Received: 3 October 2021 | Accepted: 22 February 2022

DOI: 10.1002/rev3.3346

SYNTHESIS

Review of Education BERA

Active learning promotes more positive attitudes towards the course: A meta-analysis☆

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Funding information
None

Abstract

This review aims to analyse the results of individual studies examining the effect of the active learning approach on students' attitudes towards course by meta-analysis method, also expose the impact of various study characteristics on this effect. As a result of the literature review carried out for this purpose, 144 studies (158 effect sizes) that meet the inclusion criteria were included in the meta-analysis. The result of the analysis by using the random-effects model indicated a moderate overall effect size for the effectiveness of active learning on attitudes towards the course ($g = 0.757$). This reveals that active learning is more effective on students' attitudes towards the course than traditional lecture-based methods. According to the analyses made to detect publication bias, it was determined that there was no publication bias in the meta-analysis. Moreover, moderator analyses were conducted for ten possible moderator variables. The moderator analyses indicated that the effect of active learning on attitudes towards the course moderated only by a variable, the developer of the scale. The sub-group analysis of scale developers revealed a strong effect for the studies in which the scale was developed by the research author ($g = 1.159$) and a

☆This study was produced from the doctoral dissertation of the first author conducted under the supervision of the second author.

moderate effect for the studies in which the scale was developed by another researcher(s) ($g = 0.661$).

KEYWORDS
active learning, attitudes towards course, cooperative learning, meta-analysis, problem-based learning, project-based learning

Context and implications

Rationale for this study

There have been numerous individual studies conducted to date on the effectiveness of active learning. Since these studies focus on a specific application or experiment, it may be difficult to generalise their results and provide an adequate explanation for the effectiveness of a comprehensive approach such as active learning, and sometimes inconsistencies can be seen between their results. Therefore we conduct a meta-analysis to comprehensively evaluate the results of these individual studies and obtain general results to document the approach's effectiveness.

Why the new findings matter

This review reveals the effect of active learning on attitudes, an affective factor that has an important place in the learning process and can directly affect students' interest and desires towards the course, through a comprehensive meta-analysis.

Implications for educational researchers and practitioners

Considering that the approach is effective in developing more positive attitudes towards the course in all domain subjects and education levels examined within the scope of the meta-analysis, practitioners can include active learning activities more widely in their courses. The overall effect size obtained from the research can be accepted as a criterion for the effectiveness of the active learning approach by education researchers. The effect sizes to be obtained from individual studies on the subject in the future can be interpreted by researchers by comparing them with the overall effect size of the current meta-analysis.

INTRODUCTION

Today, as a result of developments in information technology, change is happening faster than ever before. Knowledge in a field quickly becomes outdated, and learning specialised information and processes is less important (Sivan et al., 2000). For this reason, rather than memorising disjointed pieces of information, there is a need for individuals who can relate the information they have acquired, analyse them and derive new information, and adapt the information they have structured in this way to new situations and use them effectively in their lives (Ağgül-Yalçın, 2010; Güney, 2011).

The aim of education, which is restructured to become an information society, is to develop skills such as critical and creative thinking, problem-solving, and decision-making to become life skills and enable the individual to take an active part in society (Erciyeş, 2015).

Now, schools are expected to provide students with the skills to think critically, work productively in groups, analyse and synthesise information to solve different kinds of problems and develop appropriate attitudes by dealing with students' individual differences and learning styles (Mills, 2006). Unfortunately, traditional education may not be sufficient to meet these expectations.

In traditional teacher-centred education, it is accepted that the learning process consists of the combined parts of accumulated knowledge and abstracted skills, and everything is determined, transmitted and controlled by the teacher. In the learning process, factors such as reward, punishment and repetition are applied. The traditional teaching approach puts students in the place of passive receivers on to whom teachers load knowledge and concepts, and it causes the upbringing of passive, non-interacting and disconnected students, and therefore citizens (Erciyeş, 2015; Quinlan & Fogel, 2014; Ün-Açıkgöz, 2011; Zayapragassarazan & Kumar, 2012).

Factors such as the inability of this approach to respond to the expectations of today's people, new developments in learning science, shifting the focus of the teaching-learning process towards learning and changes in knowledge have caused many countries to start questioning their existing education systems and student-centred education has gained attention (Akşit, 2007; Drucker, 1996; Güneyli, 2007). Like many other countries, Turkey has developed new curricula by considering the developments, the needs of the age, and the social expectations. Accordingly, in 2004–2005, the curricula were renewed, and the student-centred approach was the main concept on which these programmes were based.

Student-centred education is an approach where students become the centre of the learning process by determining their content, activities, materials and learning pace (Collins & O'Brien, 2011). It focuses on learning processes rather than teaching and on students' needs rather than teachers' intentions (Jarvis, 2005). In this approach, the learning process itself is considered more important than the acquisition of factual knowledge and is concerned not only with knowledge construction but also with the development of effective learning strategies, referred to as 'learning to learn'. The student-centred approach is considered best practice when the goal requires acquiring independent study skills, more self-determination, collaborative work, the creation of first-hand experience, and the implementation of principal academic abilities for authentic purposes (Westwood, 2008). Active learning is an important element of this new thrust, which is called 'student-centred' or 'learning-centred' education (Millis, 2012), and it is proposed based on the learning paradigm, as opposed to the teaching paradigm in which information is transferred one way (Mizokami, 2018). Active learning is defined as 'motivating students to do something and think about what they are doing' (Bonwell & Eison, 1991); it is a student-centred learning approach (Matsushita, 2018; Poë, 2015) in which teachers lead students to think, reflect and be curious. It differs from strict expository teaching in that students participate actively in the collaborative learning effort and the production of knowledge and meaning (Behnagh & Yasrebi, 2020; Hammer & Giordano, 2012).

Today's learning paradigm is substantially influenced by constructivism, which claims that learning is actively constructed by the student (Birenbaum, 2003), and the learners initiate greater responsibility and control over their learning (Sasson et al., 2021). This way of learning is the basis of active learning. With active learning, thinking, processing, learning by doing is realised, rather than just listening. This encourages students to be responsible for their learning (Greene, 2011; Michel et al., 2009; Quinlan & Fogel, 2014).

