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Student Attitude and Mathematics Learning Success: A Meta-Analysis

Harun
Prof., Yogyakarta State University, Yogyakarta, Indonesia, *harun@uny.ac.id*

Badrun Kartowagiran
Prof., Yogyakarta State University, Yogyakarta, Indonesia, *kartowagiran@uny.ac.id*

Abdul Manaf
Doctoral student in Yogyakarta State University, Indonesia, *abdulmanaf.2017@student.uny.ac.id*

Some students consider mathematics as a subject that is very difficult and frightening, so it results in the success of learning mathematics. There are two factors that cause students' success in learning mathematics, namely internal and external factors. Students' attitudes is one of the internal factors that determine the success of learning mathematics. This study aims to prove the effect of student attitude on mathematics learning success. This type of research is quantitative meta-analysis. The variables of this study are students'attitudes as independent variables and students' mathematics learning success as dependent variables. Sources of data obtained from various research results in Indonesia since 2010-2019. Twenty-two samples of research publications were taken from online databases (google scholar, national & international journal) according to specified eligibility criteria. Data analysis using a meta-analysis approach. The results showed that there was a positive and significant influence on students' attitudes towards mathematics learning success, with the weight value of the effect size being within the specified confidence interval. The small amount of sampling error causes the effect size weight to be in the moderate category. These results have of course proven consistency and strengthened the theories or findings of previous researchers.

Keywords: student attitude, learning outcomes, learning achievement, mathematics, meta-analysis

INTRODUCTION

Mathematics is considered as the queen of science and has links with various other sciences (Atiyah, 1993). Mathematics is one of the basic lessons taught at every level of formal education, for example PAUD, SD, SMP, SMA, and University. Realizing the importance of the role of mathematics, it is hoped that every student can be able to

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master mathematics in accordance with the demands of the curriculum being taught. But it is an undeniable fact that until now the mastery of students in Indonesia over mathematics subject matter is still relatively low. In the context of education, based on the World Bank's 2018 report the acquisition of PISA participants from Indonesia is far lower than the average OECD country as shown in figure 1. The position of achieving the best value of Indonesian students is only the same as the lowest value of OECD countries. While Vietnam shows results that are superior to Indonesia (World Development Report, 2018).

