International Seminar on Student Research in Education, Science, and Technology
ISSN 3047-1532 | Volume 1 April 2024, pp. 645-660

https://www.issrestec.id/
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Universitas Muhammadiyah Mataram, Indonesia

Global Trends in Augmented Reality Technology: A Meta-Analysis Study

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Abstract: Immersive technology with augmented reality (AR) as a didactic support has gone global and enriched the learning process with various packages of excellence. Although there have previously been many meta-analyses to examine the aggregate influence of AR on student academic performance, few have considered treatment duration as a moderator variable. This research was conducted for. This random effects meta-analysis research was conducted to test the effectiveness of immersive augmented reality technology in learning by considering treatment duration as a research feature and specifically identifying data from the Scopus basis. This aim was achieved by examining 73 independent comparisons (n = 2822) that were eligible and identified from the Scopus database. The analysis results assisted by CMA software show that integrating immersive augmented reality technology in learning has a moderate effect ($g = 0.75$, $p < 0.005$) compared to learning conditions without AR. These results also add to the empirical validity of the relationship between categorical variables and research effect sizes, as it is necessary to understand the research in the context of future applications of augmented reality. These findings also provide a new direction for teachers, lecturers, stakeholders, and professionals to develop a didactical framework by considering the duration of treatment in the application of Immersive Augmented Reality in the future.

Keywords: Augmented Reality, Meta-analysis, Moderator, Effect Size.

Article History:
Received: 31-03-2024
Online : 16-04-2024

A. INTRODUCTION

Learning driven by the use of Augmented Reality (AR) has become a new trend, which combines technology in certain learning topics (Ashwini et al., 2022; Bower et al., 2014; Nordin et al., 2022; Pathania et al., 2023). AR technology is used as an interactive tool and media that connects digital information with the real world (Monfared et al., 2016). AR is said to be an efficient and promising technology that can improve the education sector. AR is a visualization technology that enables human interaction by providing users with a perception of reality using virtual information (Oueida et al., 2023). AR is the latest innovation that can expand sensory perception through digital objects (Buchner & Kerres, 2023) so it has the potential to be widely applied in the world of education (Sural, 2018; Z. A. Yilmaz & Batdi, 2021). Virtual objects via AR interfaces help teachers to visualize 2D and 3D geometric objects (Demitriadou et al., 2020; Kan & Özmen, 2021).

The use of AR supports accessibility achieved through mobile devices and dynamic switching of gesture recognition (Sun et al., 2019). The use of AR allows students to interact with virtual objects easily and naturally, thus supporting their understanding of what they are learning and improving the quality of education. AR is seen as a valuable educational tool and has great potential for future learning in supporting students' academic abilities (Bower et al., 2014). This AR integration also supports increased perception of existing material (Yadav & Gupta, 2023). AR can even be a convenient and efficient alternative in replacing risk-prone and expensive physical laboratories (Mukhtarkyzy et al., 2022). In line with that, Romano et al. (2020) details the advantages of AR, namely helping to explain processes, assisting with simulations, gaining attention, describing abstracts, explaining space concepts and replacing experiments.

AR's advantages have sparked a flurry of studies, specifically testing its effectiveness in learning. However, various previous empirical studies have provided varying and inconsistent results. Several research results reveal that augmented reality-based learning (ARBL) can increase students' motivation and interest in learning thereby supporting the improvement of their academic abilities (e.g., Al-nawaiseh et al., 2020; Aldalalah et al., 2019; Cahyana et al., 2023; Eldokhny & Drwish, 2021; Safar & Al-jafar, 2017; Setiawan et al., 2023; Silva et al., 2023; Whang et al., 2021). In contrast to that, several other individual studies show conflicting results that the use of AR has no or only a small effect on students' academic abilities (e.g., Chang et al., 2019; Chien et al., 2017; A. B. N. R. Putra et al., 2021; R. M. Yilmaz & Goktas, 2017). Even in a recent study, Buchner & Kerres (2023) found that the impact of AR technology on students' academic abilities was still unclear or inconsistent.

Meanwhile, the reality is that teachers, lecturers, stakeholders and professionals need accurate information about how much influence AR has in improving students' academic abilities. Such information is necessary to consider AR integration in education. This hope is achieved by conducting a meta-analysis study because with this work we can integrate the findings of primary studies, and investigate the reasons for inconsistency in the results of all primary studies to then consider its implementation (Franzen, 2020; Juandi, Tamur, et al., 2022; Juandi et al., 2023; Tamur, Kusumah, Juandi, Kurnila, et al., 2021; Tamur et al., 2023).

