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The Relationship between Literacy Skills and Students' Academic Achievement: A Meta-Analysis Study

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Abstract

Literacy skills and academic achievement were examined in this study. An individual's capacity to learn and apply new skills relies heavily on their ability to read and write well. In this study, a meta-analysis approach is used to calculate the correlation with the fixed-effect model, which is quantitative. The first step in formulating research questions is to identify relevant research and then look for research that doesn't publish the r-value. There are 29 articles in the sample. This study's findings on the relationship between literacy skills and student academic achievement are free from publication bias because the fixed-effect funnel plot model shows a variety of sample sizes with the asymmetric distribution. After seeing the forest plot before and after trimming and filling it, it was clear that the results of the summary effect were evident. So, the fixed-effect model of the relationship between students' reading skills and how well they do in school is very likely to be true..

Keywords: literacy, academic achievement, meta-analysis

INTRODUCTION

The primary goals of education should be to improve education holistically and to promote the quality of life in society (Almazroa, Alotaibi, and Alrwaythi 2022). Education aims to help students develop competencies that go beyond the acquisition of knowledge and skills; it entails mobilizing knowledge, skills, attitudes, and values to meet complex demands (OCDE 2018). The integrated educational framework model allows for the consideration and assessment of the abilities required in each discipline from a variety of perspectives, including technical, educational, contextual, and humanist perspectives (Chalkiadaki 2018). The framework for the twenty-first century provides strategies for identifying the skills students will need to enter the workforce of the future. Learning skills (creativity and innovation, critical thinking and problem solving, communication and collaboration); literacy skills (information literacy; media literacy; ICT literacy); and life skills (flexibility and adaptability, self-direction and initiative, social and intercultural skills, productivity and accountability, leadership and responsibility) (González) pérez & Ramírez-Montoya, 2022).

Based on the three skills above, an individual will succeed depending on literacy skills (González-pérez and Ramírez-montoya 2022). Literacy skills are a vital component of the skills development process that accompanies the economic and social changes in OECD countries (OECD 2000). People of the future will be able to access information, solve problems, and learn on their own (Kotsiou et al. 2022).

Most people think of literacy as a set of useful skills, especially the cognitive skills of reading and writing (Pahl and Rowsell 2014). However, the definition of literacy skills has changed from time to time according to the global community's needs, the demands of economic development, and research progress. In the 21st century, the notion of literacy increasingly incorporates the ability to collect and impart information using technological means (Warlick, 2013). Not only is the definition of literacy evolving, but terms like information literacy, multiliteracy, new literacy, digital literacy, and web literacy are all being used to describe the same set of skills required for 21st-century learning. As the foundation for acquiring knowledge and expressing ideas, literacy skills are at the core of 21st-century competencies. In a world overflowing with information, the ability to read critically, write persuasively, and communicate effectively is more essential than ever. Literacy is the ability to recognize, understand, interpret, create, communicate, and do math using written or printed materials in different situations (Richmond, Robinson, and Sachs-Israel 2008).

An interesting study by Brown (2022) examined the long-term effects of reading to children aged 1-2 years on their reading, language, and numeracy skills at ages 8-11. The study involved over 3500 infants and their caregivers. The results showed that children who were frequently read to at an early age had slightly better reading, spelling, and grammar skills when they were in grades 3 and 5. Infants who were read to daily for 11 minutes or more had superior reading, spelling, and grammar skills. In conclusion, literacy skills are associated with academic achievement.

Academic success is one of the most critical indicators of achieving educational goals and a significant predictor of children's learning development (Lubinski, Benbow, and Kell 2014). Many studies were found on predictors of student academic success (Banik and Kumar 2019; Dyer, Childers, and Odell 2022). In addition, student academic achievement is an important indicator in comparing the quality and equity of education between countries (OECD 2016). Not surprisingly, much research has been done over the last few decades on the factors associated with academic achievement.