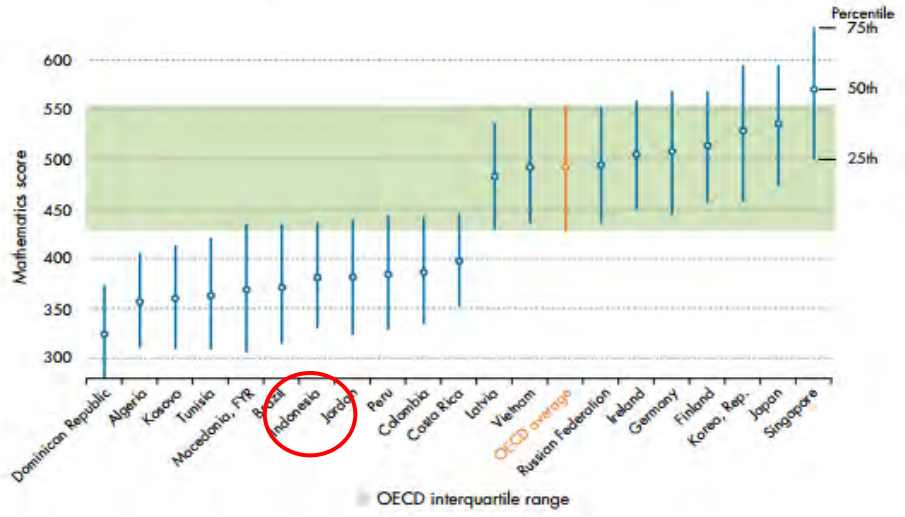


Figure 1
PISA assessment perforamance in 2015

Various efforts have been made by the Indonesian government and competent parties through the improvement of educational facilities and infrastructure as well as the improvement of mathematics learning methods. But in reality it has not shown significant changes. Some students still consider mathematics as a subject that is very difficult to learn or understand, so that it has an impact on the success of learning mathematics. The success of students' mathematics learning is influenced by both internal and external factors. Slameto (1995) states that external factors are socio-economic, natural or physical environment, social environment, school environment, and family environment. While internal factors are talent factors (Mazana&Mzomwe, 2019), or intelligence, motivation (Kirkham, 2019), roles, attitudes and interests. Many factors can affect the success of students' mathematics learning. However, among the factors that are generally considered more essential is the attitude of students (Peteros, et. al, 2019).

Students' attitudes is one of the factors that determine the success of students' mathematics learning (Capuno, et.al, 2019). A student who has a good attitude towards mathematics will have confidence (Makur, Prahmana, & Gunur, 2019) focusing more

attention than other subjects. Intensive focus on mathematics, allows students to study harder and ultimately achieve the desired results. And vice versa students who show less sympathetic attitude, are not passionate, and do not follow the process of teaching and learning mathematics in turn can make student learning outcomes or achievement low (Ozturk, 2014).

The positive attitude of mathematics students has shown to be, very influential on the success of mathematics students in Indonesia. This, shown from the results of several research results that have been published in *Google Scholar's* online database, include mathematics learning attitudes (Jemudin, 2019); and attitudes in learning mathematics (Ma'mun, 2017) affect mathematics learning achievement. Simplify scientific attitude (Haryaka & Haslida, 2019); independent attitude (Mujiono & Ladyawati, 2017); attitudes to mathematics (Sirajuddin, et. al., 2019); and constructive attitude (Labib, 2010) affect the learning outcomes of mathematics. The result of learning mathematics is the success obtained by each student in the field of mathematics after taking the teaching and learning process in one particular subject. Whereas mathematics learning achievement is the level of mastery of mathematics material achieved by students in one semester.

Based on the description above it can be concluded that students' attitudes influence the success of learning mathematics. So the authors are interested in conducting research with a quantitative meta-analysis approach to prove the effect of students' attitudes on the success of learning mathematics in Indonesia as well as to determine the value of the resulting effect size weight. Meta analysis can combine two or more published research results for statistical analysis. Meta-analysis is one of the right ways to provide information that can be accounted for in a timely manner.

METHOD

Research Design

This research is a quantitative meta-analysis (Hunter & Schmidt, 2004). Combine two or more published research results for statistical analysis. Research publications relate to the effect of students attitude on mathematics learning success

Eligibility Criteria

Hunter & Schmit (2004) stated that the completeness of information about artifacts is very important, so that corrections can be made in each individual study. The eligibility criteria used to filter the publication of research results online database are:

1. Must be the result of research in Indonesia
2. It must be the result of original research, not a review
3. Can be accessed on google scholar, national journal, and internasional journal
4. Publication at least since 2010
5. Available in Indonesian or English
6. Must be related to student attitude and success in learning mathematics
7. The variable of mathematics learning success is limited to mathematics learning outcomes and mathematics learning achievement

8. Every research publication must have a minimum sample of 15 participants
9. Must have a correlation coefficient (r) or a terminated coefficient that indicates the amount of influence produced by student attitude variables on the mathematics learning success variable

Thus, the nine criteria above are considered suffcient to be used in filtering or selecting research result (artifacts) that are the object of the meta-analysis.

Data Collection

Data collection in this study was conducted by studying the results of research on the influence of students' attitudes on learning outcomes in mathematics. The results of these studies are accessed via the internet in google scholar online database. The keywords used to make in the search are *student attitude, mathematics learning outcomes, and student mathematics learning achievement*. From the search results found 22 research publications that met the criteria specified above with the time span of publication from 2010 to 2019 (Table 1). Hunter & Schimidt (2004) stated that if there were only 10 studies studied, it would be said to be a little. Therefore, this study involved 22 research titles, which means a lot can be said.