Relatedly, in the current literature there have been many meta-analyses that specifically aim to find the overall effect of using AR in education. Meta-analyses that have been carried out by Tekedere & Göker (2016), Ozdemir et al. (2018) and Lin & Yu (2023) for example only consider limited moderator variables. Likewise, meta-analysis studies conducted by Yilmaz & Batdi (2021) and Altinpulluk (2019) have also analyzed the overall influence of AR technology in education, but did not proceed by analyzing categorical variables that might clarify variations between primary study results. Of the various meta-analysis studies that have been conducted, none has specifically considered treatment duration as a moderator. In addition to aiming to analyze the overall impact of AR integration in education, this study fills a gap in previous work by considering treatment duration as a categorical variable. This contributes to the literature, teachers, lecturers, and stakeholders to consider the use of AR in education in the future.

B. METHOD

This research uses meta-analysis to answer the objectives. In general, meta-analysis research begins with the formulation of research problems and hypotheses, followed by literature searches, then variable coding, then statistical analysis, and ends with interpretation of the same findings (Borenstein et al., 2009). The following describes the details of these stages.

1. Literature Search

The online database is chosen as the location for searching for documents or journal articles resulting from research that will be included in the analysis. Next, the Publish or Perish (PoP) program was used to collect data related to the influence of AR use in education.

2. Literature Inclusion Criteria

Primary studies collected using the PoP application were then selected. Regarding this selection process, (Baashar et al., 2022) suggest using the PICO (Population, Intervention, Comparison, Outcomes) framework. Based on the PICO framework, the inclusion criteria in the study are as follows:

a. Population

In accordance with the research objectives, the studies included in this research specifically analyze students from various levels of education as a population. The included study reports are in the form of journal articles written in English and indexed by Scopus. Studies outside these requirements are excluded from the analysis (e.g., Kan & Özmen (2021). The studies analyzed must include statistical information to obtain an effect size. Research that does not meet this will be excluded from the analysis (e.g., Nordin et al., 2022; Oueida et al., 2023; Tezer et al., 2019).

b. Intervention

Experimental research that uses AR technology as a treatment in the field of education or teaching. Meanwhile, meta-analysis studies such as (Baashar et al., 2022; Tekedere & Göker, 2016) were excluded from the analysis because they did not conduct experiments or did not use AR as a treatment. Research conducted by Whang et al. (2021) and Tao et al. (2023) was also excluded from the analysis because the AR effectiveness experiments they studied were conducted outside the educational domain.

c. Comparison

Research is experimental and must involve a control group as a comparison. Development research that only used one sample or used a qualitative approach was excluded from the analysis (eg; Karagozlu et al., 2019; Ratnawati et al., 2022; (Hidayat et al., 2021). In addition, research that involved a control group as a comparison but using structural equation modeling or survey research were excluded from the analysis (eg; (Jiang et al., 2021; Yuan et al., 2021).

d. Outcomes

The studies analyzed examined the influence of AR on students' academic abilities including knowledge, self-confidence, motivation, and skills). Studies that did not directly highlight this were excluded from the analysis (e.g., Chi et al., 2013; Osadchyi et al., 2021). Furthermore, in this research, suggestions from Pigott & Polanin (2020) namely using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol were considered as data filtering in order to produce transparent and high-quality meta-analysis stages. Figure 1 presents the data filtering process.