Based on the search results, not many studies discuss the relationship between literacy skills and academic achievement. This research wants to answer related questions; How are literacy skills related to academic achievement? This study aims to analyze the relationship between literacy skills and academic achievement with a meta-correlation analysis approach. By shedding light on this crucial connection, this research is expected to inform educational practices and policies, ultimately empowering individuals to thrive in the 21st century..

Today, literacy is not only about reading but also about being intelligent and knowing how to explore and solve complex problems. Therefore, literacy is the basis for individuals to participate in society and achieve their goals in their work and life (Jailani et al. 2020). Some aspects of literacy skills are measured, namely reading/information literacy, mathematical literacy, and digital literacy (OECD 2007). Information literacy is the capacity to determine what information is required, comprehend how information is organized, determine the best sources for specific needs, locate these sources, evaluate sources critically, and communicate this information (Thanuskodi 2019). Information literacy is vital because a growing sea ofinformation surrounds us in all formats. Digital literacy is a skill in engaging digital technology's connections and communication possibilities, in its capacity to generate, mix, reuse and share new knowledge and convey existing information (Spante et al. 2018). Numerical/mathematical literacy is the

ability to apply the concepts of numbers and arithmetic to count. Students need knowledge of number symbols, sequences, and number operations to perform mathematical operations (Chu, Van Marle, and Geary 2016). Numerical ability is also related to how students develop the ability to interpret numerical information by applying numerical concepts and mathematical operations to natural objects in everyday life (Aunio and Räsänen 2016).

Academic achievement is commonly used to predict the education system's success, assess school performance, assess teachers' classroom management skills, and measure changes in individual student achievement levels. Academic achievement includes communication skills and abilities (verbal, reading, writing), math, science, research and social reasoning, and abilities that are measured for successful academic performance (Tian and Sun 2018). Academic achievement is a performance result that shows how well an individual has achieved specific goals, which are the focus of activities in the classroom environment, especially in schools and colleges (Spinath 2012). Cognitive ability is the strongest predictor of academic success (Roth et al. 2015). This consists of abilities related to thinking, memory, and information processing of learning materials, which are generally unrelated or minimally related to SRL, motivation, or life satisfaction (Köller et al. 2019; Kriegbaum, Becker, and Spinath 2018).

METHODS
Research design

This study used a meta-analysis methodology to synthesize and quantitatively analyze independent research findings about the relationship between literacy and learning outcomes. The meta-analysis gives a thorough examination with statistical analysis of quantitative data acquired from independent investigations on particular topics (Mark W. Lipsey 2001). Meta-analysis is an empirical study of previous research that can be compared with *correlation coefficients.* (Retnawati et al., 2018) .

In meta-analysis, the effect size is used to determine standard values for evaluating the outcomes of independent studies (Turgut and Turgut 2018). Effect size estimates provide standardized and validated independent study results based on the same criteria (Mark W. Lipsey 2001). Specific criteria were used to code the research. Coding is the process of obtaining pertinent data for analysis by extracting data from specific research (Karada, 2015). In addition, statistical analysis is employed in meta-analysis research, and the results are interpreted.

