

The Use of Technology at the Higher Education Level and Student Engagement: A Meta-Analysis

Ridwan Budi Pramono*

Airlangga University

ridwan.budi.pramono-2021@psikologi.unair.ac.id

Endang Retno Surjaningrum

Airlangga University

endang.surjaningrum@psikologi.unair.ac.id

Nono Hery Yoenanto

Airlangga University

nono.hery@psikologi.unair.ac.id

Abstract

Student engagement is a recognized factor in higher education, and its importance in students' academic success has led to increased attention. While many studies have explored the impact of technology on student engagement, no meta-analysis studies have been conducted at the higher education level to the best of the researcher's knowledge. This study aims to critically evaluate the influence of technology on student engagement within the context of learning in Indonesia. A systematic review and assessment were conducted using seven databases and two search engines. This meta-analysis study includes 5 studies with 710 subjects. Although the 5 studies indicate that technology use can enhance student engagement, the results do not yield a common effect size. Furthermore, one study presents inconclusive findings. Therefore, further research is necessary to investigate this variable by implementing more appropriate research procedures.

Keywords: *technology use, meta-analysis, student engagement*

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Introduction

Education is widely recognized as the primary source of learning, playing a crucial role in teaching, preparing, and guiding students to interact with the world effectively (Farr, 2014). Academic achievement is a typical measure of students' success in acquiring new knowledge; however, there are other indicators to consider, such as changes in study habits, enhanced learning strategies, active engagement, self-regulatory behavior, and increased motivation (Cayubit, 2021). Currently,

student engagement has emerged as an intriguing indicator for research. It refers to the psychological, cognitive, emotional, and behavioral efforts that students invest in academic assignments, aiming for desired outcomes through directed and continuous actions (Gunuc & Kuzu, 2015b; Skinner & Pitzer, 2012). According to Kahn (2014), student engagement is a common challenge in higher education, necessitating special attention to identify the factors influencing its level. Moreover, student engagement is crucial for achieving academic excellence, making it a priority for universities to enhance student engagement in learning (Bundick et al., 2014; Maroco et al., 2016; Robinson, 2012). Effective learning processes can also be facilitated when students actively engage with their educational institution (Gunuc & Kuzu, 2015a).

Various factors influence students' engagement with the learning process, including environmental support (Amelia, 2021). Higher education institutions are gradually adopting digital technologies to support students in virtual learning (Lacka et al., 2021). Embracing technology in the learning environment has become inevitable due to the digital-rich landscape of today's students and teaching methods, characterized by information and communication technology (Rashid & Asghar, 2016).

In line with Indonesia's National Medium-Term Development Plan (RPJM) 2020-2021, the Ministry of Education and Culture has prioritized technology development, including its integration into education, learning aids, educational facilities, competency standards, educational administration support, management aids, education units, and educational infrastructure (Adisel & Pranansa, 2020). This is further reinforced by the ministry's policy for higher education, which emphasizes the need for digital transformation and technology adoption (Rustandi, 2020). Conducting a meta-analysis study on the use of technology in learning is crucial, as it provides empirical evidence regarding the impact of technology on education and student engagement.

According to Beetham and Sharpe (2013), the adaptability and flexibility of digital education have led to transformative changes in teaching and learning at universities. López (2010) also highlights that integrating technology into learning has increased student involvement and promoted a more student-centered approach. Several studies have shown that technology use enhances student

engagement in learning (Prasetyawati & Ardi, 2020; Rahayu et al., 2019). Another study compared two different approaches to technology use in learning activities and found similar results (Zainuddin et al., 2021). Subsequent studies compared two additional groups and demonstrated the influence of technology on student engagement in both cases (Zainuddin et al., 2019).