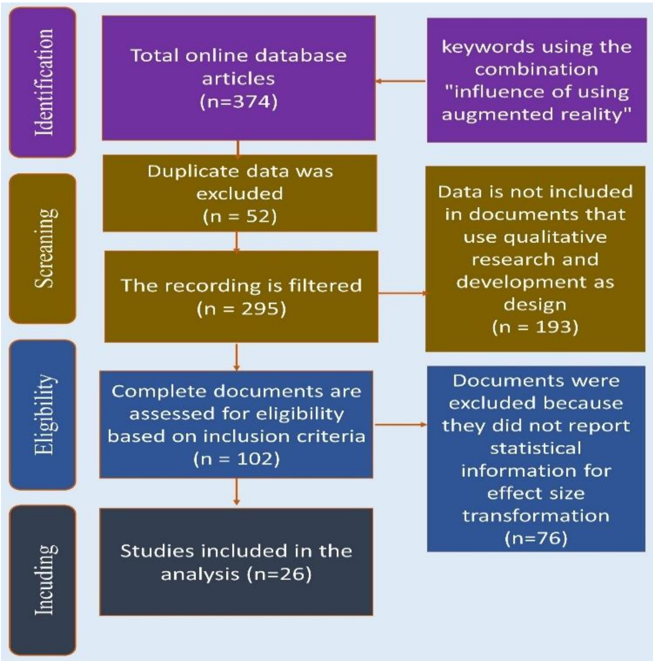

Figure 1. PRISMA procedure

Based on Figure 1, there are 26 primary studies that meet the inclusion criteria for analysis. However, some studies included more than one independent or comparison sample. As a result, in this study there were 74 independent samples in the analysis.

3. Coding Process

This research uses a coding sheet as a research instrument developed to extract information from individual studies into numerical data. With this instrument, all data is coded separately by two coders according to guidelines (Cooper, 2017). The degree of concordance of the two coders was determined by randomly selecting 5 of the 27 duplicated primary studies and distributing them. The level of agreement between the two coders was determined using Cohen's Kappa formula which was formulated by (McHugh, 2012) as follows:

$$k = \frac{Pr(a) - Pr(e)}{Pr(e)} \quad (1)$$

In equation (1) the actually observed agreement is represented by Pr (a), and the agreement due to chance is represented by Pr (e). An index of 0.85 or greater has been previously determined to be considered high (McHugh, 2012). From the calculation results, the index k = 0.97. This indicates that both coders reached substantial agreement and the instrument developed was valid. Table 1 presents the studies that met the requirements for analysis.

Table 1. Eligible studies

Author, year	Brief description	County	subject matter
Setiawan et al., 2023 (Setiawan et al., 2023)	Analyzing the effect of using Augmented Reality media on elementary school students' science processing abilities	Indonesia	Natural science
Putra et al., 2021 (A. K. Putra et al., 2021)	Comparing the effect of mobile augmented reality in a digital encyclopedia on problem solving abilities in first year students.	Indonesia	Social science
Chien et al., 2017 (Chien et al., 2017)	Analyzing the results of experiments using AR on elementary school students' scientific literacy	China	Natural science
İbili et al., 2020 (İbili et al., 2020)	analyze the influence of geometry learning supported by the use of AR on students' three-dimensional thinking abilities.	Turkey	Mathematics
Chang et al., 2019	Analyzing learning supported by AR technology on students' knowledge, skills and motivation	Taiwan	Physics
Yilmaz et al., 2017	Analyzing the effect of learning supported by AR technology on students' creative abilities in language.	Turkey	Language
Cahyana et al., 2023 (Cahyana et al., 2023)	Analyzing students' scientific literacy and numeracy who are given learning with the support of AR technology	Indonesia	Chemistry, and Biology
Bursali et al., 2019 (Bursali & Yilmaz, 2019)	The focus of the research is to analyze the effect of applying AR technology on reading comprehension, learning permanence, and elementary school students' attitudes	Turkey	Language
Aldalalah., 2019 (Aldalalah et al., 2019)	Analyzing the influence of AR on students' mathematical and visual thinking abilities.	Saudi Arabia	Mathematics
Eldokhny et al., 2021 (Eldokhny & Drwish, 2021)	Comparing the academic achievements of students supported by AR technology with students taught traditionally	Egypt	Mathematics
Hanid et al., 2022 (Hanid et al., 2022)	Analyzing the influence of AR technology support on computational thinking, visualization, and geometric concepts.	Malaysia	Mathematics
Safar et al., 2017 (Safar & Al-jafar, 2017)	Analyzing the effectiveness of AR support in learning on students' English learning achievement in the State of Kuwait.	Kuwait	Language

