Universal Journal of Educational Research 8(12A): 7676-7681, 2020 http://www.hrpub.org
DOI: 10.13189/ujer.2020.082554

Self Concept & Mathematics Achievement: A Meta-analysis

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Received October 5, 2020; Revised November 20, 2020; Accepted December 6, 2020

Cite This Paper in the following Citation Styles

(a): *[1] Indah Suciati, Khadijah, Khaerani, Abdul Manaf , "Self Concept & Mathematics Achievement: A Meta-analysis," Universal Journal of Educational Research, Vol. 8, No. 12A, pp. 7676 - 7681, 2020. DOI: 10.13189/ujer.2020.082554.*

(b): *Indah Suciati, Khadijah, Khaerani, Abdul Manaf (2020). Self Concept & Mathematics Achievement: A Meta-analysis. Universal Journal of Educational Research, 8(12A), 7676 - 7681. DOI: 10.13189/ujer.2020.082554.*

Abstract Research on self-concept and mathematics learning achievement has been done a lot, both at the elementary, junior high, high school and university levels. The average research shows a relationship between self-concept and mathematics learning achievement, so it is necessary to conduct a meta-analysis of correlational studies. Data were obtained from national journals and international databases with predetermined criteria. Based on the search, 28 studies met the specified criteria. Data analysis used a random effects approach. The software used in the analysis is JASP. 0.8. 4.0. The results of the analysis show the Q value with p-value <0,05; τ^2 or $\tau > 0$; and I^2 (%) close to 100% of the sample used meets the assumption of heterogeneity. Kendal Value τ with p-value> 0,05; and Z value with p-value> 0,05, and the image generated by the random effects model with the results of the analysis using the trim-fill approach is not different, it can be concluded that there is no publication bias. The results of the analysis show that there is a positive and significant relationship between self-concept and mathematics learning achievement. The resulting summary effect size was 0,62 in the medium category. Summary effect size values are in the interval 0,49 to 0,75. The results of this study indicate consistency and support for the theory of self-concept development.

Keywords Self Concept, Achievement, Mathematics, Meta-analysis, Correlation, Effect Size, Biased Publication

1. Introduction

Student mathematics achievement is influenced by two main factors, namely internal factors and external factors [34]. Self concept is one of the internal factors that influence student learning achievement. Positive self-concept can help someone to be optimistic and confident [30]. Self-concept is divided into two main parts, namely (1) non-academic self-concept, which consists of social relations and physical appearance, and (2) academic self-concept, which consists of language, mathematics, artistic, and other subjects. The concept of self in mathematics is shaped by how student performance compares to other students in mathematics and about peer comments about student's mathematical performance [2].

2. Literature Review

Research on self-concept and mathematics achievement has been carried out by researchers, both at the elementary school level, junior high school, senior high school, to college. The Average research shows a relationship between self-concept and mathematics achievement.

Elementary School Level

Several studies were conducted at the elementary school level, among others: about the effect of self-concept on mathematics achievement as conducted by

Handayani [7] which states that there is a positive direct effect between self-concept and mathematics achievement. Correlation studies were conducted to determine the relationship of self-concept to student mathematics achievement as conducted by Setiawan and Waspodo [3], Wirawan, Suarjana, and Renda [17], as well as Parnata, Kristiantari, and Putra [19].

Junior High School Level

At the junior high school level, a result was obtained that said that boys have a much higher mathematical self-concept than girls. But girls show higher mathematical achievements than boys [6]. In addition, the results obtained by Ernawati [9] show the results which state that self-concept has a positive and significant influence on mathematics achievement.

Senior High School Level

Research on self-concepts and mathematics achievement is mostly done at the High School level, because high school students already have mature views and thoughts to judge themselves. At this age, students begin to want to be accepted and recognized by their social environment [18]. Thus, the average results of the study showed a significant correlation between self-concept and mathematics achievement [4].

College Level

For the Higher Education level, it turns out that there is a positive and significant relationship between self-concept and student academic achievement [14]. These results are similar to Setiadi's findings [37] which state that there is a fairly strong relationship between self-concept and Student academic Achievement.

