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Meta-Analysis of the Impact of Interactive Learning Media on Students' Self-Efficacy in Mathematics Learning

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Abstract

This study aims to conduct a meta-analysis of the impact of interactive learning media on students' self-efficacy in mathematics learning. Although interactive media are widely used, previous research findings are still diverse and have not been fully integrated. The purpose of this study is to synthesize the results of quantitative studies to obtain an estimate of the combined effect size and to identify moderating factors such as education level, type of media, material, and sample size. The method used is meta-analysis with a random-effects model approach, covering 15 quasi-experimental studies that meet the PICOS inclusion criteria. The results of the analysis show that interactive media has a significant effect on increasing student self-efficacy with an average effect size of 0.72 (strong category). Junior high school and college education levels and media such as H5P, Geogebra, and videos have the most significant impact. Publication bias tests using funnel plots and Fail-Safe N (686) confirmed that the meta-analysis results were stable and not influenced by bias. This study confirms that interactive media effectively increases student self-efficacy, especially with the right choice of media and education level. As an implication, educators are advised to consider moderator factors to optimize learning outcomes. Further research is needed to explore other moderator variables such as learning approaches.

Keywords: *Interactive Media; Mathematics Learning; Self-Efficacy; Digital Media*

1. Introduction

Self-efficacy is an individual's belief in their ability to design and carry out the actions necessary to achieve a specific goal (Ramlan et al., 2021, Purwasih, 2019). In the context of mathematics education, students' self-efficacy is an important aspect that influences how students view themselves in solving mathematical problems, taking academic risks, and maintaining learning motivation. High self-efficacy can increase students' persistence in learning, while low self-efficacy tends to cause students to give up easily and avoid tasks that are considered challenging (Ningsih & Sugiman, 2021, Bandura, 1997).

With the development of digital technology, interactive learning media are increasingly being applied in mathematics learning. This media is designed to stimulate active student engagement through animations, simulations, interactive videos, and educational game-based activities. Interactive learning media are enjoyable for students and do not make them feel bored in learning, thereby increasing their motivation. In addition, interactive learning media can be used to meet the needs of students with different characteristics, present visualizations of mathematical material, such as geometry and arithmetic, provide feedback, and more. Interactive learning media contains examples of questions and discussions, which can improve students' conceptual understanding and learning outcomes (Karmila et al., 2021; Mutawa et al., 2023; Sasongko & Sari, 2025).

Several studies show that the use of interactive and technology-based learning media can improve students' conceptual understanding, learning motivation, and self-efficacy (Fitriyana et al., 2024; Gedik et al., 2024; Zahara et al., 2024; Zhang, 2022). Similar findings on the use of interactive learning media were also revealed by Pertiwi et al. (2022), who developed problem-solving-based interactive media and proved that this media was able to significantly improve students' self-efficacy. Lestari et al. (2023) and Rahman et al. (2023) also found a positive relationship between self-efficacy and student performance in solving math problems. The use of interactive media also supports student-centered learning (Haqq et al., 2024).

Based on the results of previous studies, although interactive learning media has the potential to increase students' self-efficacy in mathematics, the findings reported are still diverse and no comprehensive integrated conclusions have been obtained. A meta-analysis conducted by Juandi et al. (2021) examined the effects of using interactive media specifically on the Geogebra application and did not focus on its impact on students' self-efficacy in learning mathematics. This is where an important research gap lies, namely the need to systematically and quantitatively assess the extent of the influence of interactive learning media on student self-efficacy from various studies that have been conducted.

The main problem in this study is the absence of a quantitative-based empirical synthesis that combines the results of previous studies to obtain a more objective picture of the effectiveness of interactive learning media in increasing students' self-efficacy in mathematics learning. In addition, it is not yet known whether factors such as education level, type of media, or research design can moderate the magnitude of this influence. Therefore, this study is expected to find conclusions about the magnitude of the impact of using interactive learning media on students' mathematical self-efficacy, so that sufficient information can be obtained about the characteristics of interactive learning media and the factors that influence it.

The appropriate approach to answer this problem is to use the meta-analysis method, which is a statistical technique used to integrate the results of previous quantitative studies with a similar focus (Retnawati et al., 2018). Meta-analysis allows for the estimation of a combined effect size that can describe the overall impact of the use of interactive media on student self-efficacy.

The purpose of this study is to synthesize the results of quantitative studies related to the effect of interactive learning media on students' self-efficacy in mathematics learning through a meta-analysis approach with the following research questions.