Coding

In this research coding needs to be done. The aim is to facilitate the author in the process of data analysis. Components in coding are information about the year of research, researcher or author, sample size (N), correlation coefficient (r) or terminated coefficient, and variables (independent and dependent)

Data analysis

The steps of data analysis in this study refer to the opinion of Hunter & Schmidt (2004), Borenstein. et.al, (2009)., and Grasman (2017), namely calculating the mean population correlation, calculating the variance of the coefficient r, sampling error variance, calculating the estimated population correlation variance, calculating confidence intervals, effect sized based on correlations, forest plots, and publication bias / trim-fill analysis. To facilitate data analysis in this study using JASP software tools. 0.8. 4.0

FINDINGS

Characteristics of Research Samples

Based on the eligibility criteria determined above, as many as 22 research publications were obtained that met all the specified criteria. Research publications that will be used in the analysis are from 2010 to 2019, except for 2012 and 2013. The number of samples of each research publication is highly variable. The sample size is small with N = 18, and the largest sample with N = 360. Participants in the research varied greatly, including junior high, MTs, vocational, and high school students. Student attitude variables are constructive attitude, attitude in learning, independent attitude, scientific attitude, and learning attitude. While the students mathematics learning success variables are learning outcomes and learning achievement. The detailed characteristics of the study sample are presented in table 1 below.

Table 1
Characteristics of study samples

Year	Author	N	Characteristics	Variable	
				Independent	Dependent
2010	Labib,F	40	Student SMA, Class X	Constructive attitude	Learning outcomes
2011	Nurhayati	320	Student SMP, Class VIII	Learning attitude	Learning outcomes
2014	Erviana, L	235	StudentSMP, Class VIII	Attitudes on subjects	Learning outcomes
2015	Susilo, T. A. B., & Agustin, I	36	Student SMP, Class VIII	Attitudes on subjects	Learning outcomes
2015	Jainuri, M	18	Student SMK, Class XI	Learning attitude	Learning achievement
2015	Sulani & Palupi, R.H	62	Student SMA, Class XI	Learning attitude	Learning achievement
2015	Hakim, A. R	130	Student SMA, Class X	Attitudes on subjects	Learning achievement
2015	Ali, M.,Setyosari, P.,Dwiyogo, W. D., & Napitupulu, M.	144	Student SMA, Class XI	Attitudes on learning	Learning outcomes
2016	Lambertus, Ambarsari, M., & Maonde, F	90	Siswa SMP, Class VIII	Attitudes on learning	Learning outcomes
2016	Purnomo, P	72	Student SMP, Class VIII	Learning attitude	Learning achievement
2016	Hakim, A. R	67	Student SMP, Class VII	Attitudes on subjects	Learning achievement
2017	Asmarani, D	51	Student SMP, Class VII	Learning attitude	Learning outcomes
2017	Ma'mun, K	56	Student SMK, Class XI	Attitude in learning	Learning achievement
2017	Mujiono, L.A., & Ladyawati, E	40	Student SMP, Class VIII	Independent attitude	Learning outcomes
2018	Rahman, A	45	Student SMP, Class VIII	Attitude in learning	Learning achievement
2018	Ventini,M., Hartati, & Sukardjo, M	150	Student SMA, Class XI	Attitudes on subjects	Learning outcomes
2019	Ningsih,S., Haryaka, U., & Watulingas, J.R	183	Student SMP, Class VII	Learning attitude	Learning outcomes
2019	Sirajuddin, Arsyad, N., & Ma'rufi	130	Student MTS, Class VIII	Attitudes on subjects	Learning outcomes
2019	Biloa, W	26	Siswa SMP, Class VIII	Attitudes on subjects	Learning outcomes
2019	Susilowati, T	32	Student SMP, Class VII	Attitudes on subjects	Learning outcomes
2019	Haryaka, U & Haslida	360	Student SMP, Class VII	Scientific attitude	Learning outcomes
2019	Jemudin.,Makur., & Ali	46	Student SMP, Class VII	Learning attitude	Learning achievement

Information:
SMP = Junior high school
MTs = Tsanawiyah School
SMA = Senior High School
SMK = Vocational high School

Sampling Error Correction

There are two stages in correction of sampling error, namely calculating the correlation correlation and calculating the population correlation variance. The results of the analysis are presented in table 2 and table 3 below.