Data collection

Secondary data is collected for the analysis process depending on study outcomes. Observing the research components of journal articles based on the criteria of academics researching the same subject in connection to literacy and academic achievement yields secondary data. This meta-analysis includes all Indonesian or English studies examining the relationship between literacy and academic achievement. Because this study has been extensively conducted, this study was drawn from 2015 to 2022. The studies published in English were sourced from Google Scholar, ERIC, ProQuest, ScienceDirect, and Mendeley. Literacy search terms include literacy, information literacy, mathematical literacy, scientific literacy, digital literacy, eco literacy, and financial litercay. The first search returned 364 articles. Some studies use the value of r as a measure of influence, whereas research that does not calculate the r-value modifies the F and t values from the research results.
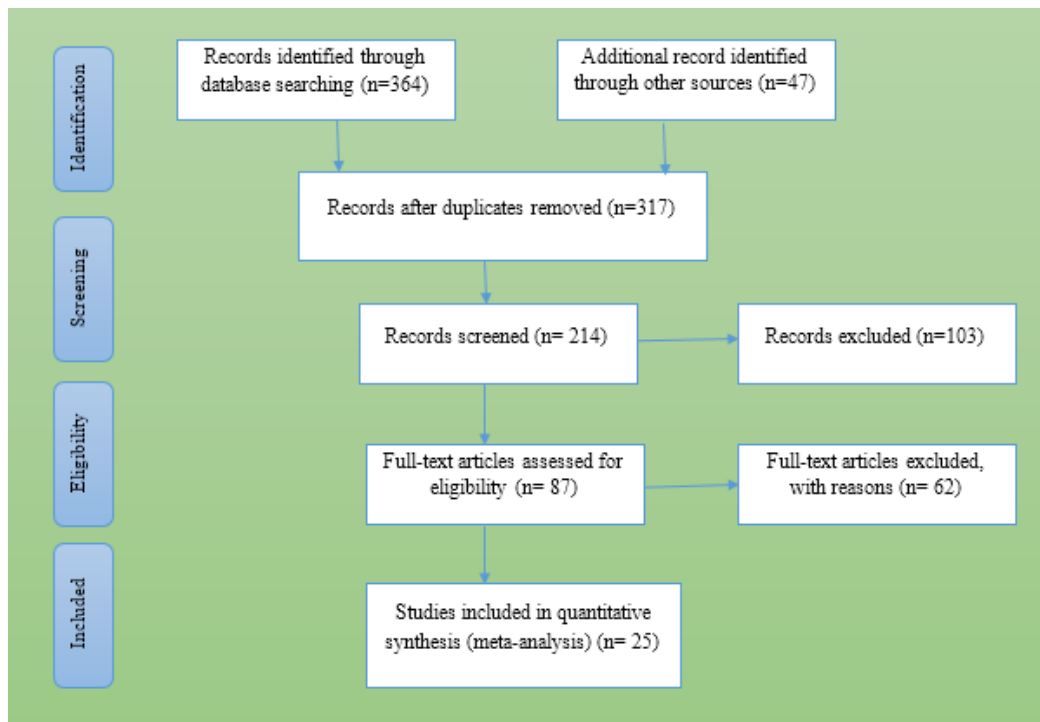
Figure 1. Schematic of Determining the Number of Samples

Coding

The search found 25 journal papers, therefore the research coding criteria were as follows: sample information (year of study, subject, independent and dependent variables), followed by quantitative graphics (sample size, average achievement, F value, t, and r). This step is completed prior to the statistical analysis.

Data analysis

In meta-analyses, the effect size is the standard way to measure the strength and direction of a relationship (Borenstein, Hedges, Higgins, & Rothstein, 2009). The Standardized Average Effect Size was used to compare the means of independent groups deemed equivalent for each study of the two variables, and the Standardized Mean Effect Size was used to compare the means of independent groups deemed equivalent for each study of the two variables (Retnawati et al. 2018). In order to calculate the impact size and summary effect with a fixed-effect model, this study's data processing technique employs descriptive statistical analysis. The JASP 0.15.0.0 software was then used to investigate publication bias.

RESULTS AND DISCUSSION

Results

The process of collecting secondary data is the result of journal articles. The subjects of each study are very different and cover a wide range of topics. Here are some research results with the traits that the researcher chose as a sample, as shown in the table below:

Table 1. Research Results Search

No.	Study	Independent Variable	Dependent variable	F	t	r	*N*
1	(Smith et al. 2015)	Literacy	Performance			0.65	304
2	(Smith et al. 2015)	Number	Performance			0.68	304
3	(Murti and Winoto 2018)	Information Literacy	Learning achievement			0.666	88