1. What is the effect of interactive media use on students' mathematics self-efficacy?
2. What moderating factors (impact of education level, type of interactive media, material, and sample size) influence how well students' self-efficacy is when learning with interactive media?
3. How does publication bias affect the effect size in this meta-analysis?

2. Research Method

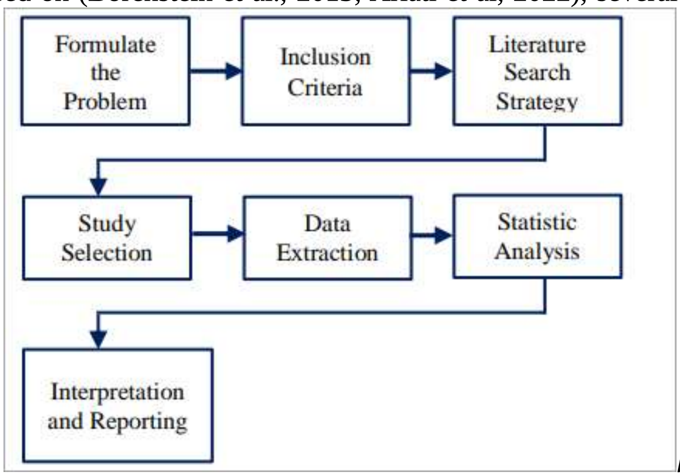
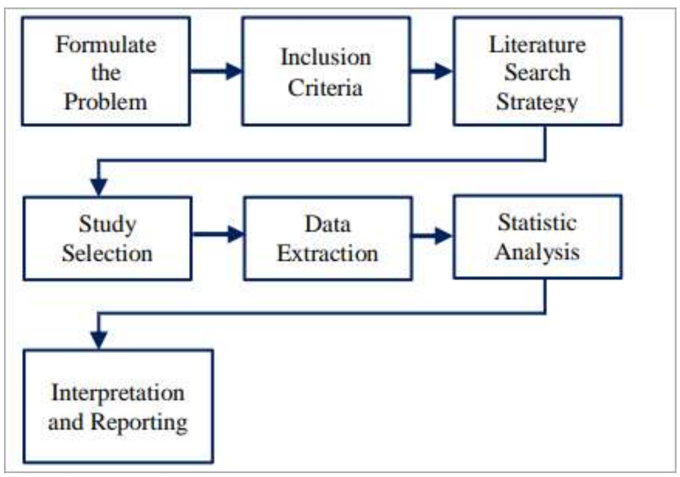
This study is a quantitative study with a comparative meta-analysis approach, which is a statistical method for integrating and synthesizing the results of quantitative studies, particularly quasi-experimental studies, to determine the effect of using interactive learning media on students' self-efficacy in mathematics learning. Based on (Borenstein et al., 2013; Ariati et al, 2022), several stages of the meta-analysis method are shown in 

Figure 1.



. Figure 1. Data Analysis Stages

Inclusion Criteria

There have been many previous studies discussing the effect of interactive media use on students' mathematical self-efficacy. Therefore, to conduct a meta-analysis, the inclusion criteria will be based on the PICOS (Population, Interventions, Comparator, Outcomes, and Study Design) approach by Liberati et al. (2009), namely:

1. The study population consists of elementary, junior high, and high school students, as well as university students.
2. Interventions in learning in the form of the use of technology-based interactive media such as Interactive Video, Geogebra, web-based interactive, H5P content, and the like
3. The comparison in the studies conducted is with learning without the use of interactive media.

4. The outcome of the intervention is an increase in students' mathematical self-efficacy
5. The article uses a quasi-experimental design (pre-test-post-test control group design or similar).
6. The article contains sufficient statistical data for effect size calculations (e.g., mean, SD, and N).
7. The article was published between 2014 and 2025.

Articles that did not meet the inclusion criteria were excluded from the analysis.

Literature Search Strategy

Studies were identified by searching articles through the Scopus, Research Gate, and Google Scholar databases, using the keywords: "multimedia learning" or "interactive media" or "self-efficacy" and ("mathematics learning" or "math learning"). In addition, searches were also combined using the words "the effect of Geogebra/H5P/Edpuzzle on self-efficacy in mathematics."

Data Extraction

After selecting the article database to be analyzed based on the inclusion criteria and study selection, the researcher then extracted the necessary data and information from the selected articles by recording the required statistical information (mean, standard deviation, and sample size) from the post-test data in the selected source articles.