Önal., 2021 (Önal & Önal, 2021)	Analyzing the effect of teaching astronomy through AR support on student achievement and interest in learning.	Turkey	Natural science
Al-nawaiseh et al., 2020 (Al-nawaiseh et al., 2020)	Analyzing the impact of using AR on tenth grade students' chemistry learning achievement and motivation.	Jordan	Chemistry
Silva et al., 2023 (M. Silva et al., 2023)	Analyzing the effect of AR technology support on students' academic levels, motivation and technology acceptance.	Mexico	Chemistry
Tarng et al., 2022 (Tarng et al., 2022)	Analyzing the effect of using the AR system on high school students' mastery of chemical equilibrium material.	Taiwan	Chemistry
Huang et al., 2023 (Huang et al., 2023)	Analyzing student learning outcomes that integrate AR technology	Taiwan	Natural science
Ibáñez et al., 2014 (Ibáñez et al., 2014)	Testing the impact of using AR on physics learning outcomes in middle schools	Spain	Physics
Abdusselam et al., 2020 (Abdusselam & Karal, 2020)	Analyzing the effect of AR-based teaching materials on academic achievement and student learning processes	Turkey	Physics
Weng et al., 2020 (Weng et al., 2020)	Analyzing the effect of AR technology support on students' biology learning outcomes	Taiwan	Biology
Karagozlu, 2018 (Karagozlu, 2018)	Analyzing the impact of AR applications on students' science achievement and problem-solving skills.	Cyprus	Natural science
Chen et al., 2020 (Chen & Liu, 2020)	Analyzing the impact of using AR on students' understanding of chemistry concepts and interest in science.	China	Chemistry
Kirikkaya et al., 2019 (Kirikkaya & Başgül, 2019)	Examining the impact of AR-supported teaching on students' academic success, motivation, and attitudes towards science subjects	Turkey	Mathematics
Binhomran et al., 2021 (Binhomran & Altalhab, 2021)	Analyzing the usability of AR technology and its influence on EFL vocabulary mastery.	Saudi Arabia	Language
Zhang et al., 2014 (Zhang et al., 2014)	Analyzing the effect of applying AR technology on learning outcomes in the field of astronomy	Taiwan	Physics
Ali et al., 2023 (Ali et al., 2023)	Menganalisis pengaruh AR terhadap kemampuan akademik siswa pada mata pelajaran matematika	Malaysia	Matematika

4. Statistical Analysis

Effect size is chosen as a parameter to estimate the population. The effect size here is defined as the magnitude of the influence of AR integration in education on student learning outcomes. In this research, the CMA version 3 (Comprehensive Meta-Analysis) program was used to help calculate the effect size for each study, including finding statistical data such as p-values, Q statistics, and confidence intervals, funnel plots, and stem-leaf graphs. The Hedges' g equation was chosen because some samples were considered small. Interpretation of effect sizes is based on classification (Cohen et al., 2017), namely, less than 0.2 (negligible), 0.2 to 0.5 (small effect), 0, 5 to 0.8 (medium effect), 0.8 to 1.3 (large effect), and more than 1.3 (very large effect). The random effects model was selected after satisfying the heterogeneity requirement. Decisions are taken by observing the p value. If the p-value < 0.05 the effect size of each study is heterogeneous which means that the effect size between studies or groups of studies may not measure the same population parameters (Borenstein et al., 2009).

The next stage is to check for publication bias to prevent misrepresentation of findings (Siddaway et al., 2019). This publication bias is possible due to the scientific fact that 6% of researchers rarely publish research that is not significant Cooper (2017) resulting in the aggregate effect size being overestimated (Juandi, Kusumah, et al., 2022; Park & Hong, 2016). This examination of publication bias was carried out by examining funnel plots, and trim and fill procedures were used to assess the impact of publication bias (Borenstein et al., 2009).

C. RESULTS AND DISCUSSION

This research was conducted to analyze the overall effect of using AR in education where the effect size is the research parameter. Then this research continued by examining the relationship between categorical variables and the study effect size. This will answer the variation in results between studies moderated by category variables.

1. Overal Analysis Results

First, the general results for achieving the first goal are described. From the results of data screening there were 73 independent comparisons included in the analysis. The research forest plot explored from the CMA is in Appendix 1. From the analysis of the research forest plot, it can be seen that the effect size for each study is not on one vertical line, which indicates variation in effect sizes between studies. Table 2 presents a summary of the analysis results.