No.	Study	Independent Variable	Dependent variable	F	t	r	N
4	Giovanni & Komariah (2019)					0.478	121
5	(Kontaş & zcan, 2022)	Mathematical Literacy	Learning achievement			0.74	332
6	(Gavsiddappa Anandhalli 2018)					0.503	105
7	(Miao et al. 2020)	Internet Literacy	Learning achievement	58.020	7,617	0.007	1105
8	(Magalhães et al. 2020)	Literacy	Math Achievement	15,160	3,894	0.014	284
9	(Banik and Kumar 2019)	Information Literacy	Learning achievement	86,970	9,326	0.028	325
10	(Abbas, Hussain, and Rasool 2019)	Digital Literacy	Learning achievement			-0.025	800
11	(Shao and Purpur 2016)	Information Literacy	Learning achievement			0.112	345
12	(Sezer 2020)	Information Literacy	Learning achievement		17.4	0.643	431
13	(Razafimahasolo et al. 2016)	Financial literacy	Learning achievement			0.735	363
14	(Pala and Başıbüyük 2021)	Digital Literacy	Learning achievement			0.682	742
15	(Pagani et al. 2016)	Digital Literacy	Learning achievement			0.532	2025
16	(Pagani et al. 2016)	Digital Literacy	Learning achievement			0.379	2025
17	(Banat & Little Adi Pierewan, 2019)	literacy reading	Learning achievement		4,507	0.012	359
18	(Liang, de la Torre, and Law 2021)	Digital Literacy	Learning achievement			0.630	642
19	(Christopher and Iyabo 2013)	Information Literacy	Learning achievement			0.473	873
20	(Lukitasari et al. 2022)	Digital Literacy	Learning achievement	99.959	9.9998	0.090	103
21	Beautiful et al. l (2022)					0.566	195
22	(Olakunle and Olanrewaju 2021)	Information Literacy	Learning achievement	4,077	2.019	0.074	746
23	(Zainuri, Sukarno, and Huda 2022)	Science Literacy	Learning achievement			0.066	156
24	(Lawon 2017)	language literacy	Learning achievement			0.560	30
25	(Sigit et al. 2021)	Eco literacy	Learning achievement			0.462	245

No.	Study	Independent Variable	Dependent variable	F	t	r	*N*
26	Fitrianawati et al. l (2019)					0.671	206
27	(Handayani, Adisyahputra, and Indrayanti 2018)	Science Literacy	Learning achievement		0.457		81
28	(Handayani et al. 2018)	Science Literacy	Learning achievement		0.214		81
29	(Thahir, Magfirah, and Anisa 2021)	Science Literacy	Learning achievement		0.370		52

Seven articles were found based on the table above that determined the r-value of the 29 articles collected, some of which were converted from F and t to obtain the r-value. Then, using the data in Table 2, determine the effect and overall effect:

Table 2. Fixed Effect Data Tabulation

No	Study	F	t	r	*n*	Y	Vy (ES)	*W*	*WY*	*WY* ²	W2 -
1	(Smith et al. 2015)		0.000	0.650	304	0.775	0.003	301	233,365	54459,181	90601
2	(Smith et al. 2015)			0.680	304	0.829	0.003	301	249.563	62281,853	90601
3	(Murti and Winoto 2018)		0.000	0.666	88	0.804	0.012	85	68,299	4664,780	7225
4	Giovanni & Komariah (2019)		0.000	0.478	121	0.520	0.008	118	61.406	3770,681	13924
5	(Kontaş & zcan, 2022)		0.000	0.740	332	0.950	0.003	329	312,708	97786,116	108241
6	(Gavsiddappa Anandhalli 2018)		0.000	0.503	105	0.553	0.010	102	56,438	3185,253	10404
7	(Miao et al. 2020)	58.02	7,617	0.007	1105	0.007	0.001	1102	7.558	57,125	1214404
8	(Magalhães et al. 2020)	15,16	3,894	0.014	284	0.014	0.004	281	3,827	14.647	78961
9	(Banik and Kumar 2019)	86.97	9,326	0.028	325	0.028	0.003	322	9,038	81,692	103684
10	(Abbas et al. 2019)		0.000	-0.025	800	-0.025	0.001	797	-19,929	397,171	635209
11	(Shao and Purpur 2016)		0.000	0.112	345	0.112	0.003	342	38,465	1479,585	116964
12	(Sezer 2020)		17,400	0.643	431	0.764	0.002	428	326,847	106828,737	183184
13	(Razafimaha solo et al. 2016)			0.735	363	0.940	0.003	360	338,226	114396,770	129600

