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[ERIES] Submission Acknowledgement

 **From** Igor Krejčí <editor@eriesjournal.com>
To Muhamad Chamdani <muhamad_chamdani@staff.uns.ac.id>, Furtasan Ali Yusuf <fay@binabangsa.ac.id>, Moh Salimi <salimi@staff.uns.ac.id>
Date 2022-03-02 12:12

Dear madame or sir,

Laksmi Evasufi Widi Fajari has just submitted the manuscript "Meta-Analysis Study: The Relationship Between Reflective Thinking And Learning Achievement" to Journal on Efficiency and Responsibility in Education and Science. You have been included as a co-author of this manuscript. If you are not a co-author of this manuscript or you have any questions, please do not hesitate to contact us on editor@eriesjournal.com.

Kind regards

Igor Krejčí

Executive editor, ERIES Journal

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March 6, 2022 Article Text

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Pre-Review Discussions

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▶ Suggested expert reviewers and comments for the Editor	evasufilaksmi97	-	0	<input type="checkbox"/>
	2022-03-06 03:23 PM			

Laksmi Evasufi Widi Fajari
Universitas Bina Bangsa,
Banten, Indonesia

Editor-in-Chief

Prof. RNDr. Jaroslav Havlíček, CSc.,
Czech University of Life Sciences Prague,
Czech Republic

I am pleased to submit an original research article entitled, “**Meta-Analysis Study: The Relationship Between Reflective Thinking And Learning Achievement**” by Muhamad Chamdani, Furtasan Ali Yusuf, Moh Salimi & Laksmi Evasufi Widi Fajari for consideration for publication in *The Journal on Efficiency and Responsibility in Education and Science (ERIES Journal)*. Because the reflective thinking is the most important skill in encouraging learning during complex problem-solving situations because it allows students to step back and think about how to solve the problem and how a set of problem-solving strategies is accomplished to achieve their goals which is manifested in learning achievement. Several studies mention that reflective thinking contributes to learning achievement. However, among the phenomena or problems studied in this research, no research has examined the relationship between reflective thinking and learning achievement comprehensively. One alternative to thoroughly analyze the relationship between reflective thinking and learning achievement is by using meta-analysis study.

Therefore, this study aims to prove and determine the relationship between reflective thinking and learning achievement and its effect size. Furthermore, this study results show that 22 research publications met the predetermined criteria through a strict screening. Quantitative meta-analysis with correlation meta-analysis type was used to analyze the data. The software used was JASP 0.8 4.0. The results showed that there was a significant relationship between reflective thinking and student achievement. The effect of reflective thinking on student achievement was in the medium category.

I want to publish this article with *The Journal on Efficiency and Responsibility in Education and Science (ERIES Journal)* because it has specific link to the journal’s aims & scope. Our manuscript is so useful to improve theory about teaching and learning, pedagogic policy maker, education policy maker and higher order thinking skills education paradigm.

This manuscript has not been published and is not under consideration for publication elsewhere. We have no conflicts of interest to disclose.

Expert reviewer suggestion:

1. Prof. Dr. Siti Irene Astuti Dwiningrum, Universitas Negeri Yogyakarta, Indonesia, e-mail: siti_ireneastuti@uny.ac.id
2. Dr. Rif’at Shafwatul Anam, Universitas Terbuka, Indonesia. e-mail: rifat.official@ecampus.ut.ac.id

Thank you for your consideration!

Sincerely,
Laksmi Evasufi Widi Fajari

Laksmi Evasufi Widi Fajari

Universitas Bina Bangsa,

Banten, Indonesia

Editor-in-Chief

Prof. RNDr. Jaroslav Havlíček, CSc.,

Czech University of Life Sciences Prague,

Czech Republic

I am pleased to **resubmit** my original research article entitled, “**Meta-Analysis Study: The Relationship Between Reflective Thinking And Learning Achievement**” by Muhamad Chamdani, Furtasan Ali Yusuf, Moh Salimi & Laksmi Evasufi Widi Fajari for consideration for publication in *The Journal on Efficiency and Responsibility in Education and Science (ERIES Journal)*. Because the reflective thinking is the most important skill in encouraging learning during complex problem-solving situations because it allows students to step back and think about how to solve the problem and how a set of problem-solving strategies is accomplished to achieve their goals which is manifested in learning achievement. Several studies mention that reflective thinking contributes to learning achievement. However, among the phenomena or problems studied in this research, no research has examined the relationship between reflective thinking and learning achievement comprehensively. One alternative to thoroughly analyze the relationship between reflective thinking and learning achievement is by using meta-analysis study.

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This manuscript has not been published and is not under consideration for publication elsewhere. We have no conflicts of interest to disclose.

Expert reviewer suggestion:

1. Dr. Siti Irene Astuti Dwiningrum, Universitas Negeri Yogyakarta, Indonesia, e-mail: siti_ireneastuti@uny.ac.id
2. Rif'at Shafwatul Anam, Universitas Terbuka, Indonesia. e-mail: rifat.official@ecampus.ut.ac.id

Thank you for your consideration!

Note: I have corrected the paper based on the previous editor's revision request by marking it with a yellow highlight in the file that I will resubmit.

Sincerely,

Laksmi Evasufi Widi Fajari



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Round 4 Status

Submission accepted.

Notifications



[ERIES] Editor Decision	2022-04-20 01:27 PM
[ERIES] Editor Decision	2022-05-25 09:03 AM
[ERIES] Editor Decision	2022-06-20 10:30 AM
[ERIES] Editor Decision	2022-07-15 12:12 PM
[ERIES] Editor Decision	2022-08-08 11:04 AM

Reviewer's Attachments

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Revisions

- | | | | | |
|---|--|---|---------------------|--------------------------------------|
| ▶ |  3436 | Manuscript+Final+Version_Edit (1).docx | July
15,
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| ▶ |  3437 | ERIES_Replies to Reviewers -Round 4.doc | June
29,
2022 | Replies to
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Review Discussions

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▶ Revised Manuscript	evasufilaksmi97 2022-05-07 04:57 AM	evasufilaksmi97 2022-06-29 08:32 AM	7	<input checked="" type="checkbox"/>
▶ Final Revision	evasufilaksmi97 2022-06-29 08:31 AM	krejci 2022-07-04 10:08 AM	3	<input checked="" type="checkbox"/>
▶ Final Revision Edited	evasufilaksmi97 2022-07-13 04:38 AM	-	0	<input checked="" type="checkbox"/>

Dear Muhamad Chamdani, Furtasan Ali Yusuf, Moh Salimi, Laksmi Evasufi Widi Fajari,

Let us know that we have reached a decision regarding your manuscript "Meta-Analysis Study: The Relationship Between Reflective Thinking And Learning Achievement" submitted to Journal on Efficiency and Responsibility in Education and Science.

Our decision is: Revisions Required

Please follow the reviewers' comments and recommendations and revise carefully your manuscript. After the completed revision, please resubmit your revised manuscript, along with Replies to reviewers' comments document, into the ERIES Journal system.

In case of any questions or doubts, please do not hesitate to contact us.