Table 2. Results Summary of Data Analysis Results

Model	N	Hedges's g	Standard error	Test of null		Heterogeneity	
				Z-value	P-value	Q	P
Fixed-effects	73	0.73	0.03	26.087	0.00	362.97	0.00
Random-effects	73	0.75	0.06	11.572	0.00		

Based on Table 1, the P value <0 means that the effect size of each study is heterogeneous. This means that the estimation method chosen is in accordance with the random effect model. From these results, the overall study effect size was 0.75 with a standard error of 0.06 which is accepted as a medium effect by category (Cohen et al., 2017). Next, publication bias checks were carried out using funnel plots. Figure 2 presents a funnel plot of research extracted from the CMA application.

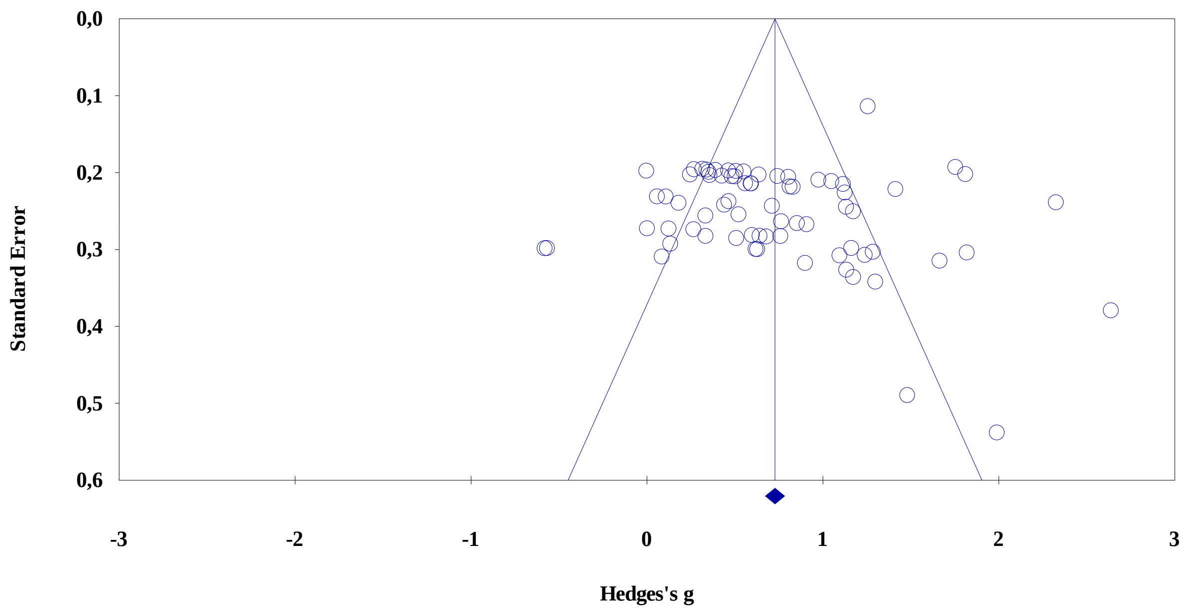

Figure 2. Research Funnel Plot

Based on Figure 2, it can be seen that the distribution of effect sizes is less than symmetrical. Therefore, the inspection procedure for the impact of bias needs to be carried out by examining Trim and Fill. Table 3 presents the Trim and Fill results.

Table 3. Trim and Fill Results

	Studies Trimmed	Random-Effects			Q Value
		Point Estimate	Lower Limit	Upper Limit	
Observed values		0.74	0.61	0.86	362.97
Adjusted values	0	0.74	0.61	0.86	362.97

Table 3 includes the trim and fill test results from the left and right according to the random effects model. The calculation results were based on a random effects model that no studies needed to be pruned. Observed and adjusted values do not change. This indicates that there is no impact due to indications of publication bias on the results of this study. Thus, the overall effect size of the study was found to be 0.74 which is acceptable for estimating the population. According to the categories (Cohen et al., 2017), the effect size can be classified as a medium effect. A graphical representation of this value is shown in Figure 3 below.