Students responsible for their learning are more likely to see the logic behind the subject being studied through active learning experiences (de Caprariis et al., 2001). Thus, they can increase their learning levels by providing more information processing and permanence (Beard & Wilson, 2005; Taylor & MacKenney, 2008). Indeed, they can develop more positive attitudes towards lessons through student-centred learning that is applied appropriately

(Collins & O'Brien, 2011). As it is known, affective factors have an important role as well as cognitive factors in the learning process (Di Martino & Zan, 2011). An affective factor, such as attitude that can directly affect students' interests and desires for the course can make a difference between students' success and failure (Kan & Akbaş, 2005). Thus, the effect of a method or approach on students' attitudes towards the course is frequently investigated in educational research.

Active learning is seen as an umbrella term (Barkley, 2018) or a general collection of various pedagogical approaches (Hagood et al., 2018), and it can take many forms in the classroom (Falconer, 2016). The implementation of active learning in educational settings is possible by the tools that support and contribute to the formation of the approach and provide learning opportunities to the students according to the principles of active learning (Aykaç, 2014; Güneyli, 2007). These tools can sometimes be fast and easy-to-apply techniques. Sometimes more complex strategies and methods require students to participate in higher-order cognitive processes by using more sensory modes (Connell et al., 2016; Mabrouk, 2007). The present study aimed to evaluate active learning from a broad perspective and comprehensively and, therefore, it was not content with a single tendency that supports active learning. However, since it is not possible to include all active learning tendencies in the meta-analysis, besides active learning techniques, cooperative learning, problem-based learning and project-based learning—which are thought to reflect the approach best and are more widely used in the education literature—were chosen.

The number of studies on the effectiveness of active learning is increasing in many countries worldwide. After putting the constructivist approach at the centre and adopting the student-centred education approach in the curriculum that entered into force in Turkey in 2005, this subject attracted the attention of many researchers, and numerous studies were conducted on the effectiveness of active learning. The effects of the active learning approach on academic achievement (Bilgiç, 2011; Mueller, 2009; Türksoy & Taşlıdere, 2016; Wale, 2013), attitudes (Akdal, 2010; Eker, 2014; Güney, 2011; Hong, 2010; Maden, 2013; Rehmat, 2015), problem-solving skills (Aşiroğlu, 2014; Ito & Kawazoe, 2015), listening and speaking skills (Kılınç, 2015; Sallabaş, 2011), scientific reasoning skills (Büyükbayraktar-Ersoy, 2015), learning retention (Akbulut, 2012; Boztaş, 2012; Lin et al., 2011; Servetti, 2010), creativity (Aydın, 2011; Kiras, 2013), learning process (Camci, 2012; Ghilay & Ghilay, 2015), learning strategies (Koçak, 2010), and self-efficacy (Aydede, 2009; Saygı, 2009; Uçal-Canakay, 2007) were investigated. Individual studies have different forms, subject areas and education levels. Since these studies focus on a specific application or experiment, their results are not generalisable and do not provide sufficient explanation for the effectiveness of a comprehensive approach such as active learning. In addition, individual studies may give inconsistent results regarding the approach's efficacy. This makes it difficult to reach a general conclusion. To overcome this, upper studies such as meta-analysis are used to combine the results of numerous small-scale studies, representing a wider universe and enabling generalisation.

In the meta-analyses carried out to determine the effect of active learning on students' attitudes towards the course, it was generally limited to one of the tendencies that support active learning such as cooperative learning (Çapar & Tarım, 2015; Karakuş & Öztürk, 2016; Kyndt et al., 2013; Othman, 1996), problem-based learning (Ayaz, 2015a, 2015b; Batdı, 2014; Demirel & Dağyar, 2016; Smith, 2003; Üstün, 2012) and project-based learning (Ayaz & Söylemez, 2016; Kaşarcı, 2013). Some of these reviews include individual studies in only one subject area, such as science (Ayaz, 2015a, 2015b; Ayaz & Söylemez, 2016; Karakuş & Öztürk, 2016; Üstün, 2012) or mathematics (Çapar & Tarım, 2015). In the meta-analysis conducted by Topan (2013), the effects of problem-based learning, project-based learning and cooperative learning methods on students' attitudes towards the course were examined under the name of student-centred methods. However, the aforementioned review is also limited to 19 studies only in mathematics.

Many studies on the subject have been carried out in different education levels, courses and countries. However, when the literature is examined, it is seen that the meta-analyses carried out to obtain a general result by combining the results of these studies are not comprehensive enough to determine the effectiveness of a fairly broad approach such as active learning. These meta-analyses generally examine the effectiveness of only one of the tendencies that support active learning and include individual studies carried out in a particular education level, course or country. In this case, there is a need for meta-analyses that will examine the effectiveness of the active learning approach from a wider perspective and more comprehensively. For this reason, it is worth researching to determine the overall effect of the active learning approach on students' attitudes towards the course by combining the effect sizes of existing individual studies implemented in different countries, subject areas and education levels.

The current review aims to analyse the results of experimental studies examining the effect of active learning on students' attitudes towards the course compared to the traditional method with meta-analysis and to reveal the effect of various study characteristics on research. To attain that objective, the following research questions were addressed:

RQ 1. What is the effectiveness of the active learning approach on students' attitudes towards the course?
RQ 2. What factors moderate the effectiveness of the active learning approach (if any) on students' attitudes towards the course?

The study characteristics determined for this meta-analysis are: (a) publication year; (b) publication type; (c) domain of subject; (d) educational level; (e) developer of scale; (f) sample size (the number of participants per a comparison); (g) duration of treatment; (h) implementer; (i) research design; and (j) published domestically versus abroad.

METHOD

Literature search

A literature search in databases was primarily performed to identify the objective experimental or quasi-experimental studies on the active learning approach between 2007 and 2016 (Table 1). The search was conducted between April 2017 and May 2017.

In the second step, the researchers manually scanned the references of existing meta-analyses and systematic reviews ($k = 50$) on active learning and the strategies that support it. This process provided 2562 additional studies and in this way the literature search resulted in a total of 17,053 related studies. Nevertheless, proceedings papers were excluded as most were not available in full text. The study selection process is presented in the flow diagram in Figure 1.