No	Study	F	t	r	n	Y	Vy (ES)	W	WY	WY²	W2 -
14	(Pala and Başıbüyük 2021)			0.682	742	0.833	0.001	739	615,472	378805,187	546121
15	(Pagani et al. 2016)			0.532	2025	0.593	0.000	2022	1198,906	1437374,460	408884
16	(Pagani et al. 2016)			0.379	2025	0.399	0.000	2022	806.558	650536,463	408884
17	(Banat & Little Adi Pierewan, 2019)		4,507	0.012	359	0.012	0.003	356	4,439	19,701	126736
18	(Liang et al. 2021)			0.630	642	0.741	0.002	639	473,765	224453,196	408321
19	(Christopher and Iyabo 2013)			0.473	873	0.514	0.001	870	447,117	199913,882	756900
20	(Lukitasari et al. 2022)	99.959	9.9998	0.090	103	0.090	0.010	100	9,032	81.574	10000
21	Beautiful, et al. l (2022)			0.566	195	0.642	0.005	192	123.191	15175,922	36864
22	(Olakunle and Olanrewaju 2021)	4.0770	2.019	0.074	746	0.074	0.001	743	54,951	3019,630	552049
23	(Zainuri et al. 2022)			0.066	156	0.066	0.007	153	10,113	102,267	23409
24	(Lawon 2017)			0.560	30	0.633	0.037	27	17.086	291,948	729
25	(Sigit et al. 2021)			0.462	245	0.500	0.004	242	120.964	14632,278	58564
26	Fitrianawati et al. l (2019)			0.671	206	0.813	0.005	203	164.950	27208,389	41209
27	(Handayani et al. 2018)			0.457	81	0.494	0.013	78	38,494	1481,788	6084
28	(Handayani et al. 2018)			0.214	81	0.217	0.013	78	16,954	287,440	6084
29	(Thahir et al. 2021)			0.370	52	0.388	0.020	49	19.033	362.245	2401