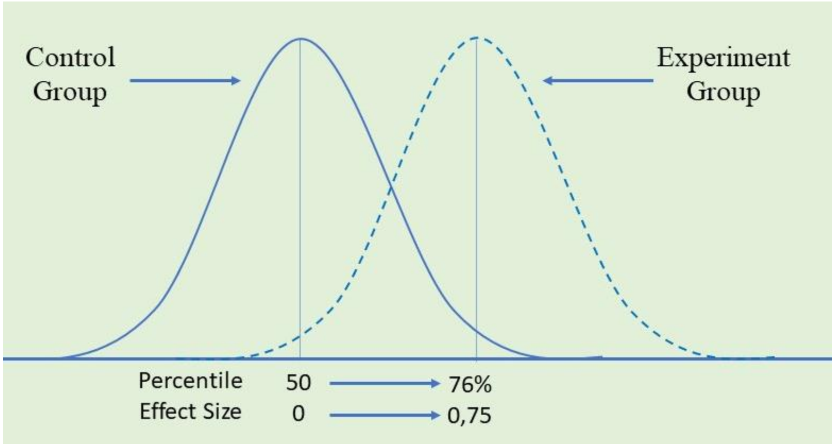

Figure 3. Visualization of effect sizes

Figure 3 was prepared based on a point estimate of 0.75 which covers the area corresponding to the 76th percentile under the standard normal curve. If the same performance measures were applied to both groups then the "average" student taught in the usual way who scored at the 50% level would score at the 76% level if taught using AR. The number of subjects in this study was 2786 and 72 comparisons. The average sample size per class was 36 students. Thus, a standard score of 0.74 can be interpreted as meaning that the average student is ranked 18th in the experimental group, equivalent to students who are ranked 9th in the control group.

The analysis results gave the overall effect size as 0.74 which is categorized as a medium effect according to (Cohen et al., 2017). This result is not much different from previous studies where the average effect size of studies on the influence of using AR in education is in the range of 0.6 to 0.8 (e.g., (Baashar et al., 2022; Lin & Yu, 2023; Tekedere & Göker, 2016). This study also supports previous studies that the integration of AR in educational environments helps improve students' academic achievement in collaborative learning environments, as well as increasing their retention and ability to translate it into other environments (Silva et al., 2022; Whang et al., 2021). The analysis results also prove the superiority of the experimental group in general not only from a cognitive perspective but also from a student motivation perspective (e.g., Atalay, 2022; Gopalan et al., 2015), cognitive development (Yildiz, 2022), student collaboration, and their learning experiences (Jesionkowska et al., 2020; Reeves et al., 2021) supports previous theoretical assumptions that immersive augmented reality technology can improve the quality of education (Djibril & Çakir, 2023; Yadav & Gupta, 2023). AR can also help students to increase their focus through fun activities and immersive experiences (Cardenas-Valdivia et al., 2023; Samala & Amanda, 2023). AR integration also provides satisfaction to students with various interesting content (Karagozlu et al., 2019).

2. Results of Analysis of Study Characteristics

Heterogeneity analysis results have found high variability in ES samples. This underlines the importance of analyzing moderating variables or what are often referred to as study characteristics (Garzón & Acevedo, 2019). Based on gaps in previous literature and also as a result of the PICO framework, we analyze comparisons between countries, and subject matter as a moderating variable. Table 4 presents the results of the moderator analysis for the treatment duration variable.

Table 4 . Trim and Fill Results

Comparison Between Countries	N	Ukuran efek		CL_{95}	*Heterogeneity*		
		ES	SE		Nilai-Q	df(Q)	Nilai-P
1-3 weeks	33	0,98	0,03	[0,90;1,06]	159,12		
4 weeks or more	40	0,50	0,03	[0,41;0,56]	124,91		
Total within					284,04	71	0,00
Total between					82,07	1	0,00

This study discusses the treatment duration variable and its relationship to the main study effect size. Based on the summary of results included in Table 4 it appears that the effect sizes of the two study groups in terms of treatment duration are significantly different (P-value in total between= 0.00<0.05). This indicates that differences in effectiveness between studies can be explained by differences in treatment duration. This study highlights the importance of considering treatment duration in implementing AR. The trend analysis results suggest preferring the 1-3 week duration option when implementing AR in the future. This is related to the Hawthorne effect that students will get bored if they are given the same model or treatment for a long time (Juandi & Tamur, 2021; Tamur, Kusumah, Juandi, Wijaya, et al., 2021). This research has provided scientific information that contributed to the decision to integrate AR in learning. Apart from that, this research is useful for knowing the position and development of the effectiveness of AR technology integration in education between countries. Further research is needed to examine other moderator variables such as the type of material applied to AR, differences in applications such as the comparison between using textbooks and pictures and barcoat code as a custom marker.