On the other hand, there is a conflicting opinion suggesting that universities face challenges in adapting to emerging technologies and addressing student demands related to technology usage. This is attributed to students' familiarity with technology in their daily lives, which inevitably impacts their academic achievement (Losh, 2014). Gebre et al. (2014) conducted a study revealing that prolonged use of technology or multiple applications can influence academic scores. Therefore, it can be concluded that student engagement depends on the extent of technology saturation and its application. Another study by Oetomo Dharma & Santoso (2022) found that the quality of technology affects student engagement in learning, while the proficiency level in using the internet/technology does not impact the construct. In contrast, Ariyanti et al. (2022) conducted research utilizing both qualitative and quantitative methods and obtained different results. Quantitatively, there were no students with low levels of engagement, but qualitatively, the opposite was observed.

Technology is often misconceived as an automatic enhancer of learning, leading to the assumption that technology use, student engagement, and learning are inherently interconnected and beneficial (Gillett-Swan, 2017; Kirkwood & Price, 2014). Selwyn (2016) concluded in his study that technology use does not automatically increase student engagement. The study identified four categories where technology fails to assist students: disruption (technology does not aid in assignments), distraction (technology diverts students from their learning goals), difficulty (challenges and discomfort in using technology), and detriment (low-quality technology).

These contradictory study results present an intriguing scientific gap that warrants investigation. Researchers are motivated to explore the consistency and variability of studies on technology use and student engagement in learning conducted in Indonesia. Meta-analysis aims to explain the variability among different studies while summarizing existing data (Berman & Parker, 2002). This

study assumes significance in the context of universities' efforts to accelerate technology adoption. Sánchez-Meca and Marín-Martínez (2010) assert that meta-analysis studies adhere to scientific standards demanded by empirical research, such as objectivity and systematization, and can yield consistent results across various investigations addressing the same research questions. This study is anticipated to derive key conclusions regarding the impact of technology application on student learning engagement. Its purpose is to explore technology use, student engagement, and the consequential implications for student learning engagement.

Method

This study employed a systematic review methodology, adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, to examine the impact of technology use on student engagement. The meta-analysis stage followed a series of steps, including formulating research questions, identifying relevant literature, extracting and appraising data, synthesizing data, conducting exploratory analysis, and interpreting the results (Mikolajewicz & Komarova, 2019).

Search strategy

To establish the study's scope, the researcher employed the PICO criteria as the initial step (Higgins et al., 2022). Table I provides an explanation of the criteria derived from the PICO criteria. This study focused on university students as participants, and the intervention type involved quantitative research utilizing technology to enhance student engagement.

Table 1

PICO Criteria

Participant	Intervention	Outcome
University students	All types of research and experimental research that uses the application of technology as an intervention to increase student engagement	Results related to all the effects of technology application on student engagement in learning

Data Extraction

The researcher selected specific filters and identified relevant article databases. The search was conducted across eleven databases, as outlined in Table 2: Science Direct, Web of Science, Scopus, ProQuest, EBSCO, Sagepub, Garuda Portal, Neliti, e-resources.perpusnas.go.id, Google Scholar, and Indonesia Onesearch.

Table 2

Search and keywords

Database	Filter	Search Terms	Result	Total	Date accessed
ScienceDirect	Document Type: research article, theses	technology AND "student engagement"	25	25	12 April 2022
Web of Science	Document Type: research article, theses	technology AND "student engagement"	17	17	12 April 2022
Scopus	Document Type: research article, theses	technology AND "student engagement"	40	40	12 April 2022
Proquest	Document Type: research article, theses	technology AND "student engagement"	53	53	12 April 2022
EBSCO (Psychology and Behavioral Sciences Collection)	Document Type: research article, theses	technology AND "student engagement"	49	49	12 April 2022
Sagepub	Document Type: research article, theses	technology AND "student engagement"	30	30	12 April 2022