Kind regards,

Igor Krejčí

Reviewer A:
Recommendation: Revisions Required

Originality of the work:

Acceptable

Relevance of the work:

Acceptable

Organization of the manuscript:

Acceptable

Research methodology and treatment:

Marginal

Significance of presented results:

Acceptable

Correctness of English:

Good

Clarity in writing, tables and figures:

Marginal

Citations and references to other works:

Poor

Text of the review

1. What gaps and problems will this research cover in the field? More explanation is needed on these subjects.
2. There is not enough explanation as to whether the research data provide the necessary assumptions for testing.
3. In the discussion section is very similar to the literature, and there was not enough discussion.
4. Highlights are not convincing.
5. Tables 1, 2, 3 and figures 1 and 2 were not mentioned in the text.
6. Follow the instructions for authors in the reference section.

Reviewer B:

Recommendation: Revisions Required

Originality of the work:

Good

Relevance of the work:

Good

Organization of the manuscript:

Good

Research methodology and treatment:

Marginal

Significance of presented results:

Marginal

Correctness of English:

Acceptable

Clarity in writing, tables and figures:

Acceptable

Citations and references to other works:

Acceptable

Text of the review

The paper is interesting, however, contains some crucial problems that must be addressed before I can suggest the publication.

1. The highlights should be about what have you achieved. It should work as a hook. Be more specific.

2. The approach is interesting but the fact that no journal is indexed in WoS in some "higher" index significantly reduces the findings of the research. This is crucial – the sample should be expanded by more significant journals.

3. Use italics for variables (N , t , F ...).

4. Instructions for authors specify how the equations should be formatted.

5. Why the "sei" in table 6 isn't explained.

6. Instructions for authors clearly specify the required referencing style. The list of references ignores that (Vol., No. pp. use of dots and upper commas, sometimes the whole title of the publication isn't written...).

7. Statistical tests usually do not confirm anything. You reject or fail to reject the hypothesis (you can't accept the hypothesis). This is another point – the hypothesis testing is point 7 in the data analysis in MaM section. Nevertheless, no hypothesis is specified and consequently rejected or failed to reject.

8. Discussion is very shallow, it is a crucial part of the paper. Here you compare your findings with the findings of other authors and interpret the differences or similarities.

9. Why no reference to the journal that you are submitting to? I am familiar that editors of ERIES journal do not require it but in general it supports the relevance of the paper to the journal.

REPLIES TO REVIEWERS' COMMENTS

Title of the paper: META-ANALYSIS STUDY: THE RELATIONSHIP BETWEEN REFLECTIVE THINKING AND LEARNING ACHIEVEMENT

Reviewer 1

Comment 1: What gaps and problems will this research cover in the field? More explanation is needed on these subjects.

Reply 1: Studies related to reflective thinking and its relationship to learning achievement tend to be carried out partially or only part in certain situations, so that it is difficult to see as a whole.

Comment 2: There is not enough explanation as to whether the research data provide the necessary assumptions for testing.

Reply 2: An incomplete study has several drawbacks, such as: the research results are often biased, the research results only apply to certain situations, and the research results are difficult to apply to other situations.

Comment 3: In the discussion section is very similar to the literature, and there was not enough discussion.

Reply 3: We have added data interpretation to support the discussion section.

Comment 4: Highlights are not convincing.

Reply 4: Highlights have been revised to be more specific.

Comment 5: Tables 1, 2, 3 and figures 1 and 2 were not mentioned in the text.

Reply 5: Tables 1, 2, 3 and Figures 1 and 2 have been mentioned in the text.

Comment 6: Follow the instructions for authors in the reference section.

Reply 6: Reference writing is in accordance with the instructions for authors.

Reviewer 2

Comment 1: The highlights should be about what have you achieved. It should work as a hook. Be more specific.

Reply 1: Highlights have been revised to be more specific.

Comment 2: The approach is interesting but the fact that no journal is indexed in WoS in some "higher" index significantly reduces the findings of the research. This is crucial – the sample should be expanded by more significant journals.

Reply 2: The reason why there are no "higher" indexed WoS journals is the criteria for the articles analyzed. There are several article criteria that are used as a benchmark to find articles that match the theme of this research (already explained in the methods section). So that, the focus of the search for analyzed articles is not from the article index but fixated on the article criteria that have been determined.

Comment 3: Use italics for variables (N, t, F...).

Reply 3: It's written in italics.

Comment 4: Instructions for authors specify how the equations should be formatted.

Reply 4: The writing of the formula in the article is in accordance with the instructions for author.

Comment 5: Why the "sei" in table 6 isn't explained.

Reply 5: The sei in the table is the default of the JASP software calculations.

Comment 6: Instructions for authors clearly specify the required referencing style. The list of references ignores that (Vol., No. pp. use of dots and upper commas, sometimes the whole title of the publication isn't written...).

Reply 6: The writing of references in the body of the article has been revised.

Comment 7: Statistical tests usually do not confirm anything. You reject or fail to reject the hypothesis (you can't accept the hypothesis). This is another point – the hypothesis testing is point 7 in the data analysis in MaM section. Nevertheless, no hypothesis is specified and consequently rejected or failed to reject.

Reply 7: The meta-analysis method in this study is one of the critical and evasive systematic research methods using formal statistical methods so that basically this research does not prove any hypothesis but reviews several articles with the same theme through predetermined statistical techniques. Therefore, this study compares the various effect sizes of each study and is reported in the form of combinations or conclusions with Cohen's effect size as a standard for the effect size of the overall effect of the analyzed study.

Comment 8: Discussion is very shallow, it is a crucial part of the paper. Here you compare your findings with the findings of other authors and interpret the differences or similarities.

Reply 8: The meta-analysis method is a quantitative research method by analyzing quantitative data from the results of previous studies to accept or reject the hypotheses proposed in these studies. So, the focus is on acceptance and rejection, not comparisons with other studies, because actually research with similar themes will definitely be analyzed in a meta-analysis called secondary data.

Comment 9: Why no reference to the journal that you are submitting to? I am familiar that editors of ERIES journal do not require it but in general it supports the relevance of the paper to the journal.

Reply 9: References from the editor of ERIES have been included.

META-ANALYSIS STUDY: THE RELATIONSHIP BETWEEN REFLECTIVE THINKING AND LEARNING ACHIEVEMENT

ABSTRACT

Reflective thinking is a must-have skill to connect the knowledge obtained with previous knowledge and can be seen from learning achievement. This study aims to prove and determine the relationship between reflective thinking and learning achievement and its effect size. This study used quantitative meta-analysis method. Reflective thinking is the independent variable and learning achievement is the dependent variable. The data sources were obtained from online database searches on Google Scholar and international journal platforms from 2012 to 2021. Based on the search, 22 research publications met the predetermined criteria through a strict screening. Quantitative meta-analysis with correlation meta-analysis type was used to analyze the data. The software used was JASP 0.8 4.0. The results showed that there was a significant relationship between reflective thinking and student achievement ($z = 8.139$; $p < 0.001$; 95%CI [0.400; 0.654]). The effect of reflective thinking on student achievement was in the medium category ($r_{RE} = 0.527$). The findings are consistent with those of previous research on reflective thinking skills and learning achievement.

Keywords: Learning Achievement; Meta-analysis Study; Reflective Thinking.

Research Highlight:

The assessment of 22 studies about reflective thinking

The relationship between reflective thinking and learning achievement around the world

The first meta-analysis study that tests the universality of this relationship among participants from different countries

INTRODUCTION

Developing students' higher-order thinking skills (HOTS) is a complex multidimensional educational challenge. This thinking skill is part of the general skills that must be trained to students in all subjects to improve their performance and reduce their weaknesses (Arif, 2019). According to Qasrawi & Beni Abdelrahman (2020), cognitive processes of analysis, evaluation, and creation in Bloom's taxonomy are grouped into HOTS while knowledge, understanding, and application are grouped into LOTS. Yen & Halili (2015) state that thinking skills, especially HOTS, are the main benchmark in achieving learning objectives. Included in HOTS are critical thinking, logical thinking, reflective thinking, metacognition, and creative thinking. One of HOTS is reflective thinking (Setiawan et al., 2021; Dwyer, Hogan & Stewart, 2014).