According to the effect size calculation, the average weighted effect is 0.479, with a standard deviation of 0.006 and a standard error of 0.089. The weighting effect is 95% significant for the average confidence interval (M), which falls between 0.416 and 0.45. As a result, the effects of the summary of effects are depicted in the forest plot image below;
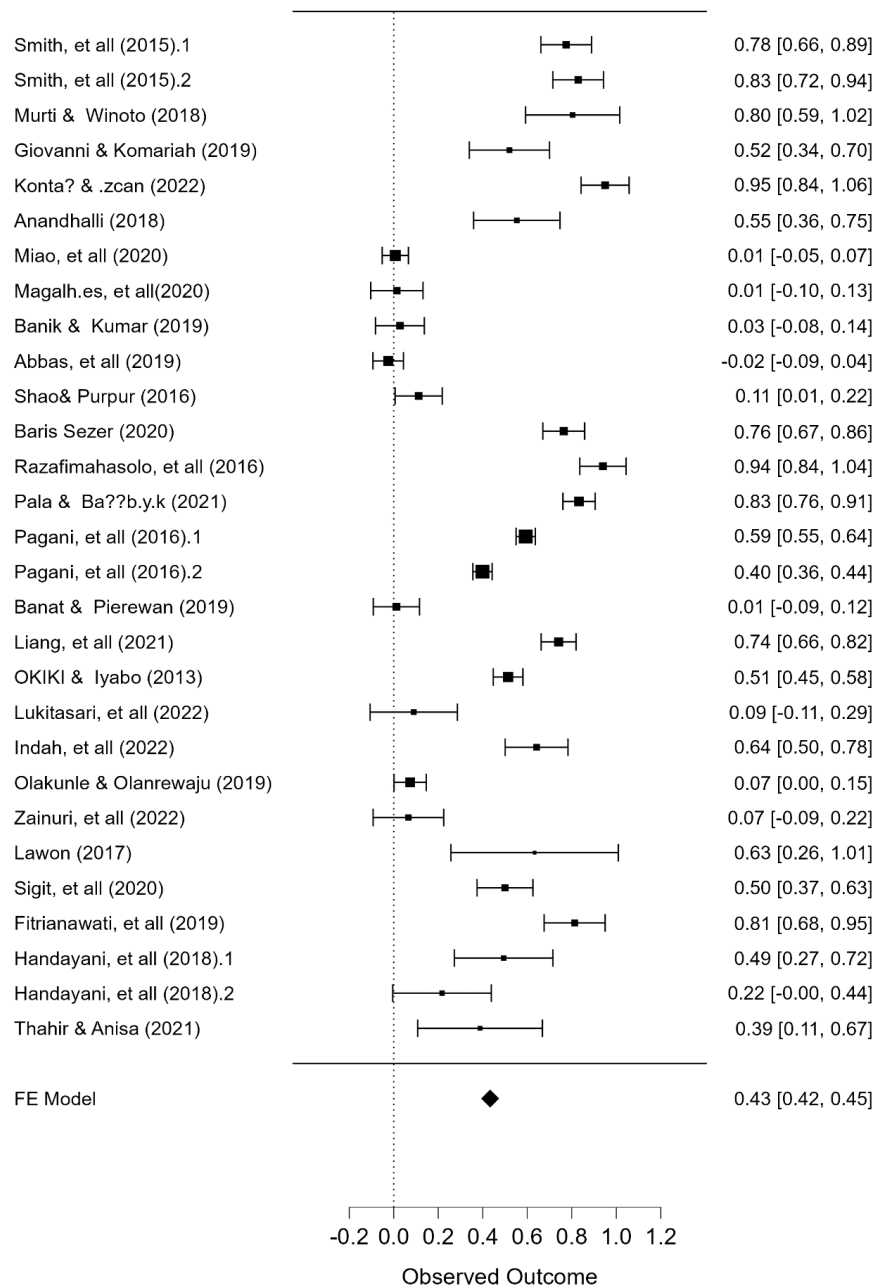
Study	Observed Outcome
Smith, et all (2015).1	0.78 [0.66, 0.89]
Smith, et all (2015).2	0.83 [0.72, 0.94]
Murti & Winoto (2018)	0.80 [0.59, 1.02]
Giovanni & Komariah (2019)	0.52 [0.34, 0.70]
Konta? & .zcan (2022)	0.95 [0.84, 1.06]
Anandhalli (2018)	0.55 [0.36, 0.75]
Miao, et all (2020)	0.01 [-0.05, 0.07]
Magalh.es, et all(2020)	0.01 [-0.10, 0.13]
Banik & Kumar (2019)	0.03 [-0.08, 0.14]
Abbas, et all (2019)	-0.02 [-0.09, 0.04]
Shao& Purpur (2016)	0.11 [0.01, 0.22]
Baris Sezer (2020)	0.76 [0.67, 0.86]
Razafimahasolo, et all (2016)	0.94 [0.84, 1.04]
Pala & Ba??b.y.k (2021)	0.83 [0.76, 0.91]
Pagani, et all (2016).1	0.59 [0.55, 0.64]
Pagani, et all (2016).2	0.40 [0.36, 0.44]
Banat & Pierewan (2019)	0.01 [-0.09, 0.12]
Liang, et all (2021)	0.74 [0.66, 0.82]
OKIKI & Iyabo (2013)	0.51 [0.45, 0.58]
Lukitasari, et all (2022)	0.09 [-0.11, 0.29]
Indah, et all (2022)	0.64 [0.50, 0.78]
Olakunle & Olanrewaju (2019)	0.07 [0.00, 0.15]
Zainuri, et all (2022)	0.07 [-0.09, 0.22]
Lawon (2017)	0.63 [0.26, 1.01]
Sigit, et all (2020)	0.50 [0.37, 0.63]
Fitrianawati, et all (2019)	0.81 [0.68, 0.95]
Handayani, et all (2018).1	0.49 [0.27, 0.72]
Handayani, et all (2018).2	0.22 [-0.00, 0.44]
Thahir & Anisa (2021)	0.39 [0.11, 0.67]
FE Model	0.43 [0.42, 0.45]