Database	Filter	Search Terms	Result	Total	Date accessed
Portal Garuda	Document type: research article, theses	<i>penggunaan teknologi dalam proses pembelajaran mahasiswa</i> [the use of technology in the student learning process]	1	1	19 May 2022
Neliti	Document type: research article, theses	<i>penggunaan teknologi dalam proses pembelajaran mahasiswa</i> [the use of technology in the student learning process]	27	27	21 May 2022
e-resources.perpusnas.go.id	Document type: research article, theses	<i>penggunaan teknologi dalam proses pembelajaran mahasiswa</i> [the use of technology in the student learning process]	418	418	21 May 2022
Google Scholar	Document type: research article, theses	<i>penggunaan teknologi dalam proses pembelajaran mahasiswa</i> [the use of technology in the student learning process] filetype: pdf	2050	2050	21 May 2022
Indonesia ONESEARCH	Document type: research article, theses	<i>Penggunaan teknologi dalam proses pembelajaran mahasiswa</i> [the use of technology in the student learning process]	655	655	19 May 2022
Total				3365	

Subsequently, the researcher performed an article search using inclusive and exclusive criteria, with no restrictions on language usage within the articles. Following this, a title and abstract screening was conducted, followed by a full-text screening to determine the eligibility of reports for inclusion in the meta-analysis study.

Table 3
Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Type of article	Peer-reviewed articles	Non-empirical research articles e.g., literature reviews, meta-analysis
Study focus	Articles focus on the effect or relationship of technology use on student engagement.	Articles do not focus on the effect or relationship of technology use on student engagement.
Research location	Universities in Indonesia	Universities outside of Indonesia