Table 2
Average population correlation

Sample no	N	r_{xy}	N.r_{xy}
1	40	0,499	19,960
2	320	0,327	104,64
3	235	0,688	161,68
4	36	0,475	17,100
5	18	0,491	8,838
6	62	0,521	32,302
7	130	0,479	62,270
8	144	0,258	37,152
9	90	0,517	46,530
10	72	0,675	48,600
11	67	0,214	14,338
12	51	0,307	15,657
13	56	0,720	40,320
14	40	0,606	24,240
15	45	0,510	22,950
16	150	0,639	95,850
17	183	0,147	26,901
18	130	0,283	36,790
19	26	0,523	13,598
20	32	0,566	18,112
21	360	0,343	123,48
22	46	0,430	19,780
Total	2333	10,218	991,088

Based on the table above, the mean population correlation values were obtained using the formula suggested by Hunter & Schmidt (2004) below.

$$r = \frac{\sum \lfloor N_i \; r_{xy} \rfloor}{\sum N_i} = \frac{991{,}088}{2333} = 0,425$$

The mean value of r is 0,425 which indicates there is a significant positive correlation between student attitudes and mathematics learning success. Calculating population correlation variance is a stage of analysis that must be considered. Variation of population correlation indicates a deviation from the correlation results of each study with the average correlation of all studies. Results of the analysis of population correlation variance are presented in table 3 below.

Table 3
Population correlation variance

Sample no	N	r_{xy}	N.r_{xy}	(r_{xy}-r)	(r_{xy}-r)^2	N.(rxy-r)^2
1	40	0,499	19,960	0,055	0,003	0,121
2	320	0,327	104,64	-0,117	0,014	4,380
3	235	0,688	161,68	0,244	0,060	13,991
4	36	0,475	17,100	0,031	0,001	0,035
5	18	0,491	8,838	0,047	0,002	0,040
6	62	0,521	32,302	0,077	0,006	0,368
7	130	0,479	62,270	0,035	0,001	0,159
8	144	0,258	37,152	-0,186	0,035	4,982
9	90	0,517	46,530	0,073	0,005	0,480
10	72	0,675	48,600	0,231	0,053	3,842
11	67	0,214	14,338	-0,230	0,053	3,544
12	51	0,307	15,657	-0,137	0,019	0,957
13	56	0,720	40,320	0,276	0,076	4,266
14	40	0,606	24,240	0,162	0,026	1,050
15	45	0,510	22,950	0,066	0,004	0,196
16	150	0,639	95,850	0,195	0,038	5,704
17	183	0,147	26,901	-0,297	0,088	16,142
18	130	0,283	36,790	-0,161	0,026	3,370
19	26	0,523	13,598	0,079	0,006	0,162
20	32	0,566	18,112	0,122	0,015	0,476
21	360	0,343	123,48	-0,101	0,010	3,672
22	46	0,430	19,780	-0,014	0,000	0,009
Total	2333	10,218	991,088	0,450	0,542	67,946

Based on the table above, the population correlation variance values are obtained using the formula suggested by Hunter & Schmidt (2004) below.

$$\sigma_r^2 = \frac{\Sigma\left[N_i\left(r_{xy}-r\right)^2\right]}{\Sigma N_i} = \frac{67,946}{2333} = 0,029$$

