aktif öğrenmeye dayalı çevre eğitiminin "*ülke* (Q_B=6,254; SD=2; p=0,044; p<0,05)", "*örneklem büyüklüğü* (Q_B=13,811; SD=3; p=0,003; p<0,05)", "*öğrenim düzeyi* (Q_B=108,808; SD=5; p=0,000; p<0,05)", "*yayın türü* (Q_B=107,870; SD=3; p=0,000; p<0,05)", "*ölçme aracının türü* (Q_B=18,545; SD=3; p=0,000; p<0,05)", "*ölçme aracını geliştiren* (Q_B=191,461; SD=3; p=0,000; p<0,05)", "*yayın dili* (Q_B=85,965; SD=1; p=0,000, p<0,05)", "*öğretmen etkisi* (Q_B=85,990; SD=3; p=0,000; p<0,05)" ve "*araştırmacı etkisi* (Q_B=8,332; SD=3; p=0,065; p<0,05)" bakımından manidar farklılık gösterdiği sonucuna ulaşılmıştır. Bunun aksine "*yayın yılı* (Q_B=3,880; SD=3; p=0,275; **p>0,05**)", "*uygulama süresi* (Q_B=13,290; SD=7; p=0,065; **p>0,05**)", "*araştırma deseni* (Q_B=10,905; SD=6; p=0,091; **p>0,05**)" ve "*deney grubunda kullanılan öğretim yönteminin türüne* (p=0,298; **p>0,05**)" bakımından ise manidar farklılık olmadığı sonucuna ulaşılmıştır. Araştırmadan elde edilen bulgular doğrultusunda çevre eğitimi

ISSN: 2146-0329
*** The article is a part of the PhD Thesis prepared by Selçuk ARIK under the supervision of Prof. Dr. Mehmet YILMAZ.**
****E-mail: selcuk.arik@gop.edu.tr**

uygulamalarında yapılandırmacı öğrenme ve aktif öğrenmenin sıklıkla kullanılması önerilebilir. Ayrıca çevre eğitimi uygulamalarında uygulama yapılan grubun örneklem büyüklüğü, öğrencilerin öğrenim seviyesi, uygulamada kullanılan ölçme araçları, uygulamayı yapan araştırmacı ve uygulama süresi gibi değişkenlere de dikkat edilmelidir.

Anahtar Kelimeler: Çevre eğitimi, çevre akademik başarısı, çevreye yönelik tutum, yapılandırmacı öğrenme yaklaşımı, aktif öğrenme, meta-analiz