Statistical Analysis

To reveal and generalize the results of the previous investigation, it is necessary to conduct a statistical test by calculating the effect size using the R version 4.5.0 program with R-studio V2025.5 software using the metafor library (Viechtbauer, 2010). The effect size calculation results were interpreted using the criteria determined by Hedges (Borenstein et al., 2009) as in the analysis of heterogeneity in the use of meta-analysis methods is related to sampling errors or variations in findings between different studies (Borenstein et al., 2009). To determine the extent to which sampling errors, population variance, and sample size in a study influence the conclusions of each study, a heterogeneity test is required. The results of the heterogeneity test also determine whether the study will use a random effect model or a fixed effect model. Therefore, one of these effect models is used to produce the effect size or summary effect from the research data, which is then analyzed further.

Table 1. Effect Size Classification

Effect Size (Hedges' g)	Interpretation
0.00 – 0.20	Weak
0.21–0.50	Moderate
0.51 – 1.00	Strong
> 1.00	Very strong

Heterogeneity analysis was conducted by checking the test statistics (Retnawati et al., 2018). If the p-value was < 0.05, the null hypothesis stating that the effect size of each study was homogeneous was rejected. This means that the estimation method chosen was the random effects model and vice versa for the fixed effects model. The value indicates the degree of data heterogeneity with provisions of 25%-50%, 51%-75%, and more than 75% for low, medium, and high heterogeneity, respectively (Borenstein et al., 2009).

Next, a bias test was conducted to determine whether the primary studies were free from publication bias. The publication bias test was conducted through funnel plot analysis, trim and fill test, and fail-safe N (FSN) value.

Several key variables that were the focus of this study included: (1) Interactive Media Learning: related to the types of interactive media used in learning, (2) The Impact of Interactive Media Learning: This variable was related to the impact of using interactive media learning on students' mathematical self-efficacy. In meta-analysis, researchers collect and analyze data from various relevant studies that have been conducted previously to draw broader conclusions. In this study, researchers investigated how the use of interactive media in learning affects students' mathematical self-efficacy based on previous research findings.

3. Results and Discussion

3.1 Results

The Impact of Interactive Media Use on Students' Mathematical Self-Efficacy

Based on the literature selection process according to inclusion and exclusion criteria, 15 primary studies with quasi-experimental designs were obtained and met the requirements for analysis. A summary of the statistical characteristics of these studies, including pre-test and post-test data and sample sizes for the experimental (interactive media) and control classes, is presented in Table 2.

Table 2. Research Data Extraction Results

Code	**Researcher and Year of Research**	**Media**	**Education Level**	**Experimental Class**			**Control Class**		
				Mean	Elementary	N	Mean	SD	N
A1	Niemi & Niu (2021)	Digital Storytelling	Junior High	6.09	1.26	121	4.87	1.56	121
A2	In'am et al. (2024)	Pizzaluv	High School	90.83	6.12	36	82.5	8.45	36
A3	Cano & Lomibao (2023)	Video	PT	4.09	0.37	28	3.75	0.44	27
A4	Hefter et al. (2022)	Clip Art Explainers	Junior High	2.56	1.36	55	2.83	1.45	58
A5	Zetriuslita et al. (2021)	Geogebra	PTi	0.32	0.16	42	0.17	0.09	42
A7	Kohen et al. (2022)	Geogebra	High School	4.59	0.42	58	3.93	0.8	54
A8	Hung et al. (2014)	Digital Game	Elementary	3.74	0.79	23	3.24	0.82	23
A9	Whalen et al. (2024)	Computer Attribution	Junior High School	7.18	2.22	164	6.74	2.53	158
A10	Asis et al. (2022)	Mobile App	Junior High School	3.14	0.53	40	2.93	0.45	40
A11	Rahman et al. (2023)	H5P	Junior High School	83.78	4.4	32	71.48	6.46	31
A12	Zwart et al. (2020)	Digital Materials	High School	11.33	3.09	28	13.73	1.85	11
A13	Shyr et al.	Kahoot	Junior High	4.31	0.51	12	3.58	0.72	12

Code	Researcher and Year of Research	Media	Education Level	Experimental Class			Control Class		
				Mean	Elementary	N	Mean	SD	N
	(2021)_Study_1		School						
A13b	Shyr et al. (2021)_Study_2	Quizlet	Junior High	4.45	0.54	12	3.58	0.72	12
A14	Zetriuslita et al. (2020)	Geogebra	PT	50.33	6.4	42	45.9	5.65	42
A15	Yenmez et al. (2024)	Geogebra	High School	3.47	0.5	33	3.2	0.62	33

Note. N = Sample Size;
SD = Standard Deviation.