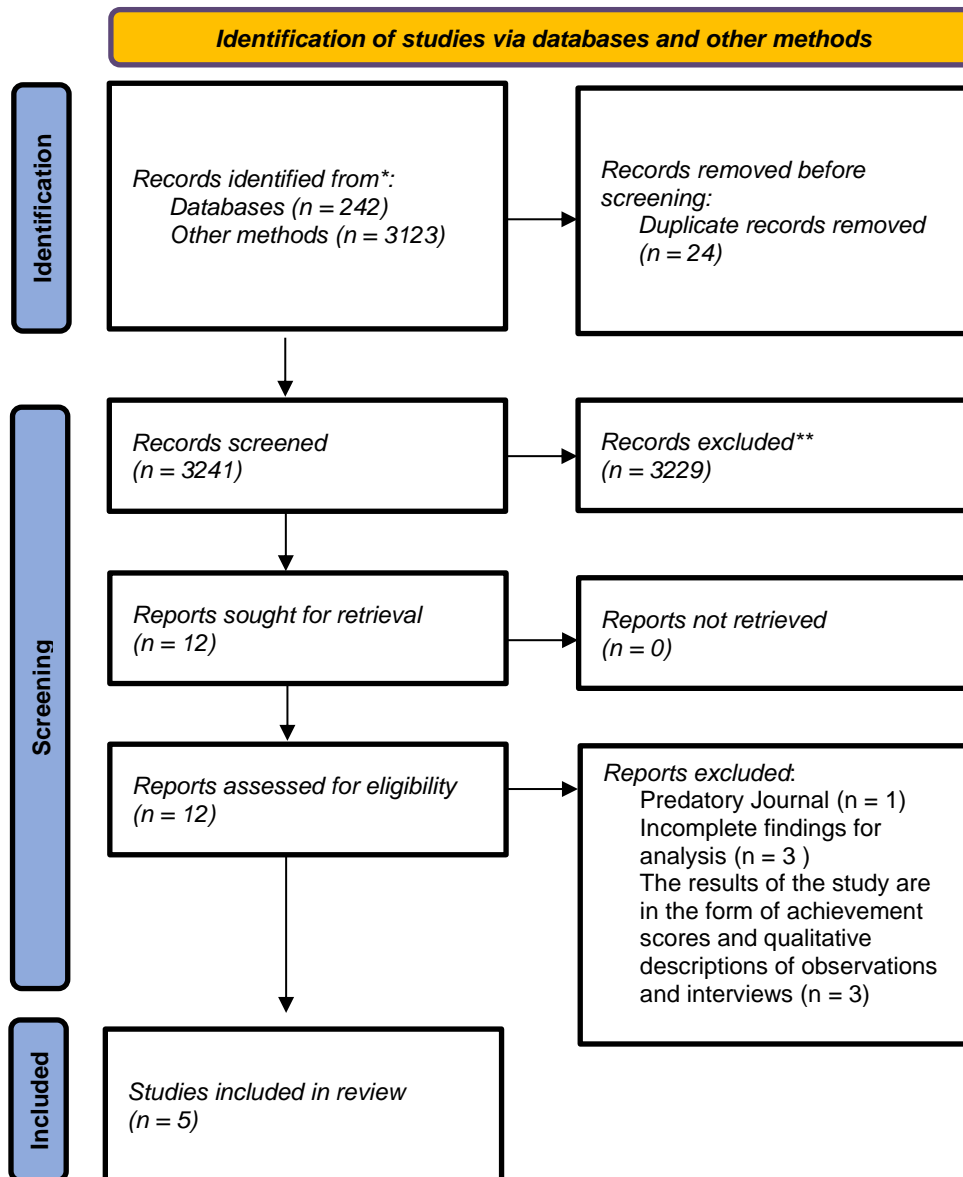
Article selection

Figure 1 presents a flowchart diagram illustrating the process of selecting articles for inclusion in the meta-analysis concerning technology use and student engagement. It provides an overview of the search and selection process. Initially, a search across databases and search engines yielded a total of 3365 articles with relevant keywords (as indicated in Table 2). Duplicate articles were then removed using a reference management tool and manual screening, resulting in a final count of 3241 articles. A total of 3329 articles underwent screening based on the inclusion and exclusion criteria. Subsequently, a feasibility review was conducted on the remaining 12 articles, which were accessible for analysis. One of these articles was identified as being from a predatory journal, and three others were deemed unsuitable due to the inadequate research data for further analysis. Meanwhile, the remaining three studies provided achievement scores and qualitative data obtained through observations and interviews.

Characteristic Data

The general information contained in the article, the time the research was conducted, the technology used in learning, and the results of the correlation analysis between the use of technology and student engagement. Five articles were deemed eligible for further analysis, as shown in Table 4. Table 4 shows the primary information from journals suitable for analysis with

Figure 1. Study selection flowchart



shown in Table 4. Table 4 shows the primary information from journals suitable for analysis with 710 participants. The research was conducted in Indonesia in a pandemic (n = 2) and non-pandemic (n = 3) research context. The technology used in the article consists of communication and information technology (n = 3), concept mapping (n = 1), and the Moodle platform with the term Interactive Digital Learning Environment (n = 1). The engagement scale used in all articles

varies, with the most widely used scale being the Online Student Engagement Scale (Dixon, 2015), with 18 statements. Next is the School Questionnaire-Engagement Composite (SESQ-ENG) scale (Hart et al., 2011), which consists of 33 question items. Another study uses the student engagement scale (Sun & Rueda, 2012), which consists of 19 items which are an adaptation scale of the engagement scale (Fredricks et al., 2004, 2005) and the student engagement scale (Ahlfeldt et al., 2005) which consists of 14 questions. Only two studies used a technology usage scale, namely the technology-media usage questionnaire scale (Rosen et al., 2013) and the communication technology scale (Yanto et al., 2021).

All studies report the effect of using technology on student engagement (Fatawi et al., 2020; Kristianto & Gandajaya, 2021; Mutiara & Kusumawardhani, 2020; Noviati, 2018; Yanto et al., 2021). However, there are studies stating no difference in the level of student engagement between offline and online learning classes that use technology (Kristianto & Gandajaya, 2021). Another study indicated that student engagement in the behavioral aspect was insignificant, although the overall variables showed the opposite (Fatawi et al., 2020).