Reflective thinking is a thinking activity that can make students try to connect the knowledge they have acquired to solve new problems related to their old knowledge (Choy & Oo, 2011). Khalid et al. (2020) state that the process of reflective thinking can be described as information or data that is used to respond, comes from within (internally), can explain what has been done, realize mistakes and correct them, and communicate ideas with symbols or images instead of a direct object. Reflective thinking is part of the critical thinking process which refers to the process of analyzing and making judgments about what has happened. Reflective thinking is the most important skill in encouraging learning during complex problem-solving situations because it allows students to step back and think about how to solve the problem and how a set of

problem-solving strategies is accomplished to achieve their goals (Shavit & Moshe, 2019; Orakci, 2021).

According to Dewey (Ozudogru, 2021), reflective thinking means being active, continuous, persistent, and carefully considering everything that is believed to be true or the format of knowledge with supporting reasons leading to a conclusion. Boody, Hamilton, and Schon (Ozudogru, 2021) explain the characteristics of reflective thinking as follows: (1) reflection as retrospective analysis or recall (ability to judge oneself), (2) reflection as a problem-solving process (awareness of how one learns), (3) self-critical reflection (developing self-improvement continuously), and (4) reflection on self-confidence and success. Students who have a reflective style tend to spend more time responding and reflecting on the accuracy of answers. Reflective individuals are very slow and careful in responding but tend to give correct answers (Kholid et al., 2020). Reflective students are more likely to perform tasks such as remembering structured information, reading by understanding and interpreting texts, solving problems, and making decisions. They may also determine their own learning goals and concentrate on relevant information. They usually have high work standards (Choy & Oo, 2011; Kablan & Gunen, 2021).

Empowering reflective thinking skills is the task of all levels of education. Belief in reflective thinking plays an important role because it is closely related to how students can evaluate themselves (Safari, Davaribina & Khoshnevis, 2020). Reflective thinking can also be used to encourage thinking processes during problem-solving because, with reflective thinking, students can predict the correct answer immediately so that they can explore problems by identifying the concepts involved, using various strategies, building ideas, drawing conclusions, re-examining solutions, and developing alternative strategies (Mirzaei, Phang & Kashefi, 2014a; Kablan & Gunen, 2021).

In addition, Qasrawi & Beni Abdelrahman (2020) state that HOTS is closely related to thinking skills following the cognitive, affective, and psychomotor domains as an integral part of the teaching and learning process. Therefore, reflective thinking skills, one of HOTS, influence learning achievement in terms of cognitive, affective, and psychomotor aspects. Learning achievement or learning academic success is the result achieved by a person after he made changes to learning, both at school and outside of school (Garcia, 2021). Several studies mention that reflective thinking contributes to learning achievement, including the research of Farahian, Avarzamani, & Rajabi (2020), Akpur (2020), Pham et al. (2020), Hsia & Hwang (2020), Aslam et al. (2021), etc.

Studies related to reflective thinking and its relationship to learning achievement tend to be carried out partially or only part in certain situations, so that it is difficult to see as a whole. For instance: Pham et al. (2020) examines reflective thinking skills and learning achievement only for ELF students in the context of academic writing. Then, Aslam et al. (2021) examines reflective thinking skills and specific learning achievement only for the students of teacher education. Furthermore, Hsia & Hwang's (2020) examines reflective thinking skills, dance learning achievement, self-efficacy and task load, especially in flipped learning conditions. Studies that are not comprehensive and focused specifically on the effect of reflective thinking skills and learning achievement have several shortcomings, such as: the research results are often biased and only applied to certain situations so that these are difficult to apply to other situations. One alternative to thoroughly analyze the relationship between reflective thinking and learning achievement is by using meta-analysis study. Meta-analysis is a systematic and quantitative research using the existing studies used by other researchers to obtain accurate conclusions

(Briggs, 2005; Basu, 2017). Malicki et al. (2021) state, “Meta-analysis is a form of research using data from other existing studies (secondary data)”. Therefore, it is a quantitative research method by analyzing quantitative data from the results of previous studies to accept or reject their hypotheses. This type of research method is increasingly popular to summarize research results. Meta-analysis is widely used in the study of research theory. In addition, it can be a source of foundation in policymaking (Borenstein et al., 2009; King & He, 2006).

In the meta-analysis, the data processed are used to make statistical conclusions. The data can be expressed by various measures that are calculated or searched in advance by formulas in various mathematical equations, which are closely related to the research objectives of the meta-analysis carried out (Pereira, 2019; Turner, Bird & Higgins, 2013). This size is known as the effect size. Meta-analysis includes content analysis that encodes the characteristics of a study, such as age, research location, or other domains in a scientific field. Effect sizes with the same characteristics are grouped and compared (Mueller et al., 2018).

Meta-analysis has some advantages, including (1) meta-analysis procedures apply useful disciplines in summarizing research findings; (2) meta-analysis is conducted in a more sophisticated manner than conventional review procedures which tend to rely on qualitative summaries or “vote-counting”; (3) meta-analysis can find influences or relationships that are obscured in other approaches to summarizing research; (4) meta-analysis provides an organized way of dealing with information from a large number of research findings under review (Briggs, 2005; Borenstein et al., 2009; Basu, 2017).

Based on the explanation above, reflective thinking skills are very important for every student at all levels of education. To make an overview of the relationship between reflective thinking and learning achievement around the world, a meta-analysis study is needed. This is the first meta-analysis study that tests the universality of this relationship among participants from different countries. Therefore, this study aims to prove and determine the effect size of the relationship between reflective thinking and learning achievement through a quantitative meta-analysis approach.

MATERIALS AND METHODS

Research Design

Quantitative meta-analysis method was used in this study. Quantitative meta-analysis is a statistical technique that combines two or more similar studies to obtain a quantitative mix of data (Mueller et al., 2018). Viewed from the process, meta-analysis is a retrospective observational study where the researcher recapitulates the data without performing experimental manipulation. The recapitulated data were obtained from research publications related to the relationship between reflective thinking skills and learning achievement at the tertiary level.

Eligibility Criteria

The research publications were selected by several criteria with the aim that the results of this extensive analysis can be more centralized. The studies to be included depend on the purpose of the meta-analysis (Tawfik et al., 2019). Therefore, the meta-analysis study hypothesis is very helpful in determining the inclusion and exclusion criteria that should be used from the outset for the identification of relevant studies (Higgins et al., 2018). The criteria for selecting the research publications studied are (1) publications that can be searched in search databases of online international journals such as Google Scholar, Springer, Eric, Proquest, SAGE, ERIC, et al.; (2) publications from various countries; (3) publications written in English; (4) publications with

Scopus, Web of Science, SINTA indexes; (4) publications with sample students; (5) publications from 2011 to 2021; (6) publications that have a value of (r) , (t) or (F) which explains the relationship between reflective thinking skills and learning achievement; and (8) the samples studied ≥ 10 .