Inclusion criteria

The following criteria evaluated the identified studies: (a) examining the effect of active learning on students' attitudes towards the course; (b) experimental or quasi-experimental studies applying the pretest-posttest control group design; (c) theses, dissertations or articles published in peer-reviewed journals; (d) published in the English or Turkish language; (e) published between 2007 and 2016; (f) including sufficient statistical information to estimate the effect sizes; (g) including participants at elementary, middle or high school levels; (h) comparing an active learning treatment with a comparison group in which traditional lecture-based instruction applied; and (i) published in full text.

Coding process

Coding was performed to determine whether the primary studies met the inclusion criteria and to prepare the analysis data. The descriptive information expressing the characteristics of the studies carried out in the experimental or quasi-experimental design listed as a result of the literature review was collected systematically. The coding process was carried out by transforming them into quantitative data.

To ensure the reliability of the study, the coding process was carried out by the first author and a second coder who has a bachelor's degree in mathematics education and a master's degree in educational sciences and has previously conducted a meta-analysis. Inter-coder reliability was estimated using the formula 'Coder reliability = [Consensus / (Disagreement + Consensus)] × 100' (Miles & Huberman, 1994). As a result, the inter-coder reliability ratio was found to be 97%. After the first coding process, the codings with disagreement among the encoders were checked together by the two coders and corrected with a joint decision.

In the first stage of the coding process, 5445 duplicates were eliminated due to the comparisons made in the study lists. After the preliminary review of the remaining 11,608 studies in the second stage, 10,732 studies that were found not to meet the inclusion criteria were excluded. The remaining 876 studies were analysed and coded as full text, and it was determined that a further 732 studies did not meet the inclusion criteria. At the end of the coding process, 144 studies (158 effect sizes) were found suitable for the analysis and formed the data set of the meta-analysis.

Multiple effect sizes are likely to be found in some individual studies. More than one effect size was reported in the current review in 12 studies. In coding such studies, the coders applied the following procedure: (a) only post-test results in studies with more than one measurement, (b) results of each post-test in studies with more than one post-test ($k = 2$), (c)

TABLE 1 Number of studies listed as a result of literature search

Keywords searched	Database	Results
"active learning", "collaborative learning", "cooperative learning", "problem based learning", "project based learning", and their equivalents in Turkish literature	Turkish Council of Higher Education Thesis Center	996
	Turkish Academic Network and Information Center—TR Index	1315
	Asos Index	
	Acar Index	
	Turkish Education Index	
	Academic Index	
	Arastirmax—Scientific Publication Index	
	Turkish Council of Higher Education Academic	
	ERIC	11,067
	Web of Science	
	Proquest Dissertation and Theses	1113

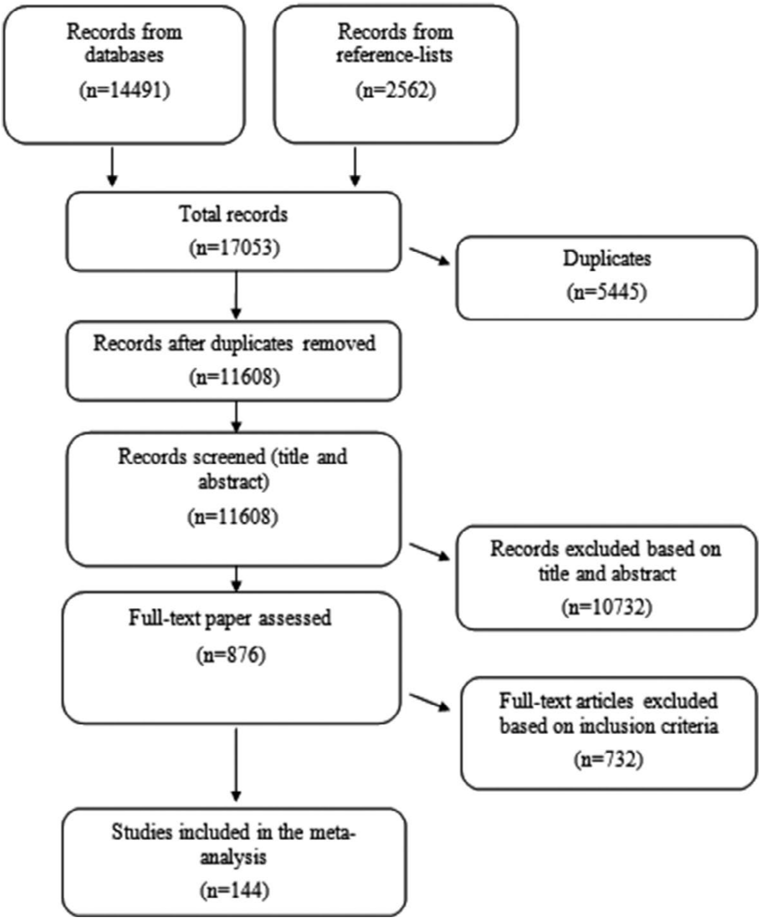

FIGURE 1 Flow diagram for the literature search process

studies with more than one independent sample ($k = 1$) effect sizes of each sample group, (d) in studies with more than one experimental or control group ($k = 9$), the results of each comparison were included in the meta-analysis separately.

Model choice

Choosing the appropriate model while conducting a meta-analysis is a critical decision (Srinivasjois, 2021). In cases where any between-study heterogeneity could not detect, and there is a good reason to assume that the true effect is fixed, the fixed-effects model would be appropriate (Harrer et al., 2022). However, suppose the inferences are to be generalised to a population where studies have different effects and characteristics. In that case, the random-effects model will need to be used (Hanji, 2017). It is important that the model to be chosen is based on the researcher's beliefs about the nature of the basic data and that it is determined according to the type of inference the researcher wants to make (Konstantopoulos & Hedges, 2009; Rothstein et al., 2013). Prior to the analysis, the researcher should decide on model selection according to the scope of the studies, the nature of the variables considered, and the design used in the studies (Başol, 2016). In the current meta-analysis, there was a wide range of variability among the individual studies in terms of their courses, scales, experimental designs, participants' educational levels and ages. In other words, they were not homogeneous because they did not have the same population parameters. Therefore, the researchers decided to estimate the overall effect size by using the random-effects model before the analysis.