Before estimating the combined effect size, a heterogeneity test was conducted to determine the appropriate analysis model. This analysis aimed to see whether the variation in results between studies was caused by sampling error or actual population variation. The results of the heterogeneity parameter test are shown in Table 3.

Table 3. Heterogeneity Parameter Test Results

Dependent Variable	Heterogeneity Parameter Test		
	Q-statistic		
	Value	Df	p-value
Self-efficacy	95.57	14	< 0.0001
I^2	88.39		
τ^2	0.37		

Referring to , a Q-statistic value of 95.57 ($p < 0.0001$) and an I^2 value of 88.39% were obtained. This I^2 value is above the 75% threshold, indicating high heterogeneity among studies. This finding is confirmed by the τ^2 value of 0.37, which indicates substantial effect variance. Therefore, the effect size estimation in this meta-analysis uses the Random-Effects Model approach.

The estimated impact of interactive media use was calculated using Hedges' g Standardized Mean Difference (SMD) with a 95% confidence level. Details of the effect size of each study can be seen in Table 4 , while the visualization of the effect distribution is presented through a forest plot at

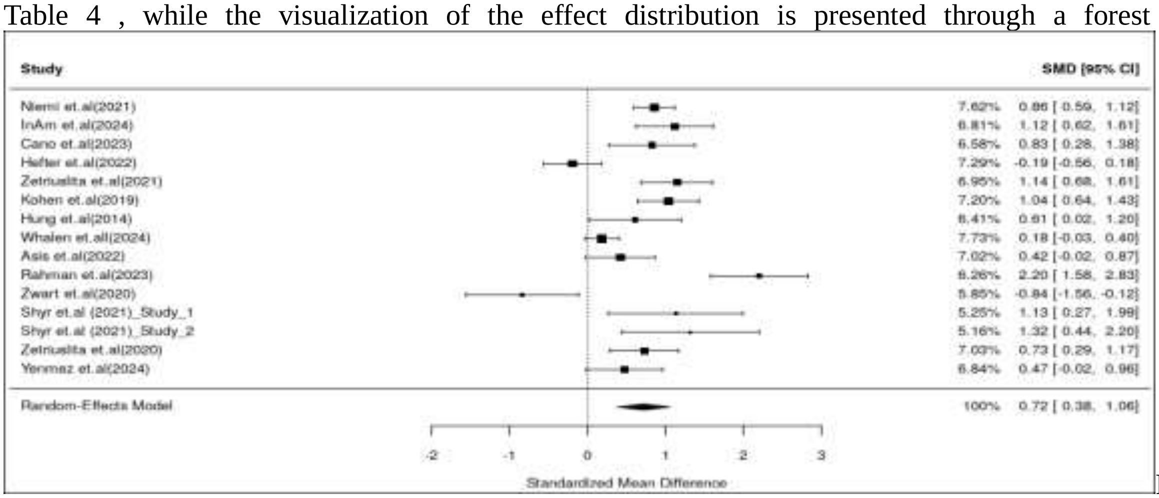


Figure *2*.

Table 4. Effect-Size Estimates

Researcher	SMD	X95%-CI	%Weight
Niemi et al. (2021)	0.86	[0.59, 1.12]	7.6
InAm et al. (2024)	1.12	[0.62, 1.61]	6.8
Cano et al. (2023)	0.83	[0.28, 1.38]	6.6
Hefter et al. (2022)	-0.19	[-0.56, 0.18]	7.3
Zetriuslita et al. (2021)	1.14	[0.68, 1.61]	6.9
Kohen et al. (2019)	1.04	[0.64, 1.43]	7.2
Hung et al. (2014)	0.61	[0.02, 1.2]	6.4
Whalen et al. (2024)	0.18	[-0.03, 0.4]	7.7
Asis et al. (2022)	0.42	[-0.02, 0.87]	7
Rahman et al. (2023)	2.2	[1.58, 2.83]	6.3
Zwart et al. (2020)	-0.84	[-1.56, -0.12]	5.8
Shyr et al. (2021)_Study_1	1.13	[0.27, 1.99]	5.2
Shyr et al. (2021)_Study_2	1.32	[0.44, 2.2]	5.2
Zetriuslita et al. (2020)	0.73	[0.29, 1.17]	7
Yenmez et al. (2024)	0.47	[-0.02, 0.96]	6.8