Data coding

Malicki et al. (2021) state that coding in meta-analysis is “the most important requirement to facilitate data collection and analysis”. Therefore, the instrument in this meta-analysis was a coding category sheet. The coding describes the characteristics of the publications used, such as the year of publication, country of origin of the study, publication sample (N) , correlation value (r_{xy}) , t -value, F -value, and remarks containing accreditation/reputation information of the journal showed in Table 1.

Authors	Year	Sample	N	r	t	F	Remarks
Tuncer & Ozeren	2012	University students	356	0.353	7.109		Elsevier
Hsieh & Chen	2012	Management students	13	0.507	1.950		Web of Science (ESCI)
Ambrose & Ker	2013	Medical students	1000	0.480			Scopus Q1
Alatas	2014	Physics students	156	0.651			Science and Technology Index (SINTA 2)
Afshar & Hamzavi	2014	ELF students	223	0.610			Web of Science (ESCI)
Chang & Lin	2014	Student	104	0.196	2.020		Scopus Q1
Yilmaz & Keser	2015	Open students	103	0.138	1.400		Scopus Q1
Laio & Wang	2016	Medical students	86	0.463	4.7994	23.034	Scopus Q1
Elaldi	2016	Medical students	64	0.337	2.815		
Ghanizadeh & Jahedizadeh	2017	Student	196	0.435	6.7298	45.290	Scopus Q2
Kalantari & Kolahi	2017	ELF students	158	0.318			Scopus Q1
Asakereh & Yousofi	2018	ELF students	132	0.810			Scopus Q2
Hosseini, Maktabi, & Manijeh	2018	Student	899	0.660			Scopus Q2
Ramdani & Badriah	2018	Biology students	137	0.371			Science and Technology Index (SINTA 3)
Zulu & Haupt	2018	Graduate students	100	0.774			Proceeding
Chen, Hwang & Chang	2019	Graduate students	19	0.629	3.340		Scopus Q1

Turan & Koc	2019	University students	640	0.071	1.815	Web of Science (ESCI)	
Farahian, Avarzamani, & Rajabi	2020	ELF students	69	0.520		Scopus Q1	
Akpur	2020	ELF students	227	0.074	1.120	Scopus Q1	
Pham, Trinh & Thi	2020	Student	40	0.667		Scopus Q2	
Hsia & Hwang	2020	Dance students	129	0.375	4.5717	20.900	Scopus Q1
Aslam et al.	2021	University students	400	0.670		Scopus Q2	

Table 1: Comparison of 22 studies based on N , r , t , and F values, 2011-2021 (source: own calculation)

Data Analysis

The data analysis in this study was carried out through the following steps: (1) analysis of the characteristics of the research sample; (2) data coding; (3) conversion of the values of t and F to the value of r correlation with the formula below;

$$F = t^2 \quad (1)$$

$$t = \sqrt{F} \quad (2)$$

$$r = \frac{t}{\sqrt{t^2 + N - 2}} \quad (3)$$

(4) heterogeneity test of effect size; (5) calculation of the summary effect or mean effect size; (6) creating forest plots and funnel plots; (7) hypothesis testing; (8) checking publication bias. The data were analyzed using correlation meta-analysis. Effect size can be categorized into the values of 0–1 based on Cohen's effect size criteria (Cohen et al., 2020). The software used in this research was JASP 0.8 4.0 because it can be installed on various computer operating systems, has Cohen's criteria options on [Table 2](#), provides assumption testing, and has many helpful features for those who want to learn the analysis and interpretation of statistical results.

Value	Criteria
< 0 + / -.1	Weak effect
< 0 + / -.3	Modest effect
< 0 + / -.5	Moderate effect
< 0 + / -.8	Strong effect
≥ + / -.8	Very strong effect

Table 2: Cohen's Effect Size Criteria (Source: Cohen et al., 2020)

The meta-analysis method in this study is one of the critical and evasive systematic research methods using formal statistical methods so that basically this research does not prove any hypothesis but reviews several articles with the same theme through predetermined statistical

techniques. Therefore, this study compares the various effect sizes of each research and is reported in the form of combinations or conclusions with Cohen's effect size as a standard for the overall effect size.

RESULTS

Based on the analysis of 22 publications with specific criteria, various values of r , t , and F were obtained for each study. Before performing the heterogeneity test, the researchers converted the t - or F -values of all research publications that have no r - to r -value. The results of the heterogeneity test are presented in Table 3 below.

	Q	df	p
Omnibus Test of Model Coefficients	66.248	1	< 0.001
Test of Residual Heterogeneity	41.734	21	< 0.001

Note. p -values are approximate.

Note. The model was estimated using Restricted ML method.

Table 3: Heterogeneity test, 2011-2021 (source: own calculation)

Estimate	
τ^2	0.081
τ	0.284
I^2 (%)	94.707
H^2	18.892

Table 4: Residual heterogeneity estimates, 2011-2021 (source: own calculation)

The results of the heterogeneity test above showed that $Q = 411.734$ with $p < 0.001$; τ^2 or $\tau > 0$; I^2 (%) is close to 100%; it means that the 22 effect sizes of the analyzed studies were heterogeneous. Furthermore, an analysis of the estimation of the summary effect or mean effect size was carried out, and a publication bias test was performed using random effect approach. The results of the analysis of the summary effect or mean effect size are presented in Table 5 below.

	Estimate	Standard Error	z	p	95% Confidence Interval	
					Lower	Upper
intercept	0.527	0.065	8.139	< 0.001	0.400	0.654

Note. Wald test

Table 5: Summary effect or mean effect size, 2011-2021 (source: own calculation)

The results of the analysis using the random effect model showed a significant positive correlation between reflective thinking and student achievement ($z = 8.139$; $p < 0.001$; 95%CI [0.400; 0.654]). The relationship between reflective thinking and student achievement was included in the moderate category ($r_{RE} = 0.527$).

Furthermore, the analysis results are presented using a visually attractive graphical method, referred to as forest plots. Forest plots allow us to know the estimated combined effect depicted by plots (dots) at certain intervals at the same time to make comparisons between studies clearer. The chart of the forest plots of the 22 studies showed in Figure 1.