Study Label	Title	Konteks	Types of article	Research Design	TU scale	Rel TU	SE Scale	Rel SE	n	M age	SD age	Gender ratio (m/fm)	raw r	Used technology
Fatawi, dkk. (2020)	Effect of Online-Based Concept Map on Student Engagement and Learning Outcome	Non pandemic	Peer-reviewed journal	experiment	na	na	Sun & Rueda, 2012	na	81	na	na	Na	0,36	Concept mapping
Kristianto & Gandajaya (2021)	Offline vs online problem-based learning: a case study of student engagement and learning outcomes	Pandemic	Peer-reviewed journal	Comparative Cross-sectional	na	na	Ahlfeldt et al, 2005	0,846	201	na	na	na	0,1	Interactive Digital Learning Environment (IDE)
Mutiara & Kusumawardhani (2020)	The Relationship between the Intensity of Information and Communication Technology Use and the Learning Engagement of Generation Z Students	Non pandemic	Peer-reviewed journal	Cross-sectional	na	na	SESQ (Hart, Stewart & Jimerson, 2011)	0,7	108	19	0,5	0,24	0,4	Information and communication technology
Noviati (2018)	Psychological Capital, Technology and Media Usage, Student Engagement, and Performance Academic: Empirical Study on University Students	Non pandemic	Peer-reviewed journal	Cross-sectional	TMUQ (Rosen et al, 2013)	0,919	OSE (Dixson, 2015)	0,848	198	na	na	na	0,74	Information and communication technology
Yanto H, dkk (2021)	Developing Operational Accounting Competencies During The Pandemic Using emergency Online Learning	Pandemic	Peer-reviewed journal	Cross-sectional	CT (2010)	0,759	Dixson (2015)	0,745	122	na	na	na	0,36	Information and communication technology

Methods in risk assessment of internal validity/risk of bias

The Glynn critical appraisal tool (Glynn, 2006) was utilized to assess the risk of bias in this study. This tool integrates bias measurement tools from various disciplines, including health, education, literature, and nursing. The questionnaire comprises four main categories: population, data collection, research study design, and research results.

The population category involves evaluating the selection of research subjects in the articles. In the data collection category, the assessment includes data collection, measurement, and data collection methods. The research study design category encompasses the methodology used, clarity regarding methods, and adherence to ethical codes. The final category focuses on the research results, with questions assessing the discussion and conclusions. Each category is assessed with responses of "Yes" (Y), "No" (N), "Unclear" (U), or "Not Applicable" (N/A), with a total score ($T = Y + N + U$). The study results are considered valid if $Y/T \geq 75$ percent or if $(N + U)/T \leq 25$ percent.

The purpose of the risk of bias assessment is to evaluate the conduct and presentation of the research. The assessment results indicate that none of the reviewed articles demonstrated good validity and appropriateness. If overall validity is in question, validity for each section must be examined individually (Glynn, 2006). Only one study was found to have valid conclusions in Section A (population) (Mutiara & Kusumawardhani, 2020; Yanto et al., 2021). Detailed results of the bias risk assessment can be found in the appendix.

Measurement

For measurement purposes, potential funnel plot asymmetry was assessed using Egger's regression and the Fail-Safe N Rosenthal Approach, while the correlation coefficient utilized the Dersimonian-Laird estimator. The analysis was conducted using the Jamovi version 2.3.12 program, with R analysis based on a random-effects meta-analysis model (REM). The interpretation of effect sizes follows Cohen's guidelines (1992), where $d = 0.2$ indicates a small effect size, $d = 0.5$ denotes a medium effect size, and $d = 0.8$ represents a large effect size.

Result

The level of heterogeneity of the analysis results is shown in Table 5; the Q-test shows the results with a high degree of heterogeneity with $Q=90.3555$ $p<0.0001$, $Tau^2 = 0.0932$, $I^2=95.57\%$. The forest plot in Figure 2 also shows the results of the Effect Size (ES) random-effects model (REM) analysis of the five existing studies. Research with $ES = 0.74$ ($0.68 - 0.8$) is the study with the largest and most convincing ES (Noviati, 2018). Other studies, although giving rise to true outcomes and positive ES (Fatawi et al., 2020; Mutiara & Kusumawardhani, 2020; Noviati, 2018; Yanto et al., 2021), show a less convincing confidence interval (CI). The study (Kristianto & Gandajaya, 2021) was the study that produced the smallest ES, $ES=0.1$ (95% CI: $-0.04 - 0.24$), with an interval that allowed negative results to appear.