Correlation variance value of 0,029 means that the combined value of variance in population correlations and variance in sample correlations obtained from sampling errors. Correct variance correlation value is obtained from

$$\sigma_{po}^2 = \sigma_r^2 - \sigma_e^2 = 0,029 - 0,006 = 0,023$$

The value of the population correlation variance of 0.023 means that the score of each population of each study studied has a small deviation from the average correlation of the population of the entire study. While the confidence interval is obtained by using a formula $r \pm 1,96\,\sigma_{po} = r \pm 0,297$, so obtained $0,128 < r < 0,722$. Thus the

correlation value of 0,425 is within the region of receipt of the interval. In addition, the value of 0,425 is in the moderate category. Thus the attitude of students towards the achievement of learning mathematics is positively correlated.

The next stage in the meta-analysis is to calculate the weight of the effect size and make a confidence interval. The results of the analysis are shown in table 4 below.

Table 4
Tabulation of fixed effect model data

N	Rxy	$Y_{(Z)}$	V_y	SE_{Vy}	W	W.Y	$W.Y^2$	W^2
40	0,499	0,548	0,027	0,164	37	20,275	11,110	1369
320	0,327	0,339	0,003	0,056	317	107,611	36,530	100489
235	0,688	0,844	0,004	0,066	232	195,842	165,320	53824
36	0,475	0,517	0,030	0,174	33	17,045	8,804	1089
18	0,491	0,537	0,067	0,258	15	8,061	4,332	225
62	0,521	0,578	0,017	0,130	59	34,085	19,691	3481
130	0,479	0,522	0,008	0,089	127	66,254	34,564	16129
144	0,258	0,264	0,007	0,084	141	37,219	9,825	19881
90	0,517	0,572	0,011	0,107	87	49,785	28,489	7569
72	0,675	0,820	0,014	0,120	69	56,571	46,381	4761
67	0,214	0,217	0,016	0,125	64	13,911	3,024	4096
51	0,307	0,317	0,021	0,144	48	15,227	4,830	2304
56	0,720	0,908	0,019	0,137	53	48,105	43,662	2809
40	0,606	0,703	0,027	0,164	37	25,995	18,264	1369
45	0,510	0,563	0,024	0,154	42	23,635	13,300	1764
150	0,639	0,756	0,007	0,082	147	111,203	84,123	21609
183	0,147	0,148	0,006	0,075	180	26,653	3,947	32400
130	0,283	0,291	0,008	0,089	127	36,949	10,750	16129
26	0,523	0,580	0,043	0,209	23	13,351	7,749	529
32	0,566	0,642	0,034	0,186	29	18,607	11,939	841
360	0,343	0,357	0,003	0,053	357	127,623	45,624	127449
46	0,430	0,460	0,023	0,152	43	19,776	9,095	1849

Based on the above table, the results of the transformation of sample correlation (r) to fisher's z (Y_z) are obtained. It also obtained the variance z (V_Y) and standard error (SE_{Vy}). The smallest standard error value is 0,053 and the largest standard error value is 0,258. The results of the calculation of the total number of weights multiplied by the effect size divided by the total number of weights obtained by the average value of the effect size weight (M) is 0,474. Furthermore, the value of the variance of the weighted average (V_M) is 0,00044 and the standard error (SEM) is 0,021. While the confidence interval is obtained by using the formula $M \pm 1,96\, SE_M = M \pm 0,021$, so obtained $0,43 < x < 0,51$ .Thus the average value of the effect size weight (M), which is 0,474 in the area of the interval reception and is in the moderate category, so that the attitude of students and the achievement of learning mathematics gives a positive zize effect.