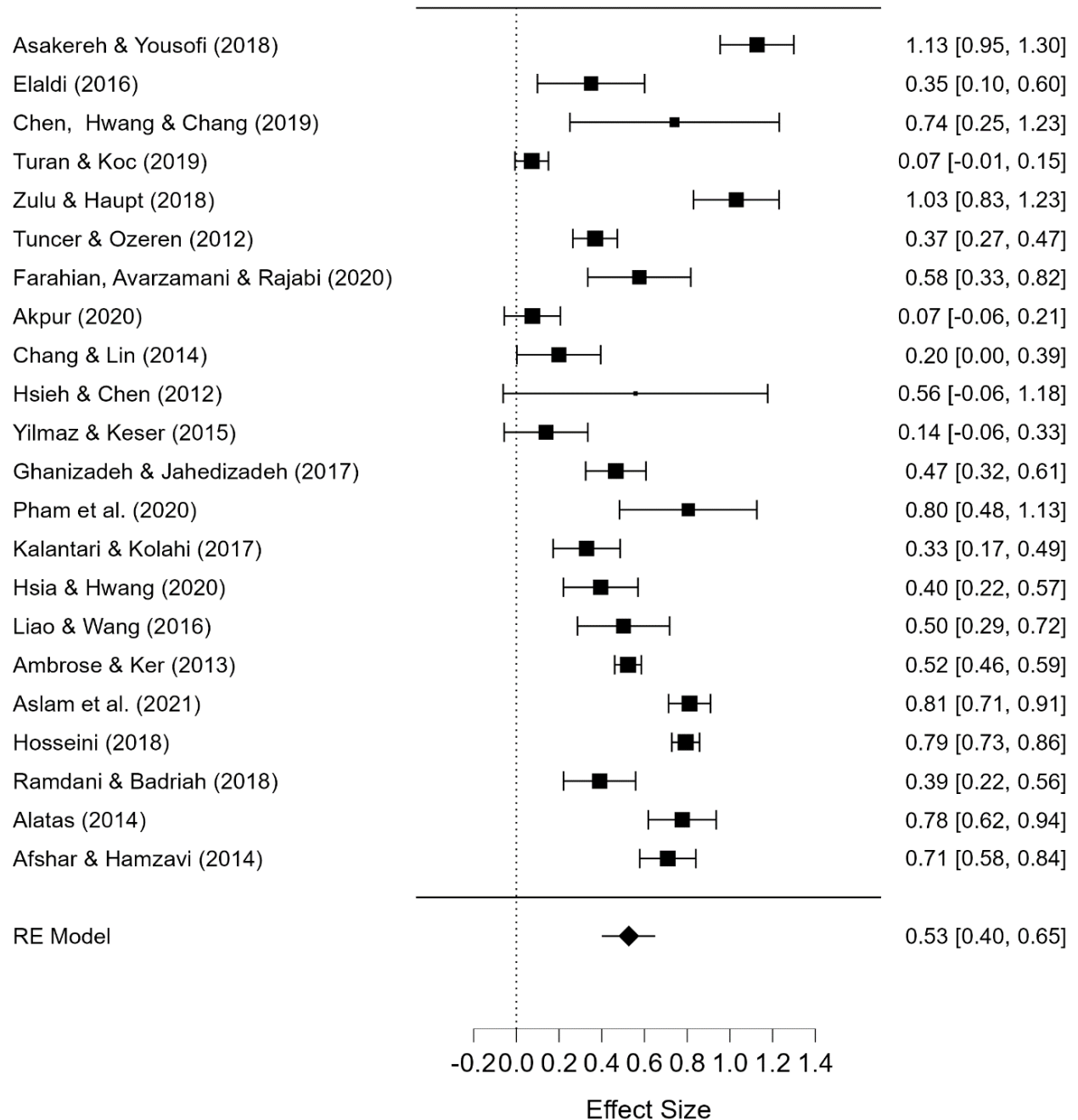


Figure 1: Meta-analysis forest plot, 2011-2021 (source: own calculation)

Based on the forest plot chart, the effect sizes of the analyzed studies vary from -0.06 to 1.30. Furthermore, the funnel plot was made. Begg's funnel plot is a scatter diagram used in meta-

analysis to visually detect the possibility of publication bias (symmetrical or asymmetrical research sample). The funnel plot chart for the 22 studies showed in Figure 2.

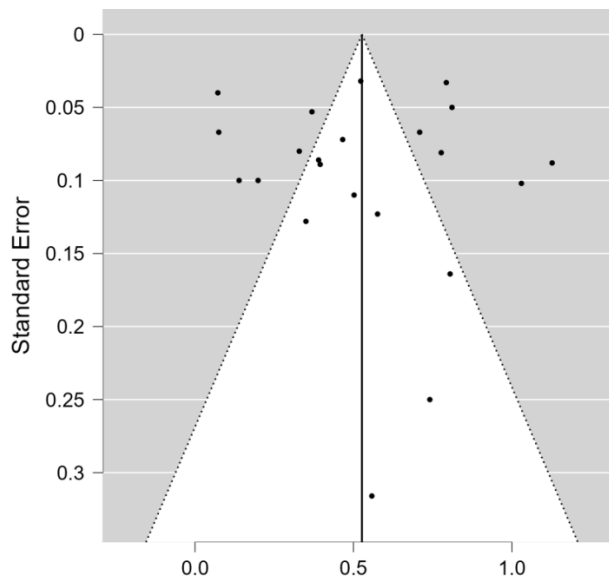


Figure 2: Funnel plot after Trim-Fill diagnosis, 2011-2021 (source: own calculation)

The results of the funnel plot chart had no clear indication of publication bias because the model formed was symmetrical or asymmetrical, so further analysis using Egger's test was necessary. Egger's test results are shown in Table 6.

	Z	p
sei	0.591	0.555

Table 6: Regression test for funnel plot asymmetry (Egger's test), 2011-2021 (source: own calculation)

Table 6 shows $Z = 0.591$ with $P > 0.05$. This confirms that the funnel plot is symmetrical. Thus, there is no publication bias problem in this meta-analysis study.

DISCUSSION

Based on the 22 research results which were analyzed through this meta-analysis, there was a significant positive relationship between reflective thinking and learning achievement indicated by a large p -value < 0.05 . Based on these results, it concludes that there is a positive effect of critical thinking skills on learning achievement. This is supported by several research results which state that the more skilled students reflect the relationship between concepts, causal relationships, analogous relationships, or differences, the more skilled they are in making decisions, conclusions, and working on questions quickly and precisely for better learning achievements (Turan, Fidan & Yildiran, 2019; Isler, Yilmaz & Dogruyol, 2020).

Furthermore, based on the results of the effect size analysis, the 22 studies showed that the relationship between reflective thinking and student achievement was in the moderate category based on Cohen's effect criteria ($r_{RE} = 0.527$). Based on the r value, it concludes that the effect of

reflective thinking skills has contribution in influencing learning achievement because it meets moderate category. This is in line with previous studies which state that students' reflective thinking processes affect learning achievement by responding quickly to a problem and linking what is known and asked in the problem with their previous knowledge to reflect on and determine the right strategy to solve the problem with reasoning (Tsingos-Lucas, 2016; Aldahmash, Alshalhoub, & Naji, 2021). Students' reflective thinking processes can be seen from the confusion and doubt in solving a problem and obstacles that make students quickly investigate it with their knowledge (Turan, Fidan & Yildiran, 2019; Spears et al., 2021).

Reflective thinking allows students to learn to think about the best strategies in achieving learning objectives (Mirzaei, Phang & Kashefi, 2014b). In addition, reflective thinking can help them integrate their thinking skills by conducting assessments (Maksimovic & Osmanovic, 2019). Reflective thinking is important for students to solve problems optimally (Spears et al., 2021). Therefore, it affects the way students decide on everything including cognitive, affective, and psychomotor activities in the components of learning achievement. This is supported by several studies stating the same theory, including Farahian, Avarzamani & Rajabi (2020), Akpur (2020), Pham et al. (2020), and Chen, Hwang, & Chang (2019).

Furthermore, Kholid et al. (2020) state that students should have reflective thinking skills in the learning process to solve problems of everyday life. With reflective thinking, someone can understand, criticize, assess, find alternative solutions, and evaluate the issues being studied. To improve students' reflective thinking skills, teachers can support them to hone their skills by using problem-based learning models, varied approaches, and open-ended essay questions (Killingsworth & Xue, 2015; Toman, 2017; Mirzaei, Phang & Kashefi, 2014b; Yilmaz, 2020).