3. Methodology

This research is a meta-analysis study [20]. The design used is *meta-analysis correlation*. Research data sourced from various studies published in national journals (SINTA Rank) and international (SCOPUS Rank) can be downloaded in an online database with predetermined criteria. The criteria used to filter or select each research object of the meta-analysis are: (1) listing the number of samples provided that the number of samples is (N) $\geqslant$ 30; (2) has a value of r (positive and significant correlation) or t or F. The value of t or F is converted to the value of r because in the analysis calculated is the effect size of the correlation. The formula used is $F = t^2$ or $t = \sqrt{F}$, or $r = t/\sqrt{t^2 + N - 2}$ [24], and (3) the research variables are self-concept and mathematics learning achievement. Data analysis included: (1) heterogeneity test, with the condition that the value of Q with a value of $p < 0{,}05$; τ^2 or $\tau > 0$; and I^2 (%) close to 100% fulfilling the assumption of heterogeneity [12], (2) calculating the effect size, (3) making forest plots and funel plots, (4) testing hypotheses, and (5) checking publication bias. The software used in the analysis is JASP. 0.8. 4.0 [32].

4. Result

Based on searches in the journals, national and international database obtained 28 studies that met the specified criteria. Table 1 presents the values of N (sample), r (correlation), t, and F of each study.

Table 1. Comparison of 28 studies based on N, r, t or F values

Author	N	r	t	F
Seaton et al, (2014)	2786	0,46	-	-
Chiu et al, (2010)	88590	0,46	-	-
Hilal, (2000)	394	0,82	-	-
Hsin-Yi Kung	2198	0,48	-	-
Awan et al, (2011)	336	0,535	-	-
Obilor, (2012)	300	-	20,55	
Andinny, (2013)	35	0,53	-	-
Alamsyah, (2016)	30	-	-	21,64
Suciati, (2016)	353	-	2,315	-
Handayani, (2017)	120	-	8,06	-
Hanifah et al, (2019)	33	0,41	-	-
Wirawan et al, (2018)	114	0,45	-	-
Parnata et al, (2014)	110	0,725	-	-
Katarina, (2017)	90	0,384	-	-
Emmanuel, et al, (2014)	120	0,72	-	-
Lee, et al, (2018)	1256	0,74	-	-
Setiadi, (2018)	490	0,39	-	-
Setiawan et al, (2015)	42	-	3,091	-
Ali et al, (2015)	144	0,288	-	-
Arrofah et al, (2015)	40	0,51	-	-
Ernawati, (2019)	284	0,452	-	-
Firdaus, (2017)	60		-	97,234
Tiorenna, (2011)	232	0,262	1,278	-
Nugroho, (2014)	74	0,926	-	-
Sihotang, (2012)	120	0,962	-	-
Tambunan, (2016)	98	-	5,857	-
Cresli et al, (2016)	171	0,609	3,479	-
Le, (2009)	170	-		-

There are 9 studies that do not have r values, so the t or F values in each study are converted to r values. Heterogeneity test results are presented in Table 2, and Table 3 below.

Table 2. Fixed and Random Effects

	Q	df	p
Omnibus test of Model Coefficients	90,25	1	< 0,001
Test of Residual Heterogeneity	839,09	27	< 0,001

Note. *p* -values are approximate.

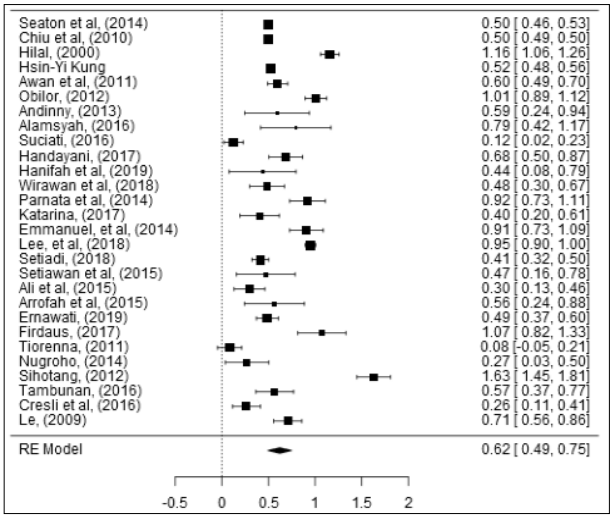

Figure 1. Forest Plot Random Effect Model

Table 3. Residual Heterogeneity Estimates

Estimate	
τ^2	0,1099
τ	0,3316
I^2 (%)	98,7516
H^2	80,1051

Q value with *p*-value < 0,05; τ^2 *or* $\tau > 0$*; and* I^2 (%) close to 100% shows that the sample used meets the assumption of *heterogeneity*, so the analysis that will be used in estimating the summary effect size and biased publication can use a random effect approach. The results of the effect size analysis are presented in the following form of forest plot (figure 1) and funnel plot (figure 2).