Heterogeneity test and moderator variables

Since meta-analyses are based on summary statistics of primary studies, it is important to consider between-study variation and check for data heterogeneity (Khan, 2020). Heterogeneity is an assumption of the random-effects model, and determining heterogeneity is one of the primary objectives of the meta-analysis (Huedo-Medina et al., 2006). To investigate heterogeneity in meta-analysis, it is necessary to decide on the study-level variables called moderators (Song et al., 2001). In the current review, the researchers performed a heterogeneity test to detect heterogeneity between the effect sizes of primary studies included in the meta-analysis and identify possible moderator variables in case of heterogeneity (Table 2).

When the heterogeneity analysis findings were examined, the fact that the *Q* value exceeds the critical value of the chi-square distribution (χ^2) indicates that the effect size values of the studies are heterogeneous (Dinçer, 2014). The I^2 value being 84% indicates a high level of heterogeneity (Deeks et al., 2008) and also the presence of possible moderator variables. In the current review, some of the study characteristics were supposed to be possible moderator variables, including: (a) publication year, (b) publication type, (c) domain of subject, (d) educational level, (e) developer of scale, (f) duration of treatment, (g) implementer, (h) research design, (i) published domestically versus abroad, and (j) sample size (the number of participants per a comparison).

Outliers, publication bias and sensitivity analysis

Sometimes, some observation results in studies are different from other results in the data set. In other words, research data has a normal model, and some results show deviations from this normal model. Such results are called 'outliers' (Aggarwal, 2017; Rousseeuw & Hubert, 2011). Since the presence of outliers among the individual effect sizes may distort the meta-analysis results (Viechtbauer & Cheung, 2010), the researchers carried out outlier analysis. The effect sizes were weighted with the inverse of the variance and ordered linearly for detecting the outliers. Afterward, weighted effect sizes with a difference greater than or equal to the distribution's standard deviation were considered outliers (see Hittner & Swickert, 2006; McLeod & Weisz, 2004; Swanson et al., 2009).

Furthermore, to detect possible publication bias that may affect the meta-analysis, funnel plot, classic fail-safe N (Rosenthal, 1979), Orwin's fail-safe N (Orwin, 1983), and the trim-and-fill (Duval & Tweedie, 2000a, 2000b) methods were used. The researchers agreed to incorporate dependent effect sizes severally into the analysis to minimise the current review's data and statistical power loss. To see how this decision affected the result of the meta-analysis, a sensitivity analysis was conducted. First, the main effect size was estimated in

TABLE 2 Findings of heterogeneity analysis

df	*Q*	χ^2	*p*	*SE*	I^2
157	993.938	190.516	0.000	0.053	84.204

which multiple effect sizes in individual studies were included separately; next, another main effect size was estimated in which multiple effect sizes were combined (i.e., an effect size for each study), and then the results of both estimations were compared.

Effect size estimation

Since different scales were used to determine the group averages in the individual studies, the effect sizes of these studies were used by standardising them. To perform this procedure, the researchers utilised the standardised mean difference effect size index developed by Hedges (1982):

$$Hedges' \ g = \left(M_1 - M_2\right) / SD_{\text{pooled}} \tag{1}$$

Here, M_1 is the mean post-test score of the experimental group in the individual studies, M_2 is the mean of the post-test score of the control group in the individual studies, and SD_{pooled} is the weighted average of the standard deviation of both groups. In individual studies where standard deviation was not reported, p values from independent groups were used instead ($k = 2$). Also, the Q_b values were utilised for the comparisons made in the moderator analyses.

Interpretation of effect sizes was based on the classification of Cohen et al. (2007). According to this classification, if the effect size is in the range of 0–0.20, there is a weak effect, a modest effect for 0.21–0.50, a moderate effect for 0.51–1 and a strong effect if greater than 1.

It was decided before the analysis to estimate the overall effect size based on the random-effects model, considering that the samples of the individual studies consisted of different countries, education levels and age groups; that is, the population sizes were different, and they did not represent the same population.

RESULTS

To determine the effectiveness of the active learning, 144 studies (158 effect sizes), representing a total of 10,209 participants, were included in the meta-analysis. As seen in Table 3, the studies were mostly published between 2007 and 2011, published as master's theses (53.8%), carried out in the science domain (50%), focused on middle school (62.6%), used the scale developed by other researchers (79.1%), had an experimental duration of 5–8 weeks (53.1%), performed by researchers (39.2%), designed in a quasi-experimental pattern (89.2%), conducted in Turkey (95.5%), and involved 50–100 participants (50.6%).

Meta-analytic results

The review utilised the treatment and control group sample sizes, means and standard deviations to estimate the effect sizes. When the effect sizes presented in the forest plot were examined (Appendix S1), it was seen that they ranged widely, from −0.599 to 5.116, and 19 out of 158 effect sizes were negative, and 139 were positive. According to Cohen et al. (2007), 19 of the positive studies had a weak, 17 had a modest, 54 had a moderate, and 49 had a strong effect.