Observed Outcome

Figure 2. Forest Plot Results

The p-value and z-value are then calculated to determine whether or not the null hypothesis is accepted. Using the results of the computation, the z-value is 50.258 and the p-value is calculated using the formula 1-NORMSDIST in Microsoft Excel (14.17) obtained the p-value decreases from (p0.05), indicating that the hypothesis is accepted at a level of significance of 95% for both one-sided and two-sided tests. Thus, there is a considerable correlation between literacy and learning results. In addition, the weighted average impact size (M) must be converted into a correlation coefficient (r) to establish whether there is a substantial association between literacy and learning outcomes. The calculated value of r is 0.433, with a confidence interval of 0.36 to 0.46 that includes the category "strong".

The method of detecting publication bias in 29 studies is an effort to gather unpublished study data and examine research conclusions that conclude that literacy influences the improvement of learning outcomes. The outcomes of detecting published research bias using JASP software are as follows:

Table 3. Rank correlation test for Funnel plot asymmetry

Rank correlation test for Funnel plot asymmetry

	Kendall's	p
Rank test	-0.042	0.750
Regression test for Funnel plot asymmetry ("Egger's test")		

Rank correlation test for Funnel plot asymmetry

	Kendall's	p
	z	p
sei	2,504	0.012

The rank correlation test for funnel plot asymmetry was used to see research that included publishing bias and unbiased publication based on the Kendall value and the amount of the regression correlation coefficient with variance. The study includes publication bias if the p-value is less than (0.05); if the p-value is greater than (0.05), the study does not include publication bias. The rank correlation method returns a value of -0.042 with a p-value of (0.750) (0.05), whereas the regression method returns a value of 2.504 with a p-value of (0.012) (0.05), indicating that no evidence of publishing exists. In addition, the missing research information can be seen in the Trim-fill Analysis diagram below:
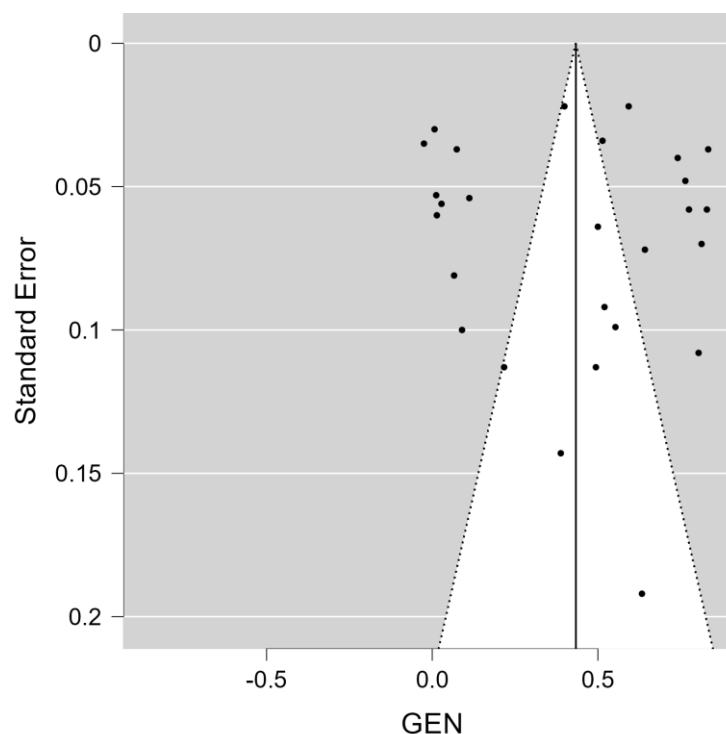
Figure 2. Funnel Plot Results