The value of summary effect size (M) generated from the whole study is 0,62 in the interval 0,49 to 0,75. The effect size of each study can be presented in the form of the following funnel plot.

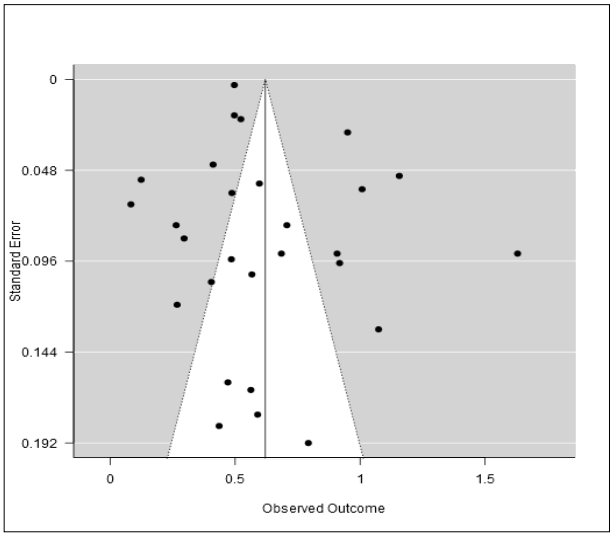

Figure 2. Funnel Plot Random Effect Model

The resulting funnel plot shows that black nocta is collected in funnel plot funnel, so in this study using a large sample. The next analysis is to test the hypothesis of the following research.

Ho: There is no positive and significant relationship between self concept and mathematics achievement

Ha: There is a positive and significant relationship between self concept and mathematics achievement

Based on M (0.62) and SE (0.07) values, a *Z* value is of 7,39. substituted Z value into the formula *p*-value = 1–NORMSDIST (7,39), so that the *p*-value = 0,00 < 0,05 (95% confidence interval). Thus the Ho hypothesis is rejected, meaning that there is a positive and significant relationship between self concept and mathematics achievement.

The next analysis is to check publication . The approach used to check biased publication is rank correlation test (table 4), regression test (table 5), and trim fill analysis. The results of the trym fill analysis estimation are presented in the following forest plot and funnel plot (figure 3).

Table 4. Rank correlation test for Funnel plot asymmetry

	Kendall's τ	P
Rank test	0,0585	0,664

Table 5. Regression test for Funnel plot asymmetry ("Egger's test")

	Z	p
sei	0,1932	0,847

Kendal value τ with *p*-value> 0,05; and the *Z* value with *p*-value> 0,05, it can be concluded that there is no publication bias. These results are supported by the funnel plot diagnostic trim-fill analysis.

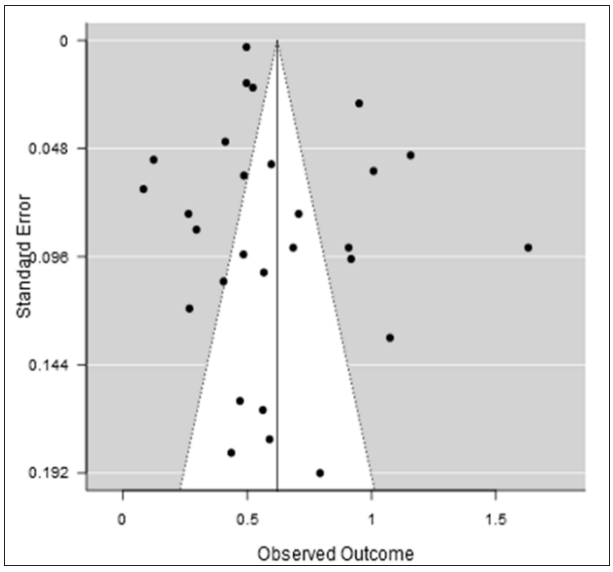

Figure 3. Funnel Plot diagnostik trim-fill analysis.