D. CONCLUSIONS AND SUGGESTIONS

The research results show that the overall influence of applying AR in learning has a moderate influence on student academic achievement. The results of the analysis also show that differences in treatment duration highlight differences in effect sizes between individual studies. The results of this research provide scientific information that contributes to integrating AR into learning, including considering its use in the future. However, this research cannot include data from paid databases such as IEEE and Sage Publication. Further work is therefore needed to collaborate with affiliated universities on documents in paid databases so that more articles can be included in the analysis. Further research is needed to test other moderator variables, such as the type of material applied to AR and differences in application, such as comparing textbooks and images and barcodes as custom markers.

ACKNOWLEDGMENT
I acknowledge and appreciate the technical assistance of the UPI postgraduate students involved as coders in this study

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Appendix: Research forest plot

META ANALYSIS

Study name	Statistics for each study						
	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Bursali & Yilmaz, 2019a	0,815	0,219	0,048	0,386	1,244	3,721	0,000
Bursali & Yilmaz, 2019b	0,832	0,219	0,048	0,402	1,262	3,793	0,000
Bursali & Yilmaz, 2019c	0,596	0,215	0,046	0,174	1,017	2,771	0,006
Bursali & Yilmaz, 2019d	0,593	0,215	0,046	0,172	1,015	2,761	0,006
Aldalalah et al 2019a	1,128	0,227	0,051	0,683	1,572	4,972	0,000
Aldalalah et al 2019b	0,561	0,215	0,046	0,141	0,982	2,616	0,009
Al-Nawaiseh, eta al. 2020	1,242	0,308	0,095	0,638	1,845	4,032	0,000
Cahyana et al. 2023a	2,328	0,240	0,057	1,858	2,797	9,717	0,000
Cahyana et al. 2023b	1,258	0,115	0,013	1,034	1,483	10,987	0,000
Cahyana et al. 2023c	1,813	0,203	0,041	1,415	2,211	8,936	0,000
Cahyana et al. 2023d	1,118	0,216	0,047	0,695	1,541	5,180	0,000
Eldokhny et al 2021b	0,088	0,310	0,096	-0,520	0,696	0,283	0,777
Safar et al. 2017a	1,136	0,327	0,107	0,495	1,777	3,473	0,001
Yilmaz & Goktas, 2016a	0,354	0,200	0,040	-0,038	0,746	1,769	0,077
Yilmaz & Goktas, 2016b	0,978	0,210	0,044	0,566	1,390	4,655	0,000
Yilmaz & Goktas, 2016c	0,745	0,205	0,042	0,343	1,147	3,628	0,000
Yilmaz & Goktas, 2016d	1,051	0,212	0,045	0,636	1,467	4,961	0,000
Yilmaz & Goktas, 2016e	0,000	0,198	0,039	-0,389	0,389	0,000	1,000
Yilmaz & Goktas, 2016f	0,807	0,207	0,043	0,402	1,212	3,907	0,000
Huang et al. 2021a	1,164	0,299	0,089	0,578	1,750	3,895	0,000
Huang et al. 2021b	0,600	0,282	0,080	0,047	1,153	2,127	0,033
Huang et al. 2021c	0,643	0,283	0,080	0,089	1,198	2,273	0,023
Huang et al. 2021d	1,287	0,304	0,092	0,692	1,883	4,236	0,000
Tarng & Ou, 2022a	1,416	0,222	0,049	0,980	1,852	6,370	0,000
Tarng & Ou, 2022b	1,098	0,308	0,095	0,493	1,703	3,560	0,000
Tarng & Ou, 2022c	1,667	0,315	0,099	1,048	2,285	5,284	0,000
Tarng & Ou, 2022d	0,639	0,204	0,041	0,240	1,038	3,139	0,002