Before estimating the main effect size, an analysis was carried out to determine whether there were outliers among the research data. In the first place, the 158 effect sizes were weighted with the inverse of their variance and then ordered from smallest to largest

TABLE 3 Findings of moderator analyses

Moderator	k	Effect size (g)	95% CI Lower L.	95% CI Upper L.	Q_b	p
Publication year	**158**					
2007–2011	102	0.803	0.674	0.931	1.377	0.241
2012–2016	56	0.673	0.500	0.847		
Publication type	**158**				4.030	0.133
Master's thesis	85	0.694	0.553	0.836		
Doctoral dissertation	20	1.028	0.735	1.321		
Article	53	0.755	0.577	0.933		
Domain subject	**157**[a]				7.313	0.198
Social sciences	17	0.844	0.526	1.162		
Science	79	0.699	0.554	0.844		
Mathematics	43	0.693	0.494	0.891		
Language	10	1.269	0.849	1.689		
Arts	4	0.905	0.267	1.542		
Physical education	4	0.853	0.184	1.522		
Educational level	**158**				1.853	0.396
Primary school	31	0.798	0.564	1.031		
Middle school	99	0.706	0.575	0.838		
High school	28	0.895	0.644	1.147		
Developer of scale	**156**[b]				15.587	0.000*
Author	31	1.159	0.930	1.388		
Other researcher(s)	125	0.661	0.548	0.774		
Experimental duration	**151**[c]				4.286	0.369
1–4 weeks	40	0.856	0.655	1.057		
5–8 weeks	84	0.711	0.572	0.850		
9–12 weeks	16	0.577	0.260	0.894		
13–16 weeks	8	0.485	0.045	0.924		
>16 weeks	3	1.019	0.303	1.736		
Implementer	**129**[d]				4.585	0.101
Researcher	62	0.602	0.445	0.759		
Course instructor	46	0.701	0.521	0.881		
Both	21	0.942	0.673	1.212		
Research design	**146**[e]				0.703	0.402
Experimental	5	0.997	0.419	1.574		
Quasi-experimental	141	0.745	0.635	0.855		
Published domestically/ abroad	**158**				1.048	0.306
Turkey	151	0.745	0.639	0.851		
Abroad	7	1.000	0.523	1.477		
Sample size	**158**				1.499	0.473

TABLE 3 (Continued)

Moderator	k	Effect size (g)	95% CI Lower L.	Upper L.	Q_b	p
<50	62	0.842	0.671	1.013		
≥50 <100	80	0.705	0.561	0.850		
≥100	16	0.717	0.407	1.027		

Note: Random effects model, $*p < 0.05$.

[a]A study was conducted in more than one domain subject and therefore excluded.

[b]Two studies were not specified and therefore excluded.

[c]Seven studies were not specified and therefore excluded.

[d]Twenty-nine studies were not specified and therefore excluded.

[e]Twelve studies were not specified and therefore excluded.

(Appendix S2). Next, the *SD* of the distribution was computed as *SD* = 1.535. The differences between the weighted effect sizes in the last two rows (Diğler, 2011; Savuran, 2007, respectively) of the distribution were greater than the *SD* of the distribution. Thus, the effect size of Savuran (2007) and Diğler (2011) were defined as outliers and were winsorised to the preceding effect size (Acar, 2008) in the distribution. After the procedure, Savuran's (2007) effect size decreased from 3.661 to 2.777, and Diğler's (2011) decreased from 5.116 to 2.801. The differences between the weighted effect sizes fell below the new *SD* (1.538) of the distribution, and further analysis was carried out by utilising winsorised effect sizes.

To address the primary research question, the overall effect size was estimated as 0.757 under the random-effects model with a standard error of 0.053 ($p = 0.000$). At a 95% CI, the lower limit of the overall effect size was 0.653, and the upper limit was 0.860. Accordingly, this positive overall effect size ($g = 0.757$) represented that the effect of the process was in favour of the treatment group, implying that active learning is more effective on students' attitudes towards the course than traditional lecture-based instruction. Furthermore, this effect was found to be moderate according to the classification proposed by Cohen et al. (2007).

After estimating the overall effect size, a sensitivity analysis was conducted to check how sensitive the result obtained was to changes in some aspects of the data. Hence, a single combined effect size value was estimated for each of the 12 studies with multiple effect sizes, and a different overall effect size was estimated to make a comparison. It was observed that the difference between the overall effect size ($g = 0.757$) was estimated by combining 158 effect sizes in the first case and the overall effect size ($g = 0.786$) estimated by combining 144 effect sizes in the second case was found to be trivial (Table 4).

Publication bias

To detect whether the meta-analysis result suffered from publication bias, the researchers have resorted to various ways. In the first place, based on the suggestions of Banks et al. (2012), the summary effect sizes of published and unpublished studies were compared. The sub-group analysis showed that the effect sizes of published ($g = 0.755$) studies do not systematically differ from unpublished ($g = 0.758$) studies ($p = 0.980$). Afterward, the researchers carried out a visual examination of the distribution in the funnel plot. As a result of the said examination, it was seen that the effect sizes of the studies did not show excessive asymmetry (Figure 2). To detect publication bias, not only was visual examination satisfied but other statistical methods were also used.

TABLE 4 Findings of sensitivity analysis

N[a]	*Hedges' g*	*Std. Er.*	*Var.*	*Lower*	*Upper*	*p*	*Z*	*df*
158	0.757	0.053	0.003	0.653	0.860	0.000	14.340	157
144	0.786	0.056	0.003	0.677	0.896	0.000	14.082	143

[a]Number of combined effect sizes.

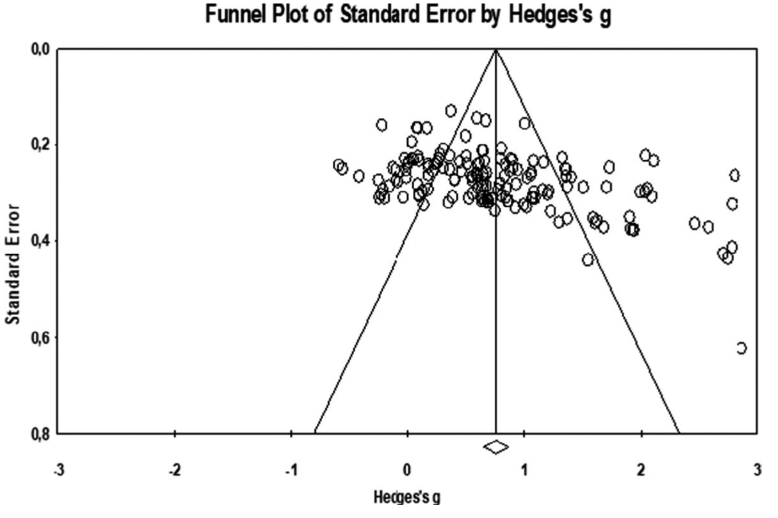

FIGURE 2 Funnel plot

The result of classic fail-safe N (Rosenthal, 1979) showed that 46,696 additional studies with null effect findings are necessary to decrease the overall effect size (0.757; $p < 0.0001$) to an insignificant level ($p > 0.05$). On the other hand, the result of Orwin's fail-safe N (Orwin, 1983) suggested that 1,036,357 studies with null results were needed to bring the overall effect size to a trivial level ($g = 0.001$). The number of additional studies shown by both analyses exceeds the '5k+10' limit (Rosenthal, 1979). Also, the trim-and-fill method (Duval & Tweedie, 2000a, 2000b) findings displayed no difference between observed and adjusted effect sizes, and the number of studies that needed to be trimmed was 0 (Table 5). Considering the results of the statistical tests performed, it can be said that the results of the current review did not contain publication bias.