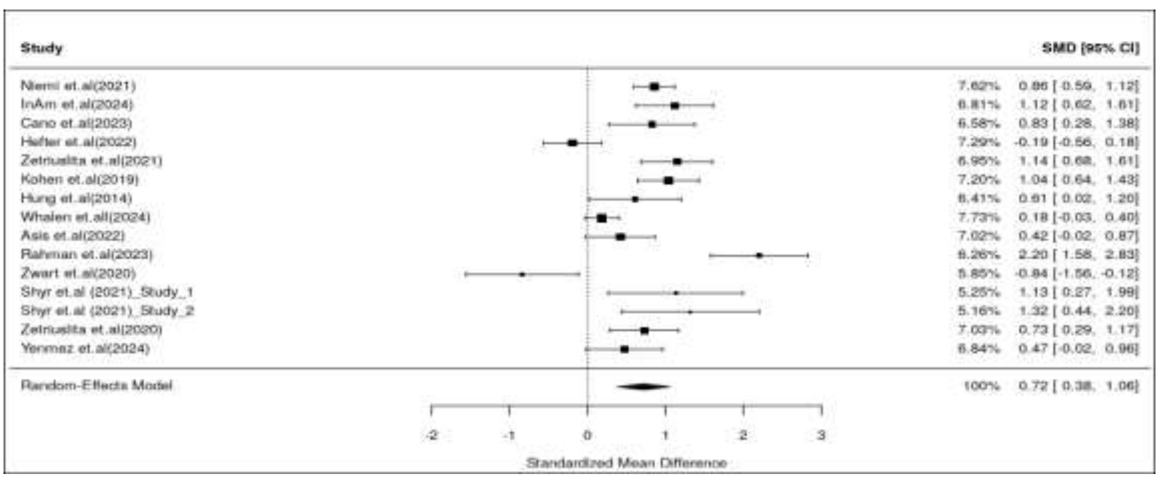


Figure 2. Forest Plot results using random effect

Based on the Random-Effects Model analysis in , a combined average effect size (SMD) of 0.72 was obtained with a confidence interval (95% CI) ranging from 0.38 to 1.06. Statistically, these results indicate that the use of interactive learning media has a significant positive impact on increasing students' mathematical self-efficacy, given that the confidence interval range does not include zero.

Moderator Variables That Affect Students' Self-Efficacy with Interactive Learning Media

Given the high heterogeneity of the data (I^2 =88.39%) found in the main analysis, further analysis was conducted to identify moderator factors that influence the effectiveness of interactive media. The variables analyzed included education level, type of media, teaching material, and sample size. A summary of the effect size estimates and statistical significance for each subgroup is presented in Table 5.

Table 5. Effect Size Moderator Variable

Moderator Variable	Code	Estimate	95% - CI	Std_Error	P_Value

Moderator Variable	Code	Estimate	95% - CI	Std_Error	P_Value
Education Level (QM(df = 4) = 14.7628, p = 0.0052)					
Elementary	A8	0.61	[-0.870 ; 2.091]	0.76	0.41
Junior High School	A1, A4, A7, A9, A10, A11, A13, A13b	0.79	[0.321; 1.323]	0.28	0.01
Senior High School	A2, A7, A12,	0.49	[-0.236; 1.221]	0.37	0.48
Higher Education	A3, A5, A14	0.9	[0.067; 0.173]	0.42	0.03
Media (QM(df = 12) = 128.9005, p < 0.0001)					
Clip_Art_Explainers	A4	-0.19	[-0.701; 0.32]	0.26	0.46
Computer_Reatribution	A9	0.19	[-0.23; 0.599]	0.21	0.38
Digital_Game	A8	0.61	[-0.078; 1.298]	0.35	0.08
Digital_Materials	A12	-0.84	[-1.64; -0.034]	0.41	0.04
Digital Storytelling	A1	0.86	[0.418; 1.297]	0.22	0
Geogebra	A5, A7, A14, A15	0.86	[0.576; 1.143]	0.15	0
H5P	A11	2.21	[1.486; 2.923]	0.37	0
Kahoot	A13	1.13	[0.199; 2.06]	0.48	0.02
Mobile_App	A10	0.42	[-0.143 ; 0.989]	0.29	0.14
Pizzaluv	A2	1.12	[0.508; 1.726]	0.31	0
Quizlet	A13b	1.32	[0.369; 2.27]	0.49	0.01
Video	A3	0.83	[0.172; 1.479]	0.33	0.01
Matter (QM(df = 4) = 17.4532, p = 0.0016)					
Function	A7, A13, A3b, A15	0.96	[0.246; 1.677]	0.37	0.01
Geometry	A1, A5, A8, A11, A12, A14	0.81	[0.246; 1.367]	0.29	0
Calculus	A3	0.83	[-0.556; 2.208]	0.71	0.24
Not_Specified	A2, A4, A9, A10	0.37	[-0.294; 1.033]	0.34	0.28
Sample Size (QM(df = 2) = 16.7726, p = 0.0002)					
<30	A3, A8, A12, A13, A13b	0.59	[-0.05; 1.228]	0.33	0.07
≥30	A1, A2, A4, A5, A6, A7, A9, A10, A11, A12, A14, A15	0.78	[0.362; 1.188]	0.21	0
Overall		0.72	[0.383; 1.056]	0.17	< 0.0001