In this study, no publication bias was found. Publication bias can be detected through analysis of the symmetrical shape of the funnel plot and Egger's test. They have the same conclusion. Analysis of publication bias is needed to determine the level of significance of the sources used, the quality of relevant research methods, accurate study conclusions, and different sample sizes which will affect minimally biased research conclusions (Nair, 2019; Joobar et al. al., 2012). Therefore, the studies that were not included had the same results as those included as a sample in this meta-analysis.

CONCLUSION

From the results and discussion above, it is confirmed that there is an effect of reflective thinking skills on learning achievement, which is indicated by the effect size of 22 publications which are proven to be heterogeneous and have a positive correlation value in the moderate effect category. Furthermore, publication bias does not exist, which means that the publications under review truly reflect the actual situation. The characteristics of the publications studied show the same sample, namely students, even though they are from various scientific fields. It is recommended that future researchers use similar themes by focusing on the sample of the research publications, such as elementary school, junior high school, high school, or non-formal education students. It is intended that there will be more theories on the relationship between reflective thinking skills and student achievement so that teachers will improve their teaching and consider this topic. The limitation in this research is that some publications are not reputable by Scopus, Web of Science, or SINTA. In fact, the better the reputation of the journal being studied is, the higher the quality of the data is presented.

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Dear Muhamad Chamdani, Furtasan Ali Yusuf, Moh Salimi, Laksmi Evasufi Widi Fajari,

Let us know that we have reached a decision regarding your manuscript "Meta-Analysis Study: The Relationship Between Reflective Thinking And Learning Achievement" submitted to Journal on Efficiency and Responsibility in Education and Science.

Our decision is: Revisions Required

Please follow the reviewers' comments and recommendations and revise carefully your manuscript. After the completed revision, please resubmit your revised manuscript, along with Replies to reviewers' comments document, into the ERIES Journal system.

In case of any questions or doubts, please do not hesitate to contact us.

Kind regards,

Igor Krejčí

Reviewer A:
Recommendation: Revisions Required

Originality of the work:

Good

Relevance of the work:

Good

Organization of the manuscript:

Acceptable

Research methodology and treatment:

Acceptable

Significance of presented results:

Acceptable

Correctness of English:

Acceptable

Clarity in writing, tables and figures:

Acceptable

Citations and references to other works:

Acceptable

Text of the review

1. Highlights are still just descriptive about the goal, they are not telling anything about the achievement. Highlights should be selling your findings. If these are really the highlights of your research, I suppose the manuscript should be declined.

2. Italics are used, then it stops.

3. "sei" still isn't explained. It doesn't matter that it is the default output. The explanation is necessary.

4. "to accept or reject their hypotheses" I already wrote that in the previous review. You can't (!) accept the hypothesis. You reject or fail to reject the statistical hypothesis.

Otherwise, I like the paper and after the final correction of all issues I would recommend the paper for publication

REPLIES TO REVIEWERS' COMMENTS

Title of the paper: META-ANALYSIS STUDY: THE RELATIONSHIP BETWEEN REFLECTIVE THINKING AND LEARNING ACHIEVEMENT

Comment 1: Highlights are still just descriptive about the goal, they are not telling anything about the achievement. Highlights should be selling your findings. If these are really the highlights of your research, I suppose the manuscript should be declined.

Reply 1: We've improved our research highlight to make it more interesting and informative.

Comment 2: Italics are used, then it stops.

Reply 2: Italics has been used throughout the manuscript.

Comment 3: "sei" still isn't explained. It doesn't matter that it is the default output. The explanation is necessary.

Reply 3: "sei" is already explained in the note below the table.

Comment 4: "to accept or reject their hypotheses" I already wrote that in the previous review. You can't (!) accept the hypothesis. You reject or fail to reject the statistical hypothesis.

Reply 4: The rejection or acceptance of the hypothesis has been explained both in the background, data analysis techniques and research results.

Notes:

All aspect that are corrected above are marked with **green highlights** while **yellow highlights** in the manuscript are a sign of a review at an earlier stage.

META-ANALYSIS STUDY: THE RELATIONSHIP BETWEEN REFLECTIVE THINKING AND LEARNING ACHIEVEMENT

ABSTRACT

Reflective thinking is a must-have skill to connect the knowledge obtained with previous knowledge and can be seen from learning achievement. This study aims to prove and determine the relationship between reflective thinking and learning achievement and its effect size. This study used quantitative meta-analysis method. Reflective thinking is the independent variable and learning achievement is the dependent variable. The data sources were obtained from online database searches on Google Scholar and international journal platforms from 2012 to 2021. Based on the search, 22 research publications met the predetermined criteria through a strict screening. Quantitative meta-analysis with correlation meta-analysis type was used to analyze the data. The software used was JASP 0.8 4.0. The results showed that there was a significant relationship between reflective thinking and student achievement ($z = 8.139$; $p < 0.001$; 95%CI [0.400; 0.654]). The effect of reflective thinking on student achievement was in the medium category ($r_{RE} = 0.527$). The findings are consistent with those of previous research on reflective thinking skills and learning achievement.

Keywords: Learning Achievement; Meta-Analysis Study; Reflective Thinking.

Research Highlight:

The assessment of 22 studies about reflective thinking

There is a positive relationship between reflective thinking and learning achievement around the world

Hubungan X dan Y termasuk ke dalam kategori sedang

The evaluation of important aspects of education through comprehensive meta-analysis study

INTRODUCTION

Developing students' higher-order thinking skills (HOTS) is a complex multidimensional educational challenge. This thinking skill is part of the general skills that must be trained to students in all subjects to improve their performance and reduce their weaknesses (Arif, 2019). According to Qasrawi & Beni Abdelrahman (2020), cognitive processes of analysis, evaluation, and creation in Bloom's taxonomy are grouped into HOTS while knowledge, understanding, and application are grouped into LOTS. Yen & Halili (2015) state that thinking skills, especially HOTS, are the main benchmark in achieving learning objectives. Included in HOTS are critical thinking, logical thinking, reflective thinking, metacognition, and creative thinking. One of HOTS is reflective thinking (Setiawan et al., 2021; Dwyer, Hogan & Stewart, 2014).

Reflective thinking is a thinking activity that can make students try to connect the knowledge they have acquired to solve new problems related to their old knowledge (Choy & Oo, 2011). Khalid et al. (2020) state that the process of reflective thinking can be described as information or data that is used to respond, comes from within (internally), can explain what has been done, realize mistakes and correct them, and communicate ideas with symbols or images instead of a direct object. Reflective thinking is part of the critical thinking process which refers to the process of analyzing and making judgments about what has happened. Reflective thinking is the most important skill in encouraging learning during complex problem-solving situations because it allows students to step back and think about how to solve the problem and how a set of

problem-solving strategies is accomplished to achieve their goals (Shavit & Moshe, 2019; Orakci, 2021).

According to Dewey (Ozudogru, 2021), reflective thinking means being active, continuous, persistent, and carefully considering everything that is believed to be true or the format of knowledge with supporting reasons leading to a conclusion. Boody, Hamilton, and Schon (Ozudogru, 2021) explain the characteristics of reflective thinking as follows: (1) reflection as retrospective analysis or recall (ability to judge oneself), (2) reflection as a problem-solving process (awareness of how one learns), (3) self-critical reflection (developing self-improvement continuously), and (4) reflection on self-confidence and success.

Students who have a reflective style tend to spend more time responding and reflecting on the accuracy of answers. Reflective individuals are very slow and careful in responding but tend to give correct answers (Kholid et al., 2020). Reflective students are more likely to perform tasks such as remembering structured information, reading by understanding and interpreting texts, solving problems, and making decisions. They may also determine their own learning goals and concentrate on relevant information. They usually have high work standards (Choy & Oo, 2011; Kablan & Gunen, 2021).