According to the above image of the funnel plot, there is no visible circle in the image of the funnel plot for the fixed-effect model, showing that there is no missing research, demonstrating that literacy has a relationship or influence on learning outcomes and is protected from publication bias. The results of the forest plot display indicate that the Summary effect of the fixed-effect model does not shift or is smaller than the summary effect results before and after using the Trim and Fill method, indicating that the fixed-effect model's conclusions regarding the relationship between literacy and learning outcomes are valid.

Discussion

According to the interpretation of the research results provided above, there is a high association between literacy skills and learning outcomes. The association is evident based on the summary impact of 0.43 with the fixed-effect model. The r-value of 0.43 suggests that the association is relatively powerful. However, the magnitude of the link differed depending on the type of sample (age or degree of schooling), the nature of the literacy skill measure, and the location of the study (Europe/west or Asia/east).

However, one study, Research 10, has a negative correlation. According to the study, if a person's literacy skill level is high, it tends to be weak in academic achievement, and vice versa; if the literacy skill level is low, it tends to have high academic achievement. Study 10 is a study conducted by Abbas et al. (2019) on 800 MS/M. Phil & Ph.D. students are studying in higher education institutions in Punjab. It was concluded that digital literacy did not affect academic achievement. The study results explain that academic achievement is only related to program r and completing assignments, and through other academic work, achievement can be increased. By following the directions and guidelines, students can achieve high

academic achievement in their courses. Some respondents said that their academic achievement was higher because of regular study in the departmental library and handouts given by lecturers. However, practicing and studying various books, articles, journals, and online databases can improve academic and research skills. This finding is in line with the findings of Amiri (2009), who concluded that computer accessibility and digital literacy positively affect students' academic performance.

The highest correlation was found in Study 5, with an r-value of 0.74. Research 16 is a study conducted by Kontaş & zcan (2022) with a sample of 8th-grade middle school students in a provincial center in the Southeastern region of Turkey with a sample of 347 students. Again the results support that literacy skills are a key component of the skills development process (OECD 2000). In practice, literacy skills and academic achievement are related to each other. Students who have good literacy skills in this field will have good achievements in the field.

Literacy skills are one of the factors in achieving academic achievement. The higher the digital literacy skills, the higher the learning outcomes. The same is true for other literacy skills. The higher the information literacy, science, and financial skills, the higher the learning outcomes. Therefore, to achieve the goal of good learning outcomes, it is necessary to consider literacy learning.

The results of this study prove that literacy skills have a relationship with students' academic achievement. These results open opportunities for improving literacy skills in learning both in elementary schools and universities. It is recommended that the educational process of students, both at school, at home, and in the community, should help students grow and improve literacy skills that will increase various other intelligence so that they can be used in dealing with and solving various life problems. There is also a need for further research related to the importance of various types of literacy in improving students' academic achievement.

This meta-analysis includes a significantly smaller sample of studies from western countries (Europe) than from Asian countries. In the future, it will be necessary to do a meta-analysis on this topic with a balanced number of samples from the west and east, or study with specific samples from Europe and Asia, in the context of practice. Specifically, so that firmer conclusions can be reached about the association between literacy abilities and academic accomplishment in various communities.

CONCLUSION

According to the findings of the reform, literacy skills are positively correlated with academic achievement, with an r-value of 0.43 (strong/moderate category). This demonstrates that the greater the increase in the literacy skill variable, the greater the impact on academic achievement. Furthermore, problems with the strength of the confusing correlation between literacy skills and academic achievement variables based on varying literature (some in low to high categories) become apparent after a meta-analysis, namely in the medium category. Correlation varies depending on the sample type.

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