Based on Table 5, the following are the details of the statistical findings for each moderator category:

1. **Education Level:** The analysis shows significant differences between education level groups (Q_m = 14.76,P = 0.0052). Specifically, the Higher Education (PT) and Junior High School (SMP) levels showed a significant impact with estimated effect sizes of 0.90 ($p = 0{,}03$) and 0.79 ($p = 0{,}005$), respectively. Conversely, at the Elementary School (SD) and Senior High School (SMA) levels, although there was a positive effect, the results did not reach statistical significance ($p > 0{,}05$).
2. **Media Type:** There was significant variation based on the type of media used (Q_m =128.90,$p < 0{,}0001$). Gamification-based and highly interactive media such as H5P, Quizlet, Kahoot, and Pizzaluv recorded effect sizes in the "very strong" and significant categories. Meanwhile, media such as Geogebra and Video had an impact in the "moderate to strong" category, which was also statistically significant.
3. **Mathematics Material:** The topics discussed had different effects (Q_m =17.45,$p = 0{,}0016$). Function and Geometry materials were proven to have a strong and significant impact on increasing self-efficacy.

4. **Sample Size:** The sample size of the study affects the stability of the results (Q_m =16.77,$p = 0{,}0002$). Studies with a sample size of≥ 30 show a significant effect ($p < 0{,}0001$), while studies with a small sample size (<30) do not show a statistically significant impact ($p = 0{,}07$).

Publication Bias on Meta-Analysis Results

Evaluation of potential publication bias was conducted through three approaches: visual inspection, statistical correlation/regression tests, and Fail-Safe N (FSN) analysis. Visually, the distribution of study effect sizes is displayed in a Funnel Plot at

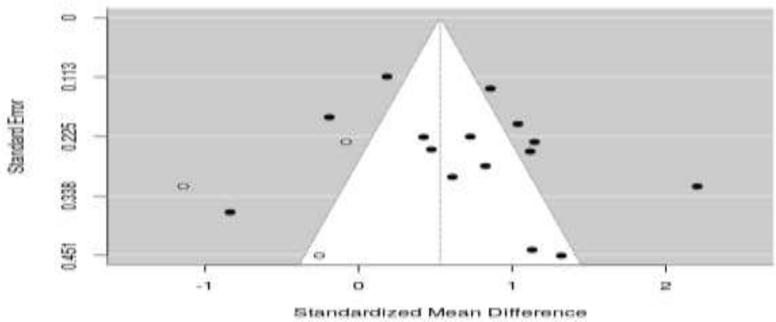


Figure 3.