Table 5

Heterogeneity

Tau	Tau ²	I ²	H ²	R ²	df	Q	P
0.305	0.0932 (SE= 0.0802)	95.57%	22.589	.	4.000	90.356	<.001

The forest plot in Figure 2 shown the effect estimates and confidence interval for each study that is represented by a block at the point estimate intervention effect with a horizontal line extending either side of the block (Deeks et al., 2022).

Figure 2. Forest plot

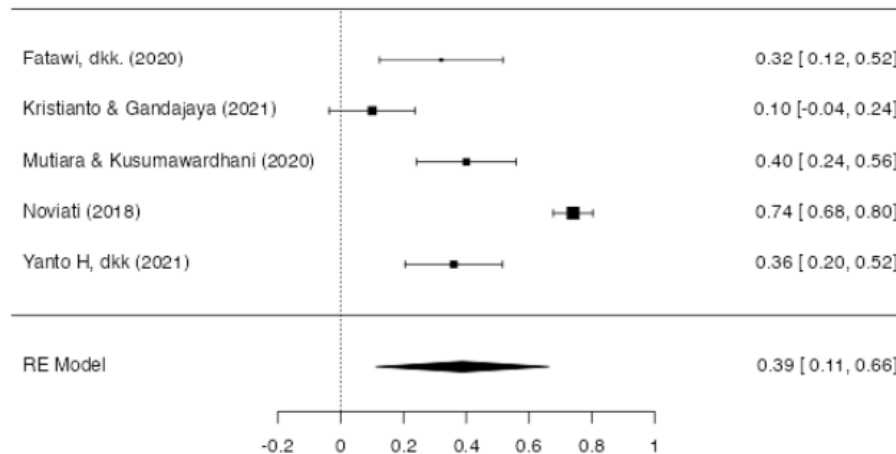


Table 6 shows the results of fail-safe biased publications ($n=503,000$, $p<0.001$). This means that the minimum number of undetected studies required to change the conclusions of the ES meta-analysis is 503,000 articles. However, the ES conclusion has no meaning. After all, the results of the studies in table 5 show a high degree of heterogeneity and the asymmetry funnel plots, which were not used because there were less than ten studies (Higgins et al., 2022).

Table 6
Publication Bias

Test Name	value	p
Fail-Safe N	503.000	<.001
Begg and Mazumdar Rank Correlation	0.000	1.000
Egger's Regression	-1.502	0.133
Trim and Fill Number of Studies	2.000	.

Discussion

This study aims to systematically examine the consistency and variability of studies investigating the relationship between technology use and student engagement. Although the effect size (ES) conclusions are inconclusive, the consistency of the studies cannot be determined. However, the

researcher can conduct a qualitative analysis of the existing five studies to assess their variability. The study with the smallest ES ($ES = 0.1$; $-0.04 - 0.24$) is conducted by Kristianto & Gandajaya (2021). This study compares online and offline learning during the pandemic, using data from offline learning in 2019 and online learning in 2021. The study does not fully explain the sampling process and data collection timing, which may affect the research (Majid, 2018).

In contrast, the study by Noviati (2018) reports the largest ES ($ES = 0.74$; $0.68 - 0.8$). This study aims to determine the impact of technology and media on student engagement and achievement. Despite having a large ES, this study also has a high risk of bias. The timing of data collection and recruitment process for research subjects are not adequately explained. Although the results of this study could be potential outliers in the model, Cook's distances indicate that none of the studies have a significant influence.