Figure 3 shows the funnel plot of the diagnostic results

using the trim-fill analysis approach. There is no difference shown in Figure 2. There is no addition of empty nokta (not full) which is a characteristic of biased publication, so it can be concluded that there is no biased publication.

5. Discussion

Based on a meta-analysis of 28 studies on the relationship between self-concept and mathematics learning achievement, there is a positive and significant relationship between self-concept and mathematics learning achievement (p-value <0,05). Students' self-concept has a significant role in mathematics learning achievement. The higher the student's self-concept, the higher the mathematics learning achievement [35]. A person who has a positive self-concept tends to be optimistic, does not give up easily and feels able to solve the problem that is being or will be faced. Thus, self-concept affects the ability and learning outcomes of mathematics [18].

The summary effect size resulting from the relationship between self-concept and mathematics learning achievement is 0,62 in the moderate category [22]. Summary effect sizes result because the standard error (ES) is small and the absence of publication bias. These results indicate that self-concept in learning mathematics is very important. Self-concept is an assessment of a person's ability to take mathematics lessons. When he feels capable of mathematics, he will follow the learning process in a fun and relaxed manner so that the material is easily digested. Conversely, if someone judges himself to be inadequate in mathematics, he will experience difficulties in following the learning process. The results obtained from these findings indicate that self-concept provides opportunities for students to solve a mathematical problem in other words, a good self-concept increases good mathematics learning achievement. Based on these findings, it was revealed that students 'self-concept can improve students' mathematics learning achievement [36]. Mathematical achievement will be high if someone has a good self-concept and vice versa, mathematics achievement will be low if someone has a bad self-concept [3]. Likewise with Le's finding which states that the higher a person's self-concept, the higher his mathematics achievement [21]. In addition, gender differences also affect students' level of self-concept and mathematics achievement . As with Chiu and Klassen's research, boys tend to have high self-concept when compared to girls, while girls have higher mathematics achievement when compared to boys [6]. According to Brooks and Emmerst, there are five signs that a person has a high or positive self-concept, namely: 1) he believes in his ability to solve problems, 2) he feels equal to others, 3) he receives praise without shame, 4) he realizes that everyone has various feelings, desires, and behaviors that are not fully agreed by society, and 5) he is able to improve himself because he is able to express aspects of personality that he does not like and try to change [28]. As Brooks and Emmerst views, one that influences the self-concept of mathematics is confidence in solving mathematical problems. In line with the findings of Bakar, et al, that problem solving beliefs are very important to improve the ability to solve mathematical problems correctly, because of the positive belief that students will get high mathematics achievement [33].

6. Conclusions

The result of residual heterogeneity estimates obtained value I^2 amounting to 98,7516% shows that the sample used meets the assumption of heterogeneity, so the analysis that will be used in estimating the summary effect size and biased publication can use a random effect approach. Based on M (0,62) and SE (0,07) values, a Z value is of 7,39. substituted Z value into the formula p-value = 1– NORMSDIST (7,39), so that the p-value = 0,00 < 0,05 (95% confidence interval). Thus the Ho hypothesis is rejected, meaning that there is a positive and significant relationship between self-concept and mathematics achievement. The resulting summary effect size is 0,62 which lies at 0,49 to 0,75 intervals. The summary effect size is categorized as a moderate effect, meaning that self-concept is considered to have a positive effect on improving mathematical achievement. The large size of the summary effects resulting from the analysis of random effects cannot be separated from the small standard error values generated and Kendal value τ with p-value> 0,05; and the Z value with p-value> 0,05 it can be concluded that there is no publication bias. No biased publications also show that the 28 studied studies were conducted with caution and *scientifically rigorous*. The results of this study are very useful theoretically in the development of educational psychology. The teacher in teaching of mathematics first must develop positive self-concepts to students. For future researchers who want to develop correlational meta-analysis studies with the same theme or construction, they are expected to be able to use more studies as data, so that the results can be generalized more broadly.

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