Empowering reflective thinking skills is the task of all levels of education. Belief in reflective thinking plays an important role because it is closely related to how students can evaluate themselves. Reflective thinking can also be used to encourage thinking processes during problem-solving because, with reflective thinking, students can predict the correct answer immediately so that they can explore problems by identifying the concepts involved, using various strategies, building ideas, drawing conclusions, re-examining solutions, and developing alternative strategies (Mirzaei, Phang & Kashefi, 2014a; Kablan & Gunen, 2021).

In addition, Qasrawi & Beni Abdelrahman (2020) state that HOTS is closely related to thinking skills following the cognitive, affective, and psychomotor domains as an integral part of the teaching and learning process. Therefore, reflective thinking skills, one of HOTS, influence learning achievement in terms of cognitive, affective, and psychomotor aspects. Several studies mention that reflective thinking contributes to learning achievement, including the research of Farahian, Avarzamani, & Rajabi (2020), Akpur (2020), Pham et al. (2020), Hsia & Hwang (2020), Aslam et al. (2021), etc.

Berdasarkan paparan di atas, hipotesis penelitian ini adalah terdapat hubungan antara X dan Y. Untuk membuktikan hipotesis tersebut, perlu dilakukan penelitian. One alternative to thoroughly analyze the relationship between reflective thinking and learning achievement is by using meta-analysis study.

Meta-analysis is a systematic and quantitative research using the existing studies used by other researchers to obtain accurate conclusions (Briggs, 2005; Basu, 2017). Malicki et al. (2021) state, "Meta-analysis is a form of research using data from other existing studies (secondary data)". Therefore, it is a quantitative research method by analyzing quantitative data from the results of previous studies to accept or reject their hypotheses. This type of research method is increasingly popular to summarize research results. Meta-analysis is widely used in the study of research theory. In addition, it can be a source of foundation in policymaking (Borenstein et al., 2009; King & He, 2006).

In the meta-analysis, the data processed are used to make statistical conclusions. The data can be expressed by various measures that are calculated or searched in advance by formulas in various mathematical equations, which are closely related to the research objectives of the meta-analysis

carried out (Pereira, 2019; Turner, Bird & Higgins, 2013). This size is known as the effect size. Meta-analysis includes content analysis that encodes the characteristics of a study, such as age, research location, or other domains in a scientific field. Effect sizes with the same characteristics are grouped and compared (Mueller et al., 2018).

Meta-analysis has some advantages, including (1) meta-analysis procedures apply useful disciplines in summarizing research findings; (2) meta-analysis is conducted in a more sophisticated manner than conventional review procedures which tend to rely on qualitative summaries or “vote-counting”; (3) meta-analysis can find influences or relationships that are obscured in other approaches to summarizing research; (4) meta-analysis provides an organized way of dealing with information from a large number of research findings under review (Briggs, 2005; Borenstein et al., 2009; Basu, 2017).

Based on the explanation above, reflective thinking skills are very important for every student at all levels of education. To make an overview of the relationship between reflective thinking and learning achievement around the world, a meta-analysis study is needed. This is the first meta-analysis study that tests the universality of this relationship among participants from different countries. Therefore, this study aims to prove and determine the effect size of the relationship between reflective thinking and learning achievement through a quantitative meta-analysis approach.

MATERIALS AND METHODS

Research Design

Quantitative meta-analysis method was used in this study. Quantitative meta-analysis is a statistical technique that combines two or more similar studies to obtain a quantitative mix of data (Mueller et al., 2018). Viewed from the process, meta-analysis is a retrospective observational study where the researcher recapitulates the data without performing experimental manipulation. The recapitulated data were obtained from research publications related to the relationship between reflective thinking skills and learning achievement at the tertiary level.

Eligibility Criteria

The research publications were selected by several criteria with the aim that the results of this extensive analysis can be more centralized. The studies to be included depend on the purpose of the meta-analysis (Tawfik et al., 2019). Therefore, the meta-analysis study hypothesis is very helpful in determining the inclusion and exclusion criteria that should be used from the outset for the identification of relevant studies (Higgins et al., 2018). The criteria for selecting the research publications studied are (1) publications that can be searched in search databases of online international journals such as Google Scholar, Springer, Eric, Proquest, SAGE, ERIC, et al.; (2) publications from various countries; (3) publications written in English; (4) publications with Scopus, Web of Science, SINTA indexes; (4) publications with sample students; (5) publications from 2011 to 2021; (6) publications that have a value of (r), (t) or (F) which explains the relationship between reflective thinking skills and learning achievement; and (8) the samples studied ≥ 10 .

Data coding

Malicki et al. (2021) state that coding in meta-analysis is “the most important requirement to facilitate data collection and analysis”. Therefore, the instrument in this meta-analysis was a coding category sheet. The coding describes the characteristics of the publications used, such as

the year of publication, country of origin of the study, publication sample (N), correlation value (rxy), t-value, F-value, and remarks containing accreditation/reputation information of the journal.

Authors	Year	Sample	N	r	t	F	Remarks
Tuncer & Ozeren	2012	University students	356	0.353	7.109		Elsevier
Hsieh & Chen	2012	Management students	13	0.507	1.950		Web of Science (ESCI)
Ambrose & Ker	2013	Medical students	1000	0.480			Scopus Q1
Alatas	2014	Physics students	156	0.651			Science and Technology Index (SINTA 2)
Afshar & Hamzavi	2014	ELF students	223	0.610			Web of Science (ESCI)
Chang & Lin	2014	Student	104	0.196	2.020		Scopus Q1
Yilmaz & Keser	2015	Open students	103	0.138	1.400		Scopus Q1
Laio & Wang	2016	Medical students	86	0.463	4.7994	23.034	Scopus Q1
Elaldi	2016	Medical students	64	0.337	2.815		
Ghanizadeh & Jahedizadeh	2017	Student	196	0.435	6.7298	45.290	Scopus Q2
Kalantari & Kolahi	2017	ELF students	158	0.318			Scopus Q1
Asakereh & Yousofi	2018	ELF students	132	0.810			Scopus Q2
Hosseini, Maktabi, & Manijeh	2018	Student	899	0.660			Scopus Q2
Ramdani & Badriah	2018	Biology students	137	0.371			Science and Technology Index (SINTA 3)
Zulu & Haupt	2018	Graduate students	100	0.774			Proceeding
Chen, Hwang & Chang	2019	Graduate students	19	0.629	3.340		Scopus Q1
Turan & Koc	2019	University students	640	0.071	1.815		Web of Science (ESCI)
Farahian, Avarzamani, & Rajabi	2020	ELF students	69	0.520			Scopus Q1
Akpur	2020	ELF students	227	0.074	1.120		Scopus Q1
Pham, Trinh & Thi	2020	Student	40	0.667			Scopus Q2
Hsia & Hwang	2020	Dance students	129	0.375	4.5717	20.900	Scopus Q1

**Table 1: Comparison of 22 studies based on N, r, t, AND F values, 2011-2021
(source: own calculation)**

Data Analysis

The data analysis in this study was carried out through the following steps: (1) analysis of the characteristics of the research sample; (2) data coding; (3) conversion of the values of t and F to the value of r correlation with the formula below;

$$F = t^2 \quad (1)$$

$$t = \sqrt{F} \quad (2)$$

$$r = \frac{t}{\sqrt{t^2 + N - 2}} \quad (3)$$

(4) heterogeneity test of effect size; (5) calculation of the summary effect or mean effect size; (6) creating forest plots and funnel plots; (7) hypothesis testing; (8) checking publication bias. The data were analyzed using correlation meta-analysis. Effect size can be categorized into the values of 0–1 based on Cohen's effect size criteria (Cohen et al., 2020). The software used in this research was JASP 0.8 4.0 because it can be installed on various computer operating systems, has Cohen's criteria options, provides assumption testing, and has many helpful features for those who want to learn the analysis and interpretation of statistical results.