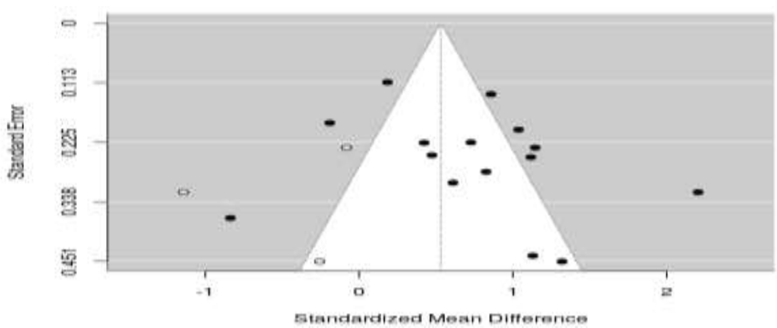
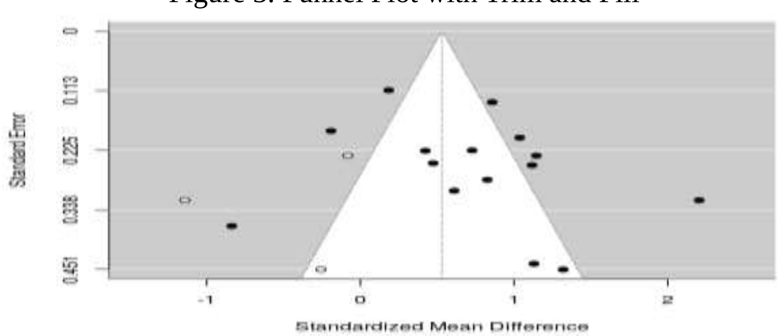


Figure 3. Funnel Plot with Trim and Fill



Based on

Figure 3, the distribution of effect size points appears symmetrically spread around the vertical average line, with most studies falling within the funnel area. Although there are some points outside the area, the pattern does not show extreme asymmetry. To objectively verify this visual inspection, a Rank Correlation test (Begg & Mazumdar) and Regression Method (Egger) were conducted, the summary of which is presented in Table 6.

Table 6. Rank Correlation and Rank Regression Results

Dependent Variable	Rank Correlation Method		Regression Method	
Student Self-efficacy	Correlation Coefficient	p-value	Regression Coefficient	p-value
	0.16	0.44	0.85	0.39

Referring to Table 6, the Rank Correlation test produced a correlation coefficient of 0.16 with a value of$p = 0{,}44$. Meanwhile, the Egger regression method produced a coefficient of 0.85 with a value of$p = 0{,}39$. Considering that both values p are far above the significance level $\alpha = 0{,}05$, statistically there is no evidence of publication bias in the data of this study

Furthermore, a robustness test was conducted using Rosenthal's Fail-Safe N (FSN) analysis. The FSN calculation results were compared with the critical threshold value using the formula $5k + 10$ (where k is the number of studies). The calculation data is presented in Table 7.

Table 7. Analysis Fire Drawer

Dependent variable	Fail-Safe N	Target Significance	Observed Significance
Self-efficacy	686	0.05	< 0.0001

With a total of $k = 15$ studies, the critical threshold is $5(15) + 10$. Based on Table 7, the FSN value obtained is 686. Since the FSN value (686) far exceeds the threshold (85), the results of this meta-analysis are categorized as stable.

3.2 Discussion

Interpretation of the Impact of Interactive Media on Students' Self-Confidence

The main findings of this study indicate that interactive learning media have a combined effect size of 0.72, which according to Cohen and Hedges' criteria is categorized as a strong effect. These results support the hypothesis that the integration of technology in mathematics learning is significantly more effective in building students' self-efficacy than conventional learning without the aid of interactive media**.**

The high impact of interactive media on self-efficacy can be explained through Bandura's social cognitive theory. Interactive media, such as Geogebra, H5P, or educational videos, provide visualizations of abstract concepts and give immediate feedback to students. This feature facilitates the creation of mastery experiences, which are the main source of self-efficacy. When students are able to visualize mathematical problems and get instant confirmation of their understanding through media, their anxiety decreases and their belief in their abilities increases. This is in line with the opinion that interactive media stimulates active engagement and reduces boredom, thereby maintaining students' intrinsic motivation.

The results of this meta-analysis reinforce the partial findings of previous studies, such as those by Pertiwi et al. (2022) and Fitriyana et al. (2024), which found a significant increase in students' self-confidence after media intervention. However, this study provides a more robust synthesis than individual studies. Compared to the meta-analysis by Juandi et al. (2021), which focused only on Geogebra, this study extends the generalization that various types of interactive media (not limited to one software) consistently have a positive impact, despite high heterogeneity between studies. This heterogeneity (as seen in Table 3) suggests that although interactive media is generally effective, the magnitude of its impact may be influenced by other factors such as education level or the specific type of media used.