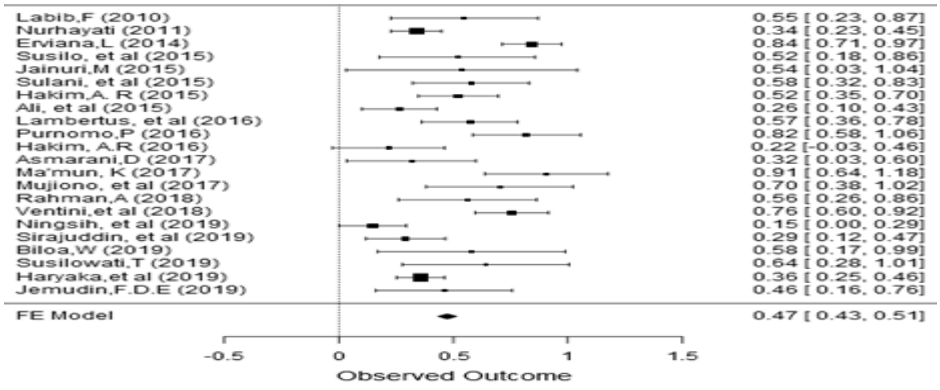
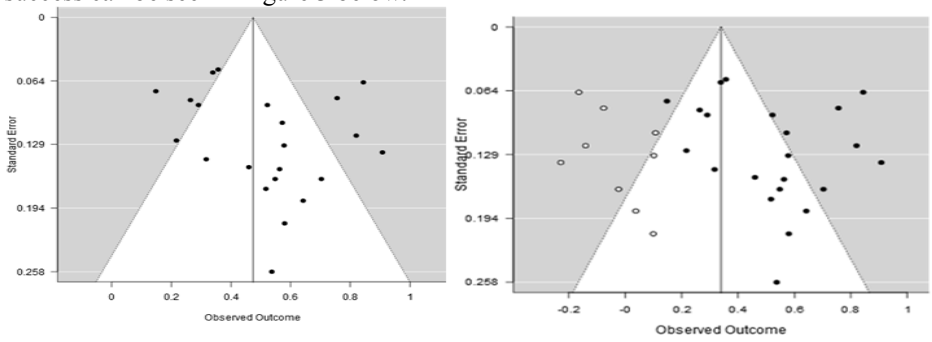


Figure 2
The forest plot summary effect

The next stage in the meta-analysis is to make a forest plot. The results of the analysis obtained forest plots for each study result marked by a square sign along the x-axis. The order of each research result is displayed in accordance with the order of data from 2010 to 2019. The estimated effect size of the combined meta-analysis is indicated by the symbol (diamond) below the plot line and comprehensively visualizes, as well as the potential heterogeneity of research results (figure 2)

Based on the forest plot summary effect above it is known that the diamond width is 0,474 at a 95% confidence interval. While the confidence intervals for each study sample are indicated by their respective plots. The calculation result of Z value is 22,552; so that the p-value <0,05 is obtained. Based on the results of one-party test, there was a rejection of the null hypothesis (Ho). It can be said that students' attitudes significantly influence the success of learning mathematics.

The next stage in the meta-analysis is checking publication bias. The results of the bias analysis of 22 research publications on students' attitudes towards mathematics learning success can be seen in figure 3 below.



(a) (b)

Figure 3
Funnel plot of the summary effect related to publication bias

Figure 3 (a) shows the funnel plot prior to the addition of the publication. It appears that there is a publication bias. So that it can be said that in 22 research publications the influence of student attitudes on mathematics learning success found no evidence of publication bias. Whereas Figure 3 (b) shows the funnel plot after adding additional publications to the trim-fill analysis approach. It appears that the funnel was found asymmetrical. Addition will have a maximum impact on the effect size.

DISCUSSION

The results of a meta-analysis of 22 research publications in Indonesia, show that there is a positive and significant influence on students' attitude towards the success of learning mathematics. These results are in line with the results of Al-Mutawah & Fateel research (2018) which states that attitude towards mathematics are positively and significantly correlated with academic achievement in mathematics. This significant correlation is due to the small variance value of the weighted average (VM) of 0,00044 and the standard error (SEM) of 0,021. These results certainly prove the consistency and strengthen the theories or findings of previous researchers. Mathematical learning attitude, attitude in learning mathematics, scientific attitude, independent attitude, attitude to mathematics lessons, and constructive attitude are components of student attitude variables that correlate to the success of learning mathematics. While learning outcomes and mathematics learning achievements are measures of student learning success variables.