Moderators

As seen in Table 2, the heterogeneity test indicated significant differences in the students' attitudes towards the course ($Q = 993.938$, $p < 0.001$). At a 95% significance level of 157 degrees of freedom, the critical value was $\chi^2 = 190.516$. The Q value exceeded the critical value of the chi-square distribution and thus revealed heterogeneity among the studies ($p < 0.01$). To address the second research question, the researchers conducted ten moderator analyses to offer possible explanations for the heterogeneity (Table 3).

The result of the moderator analysis made by the publication years of the studies showed that the summary effect size of the studies between the years 2007 and 2011 ($g = 0.803$) and the studies between the years 2012 and 2016 ($g = 0.673$) were at a moderate level. The

TABLE 5 Results of publication bias tests

Test	Results	
Classic Fail-Safe N	*Z* value for observed studies	33.751
	p value for observed studies	0.000
	Alpha	0.05
	Tails	2
	Z for alpha	1.959
	Number of observed studies	158
	Number of missing studies that would bring the *p*-value to > alpha	46696
Orwin's Fail-Safe N	Hedges' *g* in observed studies (fixed effect)	0.656
	Criterion for a 'trivial' Hedges' *g*	0.0001
	Mean Hedges' *g* in missing studies	0.0000
	Number of missing studies needed to bring Hedge's *g* to under 0.001	1036357
Trim and Fill	Observed values	0.756
	Adjusted values	0.756
	Studies trimmed	0

findings of moderator analysis indicated that while the effect sizes of doctoral dissertations ($g = 1.028$) had a strong effect, the effect sizes of master's theses ($g = 0.694$) and articles ($g = 0.755$) had a moderate effect.

Considering the sub-group comparison of the domain subjects, languages ($g = 1.269$) were associated with a strong effect size, while arts ($g = 0.905$), physical education ($g = 0.853$), social sciences ($g = 0.844$), science ($g = 0.699$) and mathematics ($g = 0.693$) were associated with a moderate effect size. The findings showed that the summary effect sizes of studies conducted in elementary school ($g = 0.798$), middle school ($g = 0.706$), and high school ($g = 0.895$) were associated with a moderate effect size.

The sub-group analysis of scale developers revealed a strong effect for the studies in which the scale was developed by the research author ($g = 1.159$) and a moderate effect for the studies in which the scale was developed by another researcher(s) ($g = 0.661$). Another sub-group comparison was related to the experimental duration of studies. The studies with an experimental duration of over 16 weeks ($g = 1.019$) were associated with a strong effect size, whereas the studies with an experimental duration of 1–4 weeks ($g = 0.856$), 5–8 weeks ($g = 0.711$), and 9–12 weeks ($g = 0.577$) were associated with a moderate effect size but the studies with an experimental duration of 13–16 weeks ($g = 0.485$) were associated with a modest effect size.

The results revealed that the studies in which the intervention was implemented by researchers ($g = 0.602$), course instructors ($g = 0.701$), and researchers and course instructors together ($g = 0.942$) were associated with a moderate effect size. When comparing research designs, both experimental ($g = 0.997$) and quasi-experimental ($g = 0.745$) studies were associated with a moderate effect size.

The findings of regional differences indicated a strong summary effect size for the studies conducted abroad ($g = 1.000$) and a moderate summary effect size for the studies from Turkey ($g = 0.745$). Another sub-group comparison was the sample size (the number of participants per comparison). The studies with fewer than 50 participants ($g = 0.842$), with 50–100 participants ($g = 0.705$), and with more than 100 participants ($g = 0.717$) were associated with a moderate effect.

DISCUSSION, CONCLUSION AND SUGGESTIONS

To determine the impact of active learning on students' attitudes towards the course, 158 comparison results were obtained from 144 primary studies, and data belonging to a total of 10,209 participants, 5101 in the experimental group and 5108 in the control group, were used. As a result of estimating the effect sizes of individual studies, it was seen that they ranged from −0.599 to 5.116, and 19 of the 158 effect sizes included in the meta-analysis were negative, and 139 were positive. On the other hand, it was determined that 19 of the positive studies had a weak, 17 of them had a modest, 54 of them had a moderate, and 49 of them had a strong effect. Necessary analyses were made for outliers and publication bias. As a result of the analyses, the weighted effect sizes of the two studies were determined as outliers; therefore, these values were used by winsorising to the effect size closest to them. In addition, moderator analyses were carried out for ten different study characteristics that are thought to impact the overall effect size. In this way, a multi-dimensional evaluation was made to determine in which cases and how the effect of active learning varies.

Within the scope of the research, the overall effect size value was calculated to determine the effectiveness of the active learning approach. Since the individual studies included in the meta-analysis differed in terms of many variables such as countries, subject areas, education levels of participants, age groups, measurement tools used, and experimental designs, and they did not have the same universe parameters, the estimation of the overall effect size was carried out using the random-effects model. The overall effect size estimated as a result of combining 158 individual effect sizes to determine the effect of active learning on students' attitudes towards the course was $g = 0.757$. According to Cohen et al. (2007), this moderate effect size value reveals that active learning is more effective on students' attitudes towards the course than traditional teaching methods. This result indicates that properly implemented student-centred teaching will lead to more positive attitudes towards the course (Collins & O'Brien, 2011) and that to develop positive attitudes towards courses, approaches such as active learning should be used in the learning process that will enable students to take responsibility for their learning (Demirel & Dağyar, 2016). In most of the other meta-analyses (Ayaz, 2015a, 2015b; Batdı, 2014; Kaşarcı, 2013; Smith, 2003; Topan, 2013; Üstün, 2012) examining the effect of active learning and its components on attitudes towards the course, medium-level effect sizes were estimated, similar to the results of the research. In some meta-analyses, modest (Demirel & Dağyar, 2016; Karakuş & Öztürk, 2016; Othman, 1996) and weak (Çapar & Tarım, 2015; Kyndt et al., 2013) effect size values were obtained for the variable of attitude towards the course.