The other three studies, namely Fatawi et al. (2020) with $ES = 0.32$ ($0.12 - 0.52$), Yanto et al. (2021) with $ES = 0.36$ ($0.2 - 0.52$), and Mutiara & Kusumawardhani (2020) with $ES = 0.4$ ($0.24 - 0.56$), exhibit a wide range of confidence intervals (CIs), but still lead to positive outcomes. These three studies also lack comprehensive information on data collection. However, Mutiara & Kusumawardhani (2020) and Yanto et al. (2021) provide a clear description of their subject selection and population.

The type of technology used in these studies varies. Fatawi et al. (2020) and Kristianto & Gandajaya (2021) employ platform-based technology and learning management systems (LMS). In contrast, Mutiara & Kusumawardhani (2020), Noviati (2018), and Yanto et al. (2021) utilize general communication and information technology. Based on the ES results, it appears that all types of technology usage have an influence on student engagement. However, the manner in which technology is used is also crucial in enhancing student engagement. The effectiveness of technology as a cognitive tool in learning significantly impacts its effect on student engagement (Gebre et al., 2014). Individual characteristics of students and the application of technology to support learning methods should also be considered. General assumptions regarding collaborative learning in online environments may neglect individual differences, anxiety related to technology

use, stepping out of comfort zones, difficulties in interaction, and presentations, which can hinder loners in learning activities (Gillett-Swan, 2017).

The level of heterogeneity in this model is classified as high, with an I² value of 95.57%. Heterogeneity may stem from the limited number of studies or variations in research methodologies that influence the outcomes (Higgins et al., 2022). The article selection process resulted in only five articles meeting the eligibility criteria for meta-analysis. The risk of bias assessment reveals that all articles have a high risk of bias, primarily due to low scores in the population category, data collection, and reporting of research results.

The lack of standardized measurement tools for data collection is a major concern in this study. Only two studies (Noviati, 2018; Yanto et al., 2021) utilized a technology use scale, and only four studies reported the reliability of the student engagement scale used (Kristianto & Gandajaya, 2021; Mutiara & Kusumawardhani, 2020; Noviati, 2018; Yanto et al., 2021). The adaptation process for the scales is only reported in Mutiara & Kusumawardhani's (2020) engagement study. No studies provide information on the adaptation process for the technology use scale.

Despite not yielding conclusive results, this study aims to explore the consistency of the role of technology use on student engagement in learning. It is hoped that these findings will not impede further research on this variable. In the 21st century, technology plays a significant role in human life, and investigating its impact on student engagement, whether influential or not, is essential (Gunuc & Kuzu, 2015a).

One limitation of this study is the exclusion of studies reporting qualitative descriptive research results, which prevents their inclusion in the meta-analysis. For instance, a study on student engagement and flipped instruction concluded that student engagement was well-prepared, as indicated by qualitative assessments of student opinions and observations during the learning process (Rahayu et al., 2019). Another qualitative research study explored the use of Instagram in English as a Foreign Language writing and found that this technology effectively increased student engagement (Prasetyawati & Ardi, 2020).

Lastly, the study's limitation lies in the article selection process, which did not include gray literature. The researcher followed a systematic review method that does not encompass gray literature.

Conclusion

Based on the findings of this study, the high level of heterogeneity can be identified as a contributing factor to the discrepancies in population determination and data collection procedures. The wide range of confidence intervals (CIs) across all studies further undermines the convincing evidence of the effect of technology use on student engagement in real-world settings. Additionally, the lack of detailed description regarding the scale adaptation process in the included studies may introduce publication bias.

The results of the meta-analysis conducted in this study suggest that the impact of technology on increasing student engagement remains inconclusive. However, considering the inevitable role of technology in the learning context, it is essential to replicate studies related to this variable, irrespective of the expected results. When exploring the relationship between technology use and student engagement, researchers should pay close attention to several factors that could potentially compromise the accuracy of the study when conducting a meta-analysis. It is crucial for researchers to adhere to good research practices during their investigations and provide thorough presentation of their analytical results. Furthermore, it is encouraged for future researchers to engage in meta-analytical studies that involve searches in the gray literature, as this may lead to more conclusive findings in terms of study consistency.

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