The mean value of 0,474 is the weight of the effect size of the effect of students' attitudes on mathematics learning success. The effect size weights are in the moderate category (Cohen, et. al, 2007). Thus, the positive attitudes of students towards mathematics is one of the factors that in influence students' willingness to learn mathematics, so that mathematics learning goals can be achieved and students get high math scores.

The success of learning mathematics obtained by previous students will have an impact on the success of subsequent mathematics (Kiss, 2018). Attitude toward mathematics can be improved through the learning process approach (Perry, et al., 2016). Good mathematics learning needs to be supported by the teacher's ability to deliver material, choose models, approaches, and learning methods. The selection of the right mathematics learning model can make students happy, active, innovative, creative, and independent in the learning process. Thus the material learned or taught will be easily understood by students. Information about students' attitudes towards the success of students mathematics learning can help teachers in mathematics in the learning process.

Many factors affect student attitudes including family, strengthening of parents and teachers, teaching, and school / classroom climate (Papanastasiou, 2002). In addition, students' mathematical attitudes are influenced by three factors: First; Content coverage includes teaching materials, content emphasis, task orientation, and task based on daily life situation. Second; teaching practice is instructional method. The three teaching qualities are classroom management, classroom organization, and learning environment (Ayob & Yasin, 2017).

The variation in correlation values obtained between student attitude and mathematics learning success is due to the measurement of student attitude variables that are subjective and difficult. Attitude measurement generally uses a non-test instrument (questionnaire) with a Likert scale. While the measurement of student learning success uses the test of learning outcomes or mathematics learning achievement. According to Hamdi, Kartowagiran, & Haryanto (2018) that measurement is related to several things that occur during the learning process, especially evaluation and assessment. Thus the measurement of student attitude and mathematics learning success is related to evaluation and assessment. Apart from this, student attitude variables are considered very important in the success of learning mathematics (Diggs, 2016). Based on a sample of research publications, there were 14 publications related to the influence of students' attitudes toward learning outcomes and 8 publications related to learning achievement. This provides information that research related to student attitudes is very attractive to researchers in Indonesia. The results of checking publication bias with meta-analysis found evidence of publication bias, so it is necessary to add publications in the analysis to maximize effect size. But according to Grasman (2017) that the method still causes a lot of contradiction or debate from the meta-analysis experts.

CONCLUSION

Students' attitudes is very important in achieving success in learning mathematics, because attitude is a factor that originates in students. Researchers generally measure students' attitudes using non-test instruments, while students' tests are used to determine students' learning success. Measures of student learning success are learning outcomes and mathematics learning achievements. Correlation values from each sample of research publications affect the attitude of students to the success of learning mathematics, used as data in meta-analysis. The sample data used has varying coefficients and is positive. A meta-analysis study has provided information that there is a positive and significant influence on students' attitudes toward mathematics learning success with an effect size weight value of 0,474 in the moderate category. The weight value of the effect size is between 0,453 to 0,495 intervals. This significant correlation is due to the small sampling error. In addition, the value of the variance of the weighted average (V_M) is 0,00044 and the standard error (SEM) which is 0,021 is still relatively low. These results certainly prove and strengthen the theories or findings of previous researchers. But the results of this study still have sample size limitations. The sample taken does not represent the population of students in Indonesia. In addition, the need for additional publications in the analysis is desired to avoid publication bias and obtain a maximum effect size.

The meta-analysis research has shown the consistency of the publication of the results of research on the influence of students attitude towards the success of learning mathematics in Indonesia, so that the variable of student attitudes should be a concern of teachers in teaching mathematics material at every level of formal education. Teachers in learning must be able to foster students' mathematical attitude.

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