Ibáñez et al. 2014	1,821	0,305	0,093	1,224	2,418	5,975	0,000
Karagozlu, 2017	1,757	0,194	0,037	1,377	2,136	9,073	0,000
Kirikkaya & Ba?gül, 2019a	0,856	0,267	0,071	0,334	1,379	3,212	0,001
Kirikkaya & Ba?gül, 2019b	0,766	0,264	0,070	0,248	1,284	2,898	0,004
Kirikkaya & Ba?gül, 2019c	0,911	0,268	0,072	0,385	1,436	3,398	0,001
Kirikkaya & Ba?gül, 2019d	0,336	0,257	0,066	-0,167	0,839	1,309	0,191
	0,978	0,090	0,008	0,802	1,153	10,912	0,000
Chang et al. 2019a	0,126	0,274	0,075	-0,410	0,663	0,461	0,645
Chang et al. 2019b	0,268	0,275	0,075	-0,270	0,806	0,976	0,329
Chang et al. 2019c	0,004	0,273	0,075	-0,532	0,539	0,013	0,989
Chang et al. 2019d	0,762	0,283	0,080	0,207	1,317	2,689	0,007
Chien et al. 2017a	0,136	0,293	0,086	-0,439	0,711	0,464	0,642
Chien et al. 2017b	0,621	0,300	0,090	0,032	1,209	2,067	0,039
Chien et al. 2017c	-0,578	0,299	0,090	-1,164	0,009	-1,931	0,054
Chien et al. 2017d	-0,564	0,299	0,089	-1,150	0,022	-1,888	0,059
Chien et al. 2017e	0,630	0,300	0,090	0,042	1,219	2,098	0,036
Eldokhny et al 2021a	1,175	0,337	0,113	0,516	1,835	3,492	0,000
Hanid et al. 2022	0,524	0,255	0,065	0,024	1,025	2,055	0,040
Ibili et al .2019d	0,393	0,198	0,039	0,006	0,780	1,989	0,047
Ibili et al. 2019a	0,553	0,199	0,040	0,162	0,944	2,774	0,006
Ibili et al. 2019b	0,466	0,198	0,039	0,077	0,855	2,350	0,019
Ibili et al. 2019c	0,271	0,197	0,039	-0,114	0,656	1,378	0,168
Ibili et al. 2019e	0,341	0,197	0,039	-0,045	0,728	1,732	0,083
Ibili et al. 2019f	0,509	0,199	0,040	0,119	0,898	2,558	0,011
Onal et al. 2021a	2,640	0,380	0,144	1,896	3,385	6,948	0,000
Onal et al. 2021b	0,681	0,284	0,081	0,125	1,238	2,400	0,016
Putra et al 2021	0,467	0,238	0,057	0,001	0,934	1,963	0,050
Safar et al. 2017b	0,902	0,318	0,101	0,278	1,526	2,832	0,005
Setiawan. et al (2023a)	1,992	0,539	0,290	0,936	3,048	3,698	0,000
Setiawan. et al (2023b)	1,483	0,490	0,240	0,522	2,444	3,025	0,002
Setiawan. et al (2023c)	1,302	0,343	0,117	0,630	1,974	3,798	0,000
Silva et al. 2023a	0,502	0,206	0,042	0,099	0,905	2,442	0,015
Silva et al. 2023b	0,428	0,205	0,042	0,027	0,830	2,092	0,036
Silva et al. 2023c	0,359	0,204	0,042	-0,041	0,759	1,760	0,078
Silva et al. 2023d	0,485	0,205	0,042	0,083	0,888	2,362	0,018
Silva et al. 2023e	0,249	0,203	0,041	-0,150	0,647	1,224	0,221
Abdusselam & Karal, 2020a	0,511	0,286	0,082	-0,049	1,072	1,788	0,074
Abdusselam & Karal, 2020b	0,336	0,283	0,080	-0,219	0,891	1,187	0,235
Weng et al. 2020a	0,183	0,240	0,058	-0,288	0,654	0,762	0,446
Weng et al. 2020b	0,442	0,243	0,059	-0,033	0,918	1,822	0,068
Chen et al. 2020	0,319	0,196	0,038	-0,065	0,703	1,626	0,104
Binhomran & Altalhab, 2021a	0,061	0,232	0,054	-0,394	0,515	0,262	0,793
Binhomran & Altalhab, 2021b	0,110	0,232	0,054	-0,344	0,565	0,476	0,634
Zhang et al. 2024a	1,135	0,245	0,060	0,654	1,616	4,626	0,000
Zhang et al. 2024b	0,714	0,244	0,060	0,235	1,192	2,925	0,003
Zhang et al. 2024c	1,175	0,251	0,063	0,683	1,667	4,677	0,000
Ali et al. 2023	1,172	0,250	0,062	0,683	1,661	4,698	0,000
	0,529	0,071	0,005	0,389	0,669	7,412	0,000
	0,704	0,056	0,003	0,594	0,813	12,598	0,000