The active learning approach claims to increase academic achievement and develop positive attitudes towards courses. But, 'some attitudes are resistant to change' (Prislin & Crano, 2008, p. 9), and 'it may take time to change attitudes' (Siegel & Ranney, 2003, p. 767). Considering this feature of attitudes, it can be said that the application times should be kept long enough so that the approaches used in educational practices can cause students to develop positive attitudes towards the course. In 124 (78.48%) of the 158 individual studies analysed within the scope of the current review, the fact that the application times were less than eight weeks was not sufficient for the students to develop a positive attitude towards the course, and therefore a moderate effect size value may have emerged.

After estimating the overall effect size, moderator analyses were conducted for ten study characteristics that were thought to impact the overall effect size. The results of the moderator analyses performed and the percentages of variance explained by the study characteristics were presented in Table 6.

When Table 6 was examined, it was seen that the effect of the active learning approach was moderated only by the developer of the scale from the study characteristics. Although

TABLE 6 Results on moderator analysis

Study characteristics	*N*	*p*	R^2	Explained variance, %
Publication year	158	0.241	0.011	1.1
Publication type	158	0.133	0.003	0.3
Domain subject	157	0.198	0.061	6.1
Educational level	158	0.396	0.000	0.0
Developer of the scale	156	0.000	0.098	9.8
Experimental duration	151	0.369	0.040	4.0
Implementer	129	0.101	0.058	5.8
Research design	146	0.402	0.024	2.4
Published domestically/abroad	158	0.306	0.006	0.6
Sample size	158	0.473	0.000	0.0

the scale developer was the moderator variable that describes the largest part of the between-study variance, educational level and sample size were the variables that explain the smallest part of the between-study variance.

According to the research results, the summary effect size of the studies published between 2007 and 2011 ($g = 0.803$) and the summary effect size of the studies published between 2012 and 2016 ($g = 0.653$) was moderate and close to each other. In this case, it is possible to say that active learning has a positive and moderate effect on students developing positive attitudes towards the course throughout all the years examined within the scope of the research.

While master's theses ($g = 0.694$) and articles ($g = 0.755$) had a moderate summary effect size, doctoral dissertations ($g = 1.028$) had a strong summary effect size. Considering the other meta-analyses conducted on the subject, it was seen that master's theses and doctoral dissertations had a modest effect in Karakuş and Öztürk (2016), doctoral dissertations and articles had a strong effect in Ayaz (2015), while master's theses had a modest effect. It is thought that the lack of consistency in the results of the publication types of studies in meta-analyses may be due to the scarcity of individual studies examined within the scope of meta-analyses. So much so that Karakuş and Öztürk (2016) had only two doctoral dissertations when there were no articles, Ayaz (2015) has only three doctoral dissertations and four articles. Although Rosenthal (1995) states that meta-analysis can be performed even with two studies, he warns that the meta-analysis results performed with a few studies will not be reliable. Johnson et al. (2000) also state that analysing with only a few validation studies may be misleading. Borenstein et al. (2009) and Hedges and Olkin (1985) suggest that each category should include at least ten studies to obtain reliable results from such analyses. Therefore, in comparisons of publication types, the fact that the categories included a small number of studies made it difficult to examine the effect of the variables and may have produced different results.

The effect of the active learning approach on attitudes was also examined by moderator analysis according to the domain subjects in which the experimental procedures were performed. Since the individual studies reviewed within the scope of the meta-analysis were carried out in 12 different course types and there were few studies in some courses, this comparison was made by grouping the courses according to the domain subjects. It was observed that the largest effect sizes belonged to the domains of language ($g = 1.269$), arts ($g = 0.905$), and physical education ($g = 0.853$), respectively. The fact that the effect size is moderate even in mathematics ($g = 0.693$), which has the smallest summary effect size, can be interpreted as that active learning positively affects attitudes towards the course in all domain subjects.

In another moderator analysis, the effect of active learning on attitudes was examined according to the education levels. It was determined that the summary effect size of active learning at primary school ($g = 0.798$), secondary school ($g = 0.706$), and high school ($g = 0.895$) were moderate. Similarly, a moderate summary effect size was reported by Ayaz (2015a, 2015b), Demirel and Dağyar (2016), and Kaşarcı (2013) for primary school level, but Othman (1996) and Topan (2013) reported weak and modest effect sizes. For secondary school level, Ayaz (2015a, 2015b), Batdı (2014), Kaşarcı (2013) and Topan (2013) reported a moderate summary effect size, while Demirel and Dağyar (2016) reported a modest and Othman (1996) reported a weak summary effect size. For high school level, Ayaz (2015) and Demirel and Dağyar (2016) reported a moderate effect size, whereas N. Ayaz (2015), Batdı (2014) and Topan (2013) reported a strong and Kaşarcı (2013) reported a weak effect size.

From the meta-analysis results, it was determined that the summary effect size of the attitude scales developed by the author(s) of the study ($g = 1.144$) was larger than the summary effect size of the attitude scales developed by another researcher ($g = 0.652$). To explain the reason for this situation, the scales used in the individual studies were examined. It was determined that 80% of the attitude scales developed by the author(s) who carried out the study were piloted, factor analysis was performed in 54%, and the internal consistency coefficient was estimated in 90%. It was observed that 16% of the studies using attitude scales developed by another researcher were piloted, factor analysis was performed in 7%, and internal consistency coefficient was estimated in 27%. It is thought that the low rates of applications carried out to ensure reliability and validity for the scales that were not developed by the author(s) conducting the study are effective in the lower summary effect size values obtained from the scales in question.