Theoretically, these findings confirm that in the digital age, mathematical self-efficacy is not only influenced by internal factors within students, but can also be engineered through appropriate media interventions. Practically, these results have important implications for mathematics educators. Teachers are advised to move beyond simply using lecture methods and begin integrating interactive media (such as Geogebra or H5P) as standard in learning, especially for material that requires high visualization. The use of this media has been proven to be not only a visual aid, but also a powerful psychological instrument for building students' confidence in solving mathematical problems.

The Role of Moderators in Enhancing Student Self-Efficacy

Moderator analysis reveals that the effectiveness of interactive media is not uniform but is influenced by the context of its implementation.

The finding that interactive media is most effective at the junior high school and college levels is interesting to note. At the junior high school level, students are in a transitional stage from concrete to formal operations (Piaget's theory). Interactive media serves as a "cognitive bridge" that visualizes abstract concepts, so that students feel more capable (self-efficacious) in mastering the material. This is in line with the findings of Niemi & Niu (2021) and Rahman et al. (2023), who noted a surge in junior high school students' self-confidence through the help of digital visuals. Meanwhile, in higher education, this effectiveness is likely driven by students' established self-regulated learning, enabling them to utilize the exploratory features of the media more optimally than elementary school students who are still highly dependent on teacher instruction.

In terms of media type, gamification-based tools (H5P, Kahoot, Quizlet) showed the greatest impact. This can be explained by the immediate feedback mechanism and reward system in gamification, which provides instant validation of students' abilities. This validation creates repeated micro mastery experiences, which according to Bandura are the main source of self-efficacy. These findings support the results of a study by Shyr et al. (2021), which showed that Quizlet and Kahoot significantly increased engagement and self-confidence. Conversely, static presentation media (such as Clip Art Explainers) showed negative or insignificant effects, confirming that "interactivity" is the key, not just the use of technology.

The dominance of Geometry and Functions in the analysis results confirms that interactive media works best on topics requiring spatial and dynamic visualization. The abstract concept of functions and visual geometry are greatly aided by the object manipulation features in software such as Geogebra. The practical implication is that mathematics teachers are strongly advised to prioritize the use of interactive media on these visual topics over purely procedural/algebraic topics, in order to maximize learning efficiency.

Finally, the findings regarding sample size have crucial methodological implications. Studies with small samples (<30) tend to produce unstable and insignificant data. This suggests that future research on self-efficacy and technology should be designed with adequate statistical power, ideally with samples of more than 30 participants, to ensure generalizable results.

Validity and Robustness of Meta-Analysis Findings

The results of publication bias testing provide strong confirmation that the conclusions regarding the effectiveness of interactive media in this study are objective and not influenced by a tendency to publish only positive data (file-drawer problem).

The absence of publication bias, as indicated by the symmetry in the funnel plot and the Egger test value of 0.000 ($p > 0{,}05$), indicates that the study samples analyzed are a balanced representation of the existing research population. This is important because meta-analyses are often subject to bias, whereby studies with negative or insignificant results tend not to be published, which can lead to an overestimation of the effect[99]. However, the consistency of the statistical results in this study confirms that the effect size estimate of 0.72 is not an artifact of biased literature selection.

The high Fail-Safe N (FSN) value of 686 provides additional evidence of the robustness of the results. Theoretically, according to Rosenthal (1979), this number means that at least 686 new "hidden" or unpublished studies with zero results (no effect) would be needed to invalidate the significant conclusions of this study. Since 686 is well above the tolerance threshold (85), it is highly unlikely that these findings will change simply because of undetected previous studies**.**

The implication of this data stability is that education practitioners and policymakers can use these findings with a high degree of confidence. The conclusion that interactive media effectively increases student self-efficacy is a valid, robust finding that can be generalized to a wider population without undue concern about publication bias.

Conclusion

Based on the results of the meta-analysis, it can be concluded that the use of interactive learning media has a strong effect and a significant impact on students' self-efficacy in mathematics learning. The application of interactive media can be implemented mainly at the university and junior high school levels because it has a strong effect and a significant impact. Meanwhile, adjustments are needed for elementary and high school levels.

The variables of material and type of interactive media also have a strong effect and significant influence on the use of interactive media on student self-efficacy, so it is necessary to pay attention to and adjust the use of the type of media and material taught.

Based on this study, which analyzed 15 quasi-experimental studies, the various moderator variables have not been fully revealed. Therefore, further research is needed for a more in-depth analysis, especially of the learning models or approaches combined with the media used. Based on the findings, it would also be better to conduct research with a sample size of more than 30 samples.

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