Another moderator variable was the sample size. It was determined that the summary effect sizes of the studies with less than 50 students in the sample ($g = 0.842$), between 50 and 100 ($g = 0.705$), and over 100 ($g = 0.717$) were found to be close to each other and at a moderate level. This result supports the conclusion obtained in other meta-analyses (Ayaz, 2015a, 2015b; Ayaz & Söylemez, 2016) on the subject that different sample sizes were noted to a moderate summary effect size.

The duration of the experimental procedures was also examined in the meta-analysis. It was determined that the summary effect sizes were positive in all categories, but the largest effect size belonged to studies with 17 weeks and longer duration. This conclusion supports the views of attitude researchers that changing attitudes can take time (Siegel & Ranney, 2003). When the studies included in the review were examined, it was seen that the experimental procedure time in 124 (78%) studies was shorter than 8 weeks, and the number of studies with 17 weeks and longer duration was only three. Similar to this review, individual studies with long experimental procedure time were few in number in other related meta-analyses. In this case, it is possible to explain the absence of a significant difference in attitudes towards the course between the groups formed according to the duration of the experimental process, with the small number of long-term studies.

Another variable whose moderator analysis was performed in the research is the implementer of the experimental process. According to the findings, it was seen that the summary effect sizes of the experimental procedures performed by the researchers ($g = 0.602$), by the course instructors ($g = 0.701$), and by the researcher and the course instructor together ($g = 0.942$) were at a moderate level. According to this result, it can be said that the effect of active learning on attitudes towards the course is similar in all groups formed according to the implementer of the experimental procedure, and it is effective in developing positive attitudes towards the course in all groups.

It is known that the Hawthorne effect affects students' attitudes as well as their academic achievement (Öner-Sünkür et al., 2012) and occurs when the researcher is present in the experimental practice, or the participants are aware that they are being observed (Kocakaya, 2012). In the current meta-analysis, it was observed that the summary effect sizes did not differ significantly even when the implementers of the experimental procedure changed. Considering the use of post-test scores in estimating the summary effect sizes of the groups and the fact that this effect was seen equally in both the experimental and control groups (Lohithakshan, 2002), we can say that the Hawthorne effect did not occur in the results of the moderator analysis.

According to the results of the moderator analysis on experimental designs, both the studies using experimental (g = 0.997) and quasi-experimental (g = 0.745) designs were associated with a moderate effect size. This result may be due to the inclusion of only pre-tested experimental studies in the meta-analysis. It can be said that the equivalence of the experimental and control groups in terms of their attitudes towards the course by using the pre-test results creates the equivalence that the random creation of the sample will provide.

As a result of the moderator analyses of the research, it was also determined that individual studies conducted in Turkey (g = 0.745) had a moderate effect size, whereas individual studies conducted abroad (g = 1.000) had a strong effect size.

In both the current review and other meta-analyses on the subject, it is noticeable that there is no significant difference between the groups in general in the moderator analyses regarding the students' attitudes towards the course. It is known that many factors play a role in attitudes. Especially the time variable is very effective in forming and changing attitudes. Although this review is more comprehensive than other related meta-analyses, the number of long-term studies is few. In fact, in 81% of the studies, the implementation period was shorter than eight weeks, and the number of studies longer than 17 weeks was only three. In this case, it is believed that the implementation times in the individual studies combined within the scope of meta-analyses were not long enough to create a change in attitude and may have affected other moderator variables.

As with almost any study, the current review has some limitations. First, the results of primary studies written only in Turkish and English were combined within the scope of the meta-analysis. It is advisable to carry out extended meta-analyses, including the results of studies reported in other languages. In addition, only the effect of active learning on students' attitudes towards the course was examined in the current meta-analysis. It can be recommended to conduct meta-analyses on the effect of the active learning approach on other variables such as problem-solving, scientific reasoning, creativity, critical thinking and self-efficacy.

Another limitation of the review is that it involves individual studies conducted at primary, secondary and high school levels. In addition to these, it may be suggested to conduct meta-analyses that include the results of studies on active learning practices within the scope of pre-school, university and adult education. Besides, individual studies including the applications of project-based learning, problem-based learning and cooperative learning methods and active learning techniques were included in the current meta-analysis. Future meta-analyses may include individual studies on other components of active learning.

Combining the results obtained from articles, master's theses and doctoral dissertations can be seen as another limitation in the review. Extended reviews, including the results of papers presented at scientific meetings, can be conducted. To obtain more comprehensive information in future meta-analyses on the subject, it may be recommended to use different moderator variables such as students' socio-economic status, past experiences of active learning, achievement levels, and active learning experiences of implementers.

It has been observed that the majority of studies on active learning, as in general educational research, were conducted in a quasi-experimental design. Researchers can perform their studies in experimental design and compare their results with studies carried out in quasi-experimental design. In the review, the overall effect sizes were determined by combining the results of many studies on the effect of active learning on the attitude towards the course. These overall effect sizes can be accepted as criteria for the approach's effectiveness. The effect sizes to be obtained from individual studies on the subject in the future can be interpreted by researchers by comparing them with the overall effect sizes of the current meta-analysis. In addition to these, it can be recommended to conduct studies that examine the effect of active learning on attitudes towards the course, with an experimental duration of longer than 16 weeks. Moreover, the results of individual studies comparing active learning with other current approaches can be combined in future meta-analyses.

Finally, although the primary studies to be included in the meta-analysis were coded, it was seen that some studies did not include information such as the duration of the experiment, developer of the scale, the experimental design used, and who the implementer was, and in some studies the statistical values used to estimate the effect size were not presented. Therefore, some studies could not be included in the meta-analysis, and limited comparisons could be made with some studies. It is suggested that the results of individual studies be reported in all aspects to conduct more comprehensive meta-analyses in the future.

CONFLICT OF INTEREST

The authors declare no conflicts of interest with regard to this study.

ETHICAL APPROVAL

Ethics approval was not required for this meta-analysis.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analysed in this study.

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How to cite this article: Tutal, Ö., & Yazar, T. (2022). Active learning promotes more positive attitudes towards the course: A meta-analysis. *Review of Education*, *10*, e3346. https://doi.org/10.1002/rev3.3346