Value	Criteria
< 0 + / -.1	Weak effect
< 0 + / -.3	Modest effect
< 0 + / -.5	Moderate effect
< 0 + / -.8	Strong effect
≥ + / -.8	Very strong effect

Table 2: Cohen's Effect Size Criteria (Source: Cohen et al., 2020)

RESULTS

Based on the analysis of 22 publications with specific criteria, various values of r, t, and F were obtained for each study. Before performing the heterogeneity test, the researchers converted the t- or F-values of all research publications that have no r-value to r-value. The results of the heterogeneity test are presented in Table 3 below.

	Q	df	p
Omnibus Test of Model Coefficients	66.248	1	< 0.001
Test of Residual Heterogeneity	41.734	21	< 0.001

Note. p -values are approximate.

Note. The model was estimated using Restricted ML method.

Table 3: Heterogeneity test, 2011-2021 (source: own calculation)

Estimate	
τ^2	0.081
τ	0.284
I^2 (%)	94.707
H^2	18.892

Table 4: Residual heterogeneity estimates, 2011-2021 (source: own calculation)

The results of the heterogeneity test above showed that $Q = 411.734$ with $p < 0.001$; τ^2 or $\tau > 0$; I^2 (%) is close to 100%; it means that the 22 effect sizes of the analyzed studies were heterogeneous. Furthermore, an analysis of the estimation of the summary effect or mean effect size was carried out, and a publication bias test was performed using random effect approach. The results of the analysis of the summary effect or mean effect size are presented in Table 5 below.

	Estimate	Standard Error	z	p	95% Confidence Interval	
					Lower	Upper
intercept	0.527	0.065	8.139	< 0.001	0.400	0.654

Note. Wald test

Table 5: Summary effect or mean effect size, 2011-2021 (source: own calculation)

The results of the analysis using the random effect model showed a significant positive correlation between reflective thinking and student achievement ($z = 8.139$; 95%CI [0.400; 0.654]). Nilai p yang menunjukkan < 0.001 membuktikan bahwa hipotesis penelitian ini diterima. The relationship between reflective thinking and student achievement was included in the moderate category ($r_{RE} = 0.527$).

Furthermore, the analysis results are presented using a visually attractive graphical method, referred to as forest plots. Forest plots allow us to know the estimated combined effect depicted by plots (dots) at certain intervals at the same time to make comparisons between studies clearer. The following is a chart of the forest plots of the 22 analyzed studies.

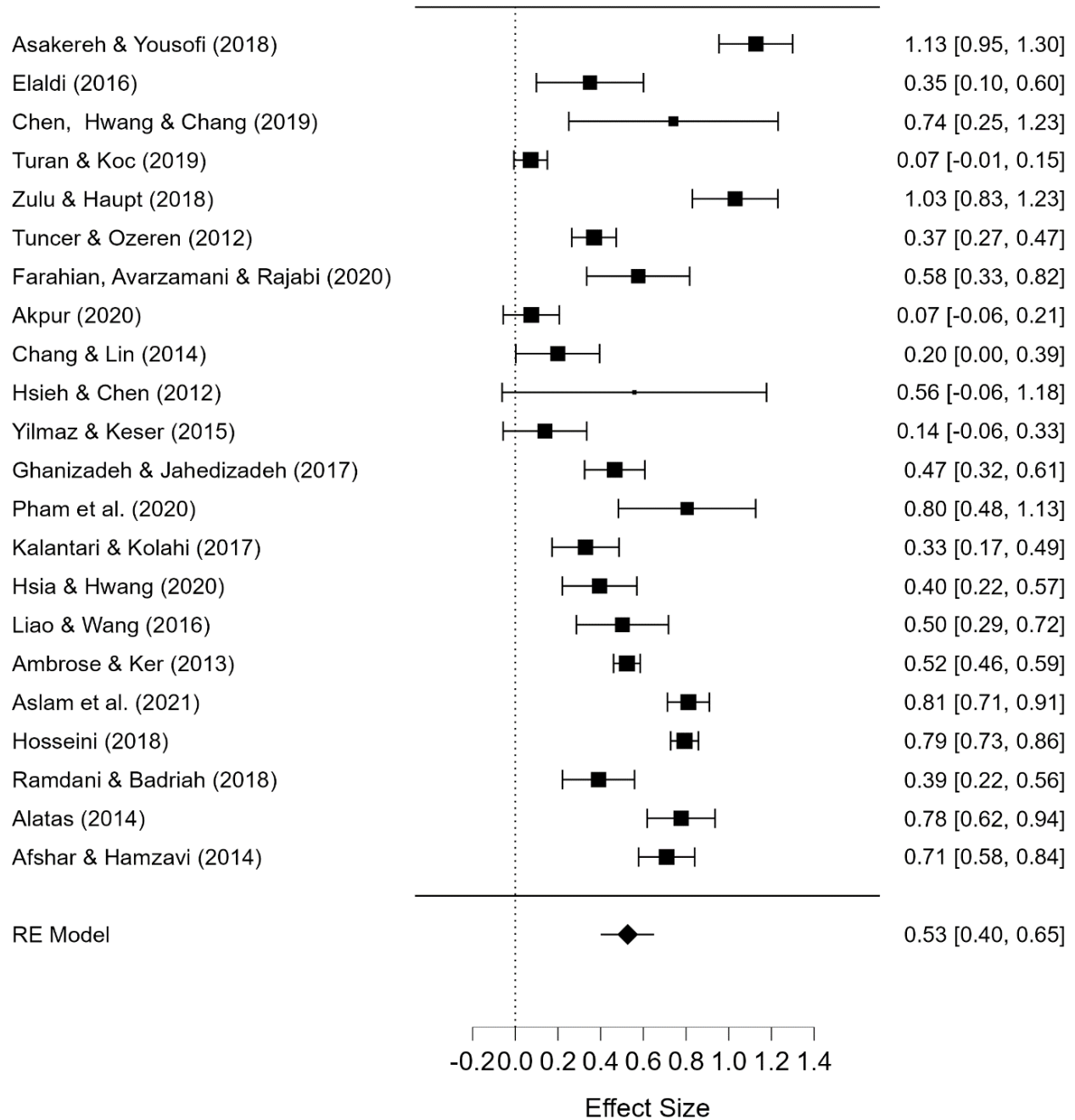


Figure 1: Meta-analysis forest plot, 2011-2021 (source: own calculation)

Based on the forest plot chart, the effect sizes of the analyzed studies vary from -0.06 to 1.30. Furthermore, the funnel plot was made. Begg's funnel plot is a scatter diagram used in meta-analysis to visually detect the possibility of publication bias (symmetrical or asymmetrical research sample). The following is a funnel plot chart for the 22 studies analyzed.

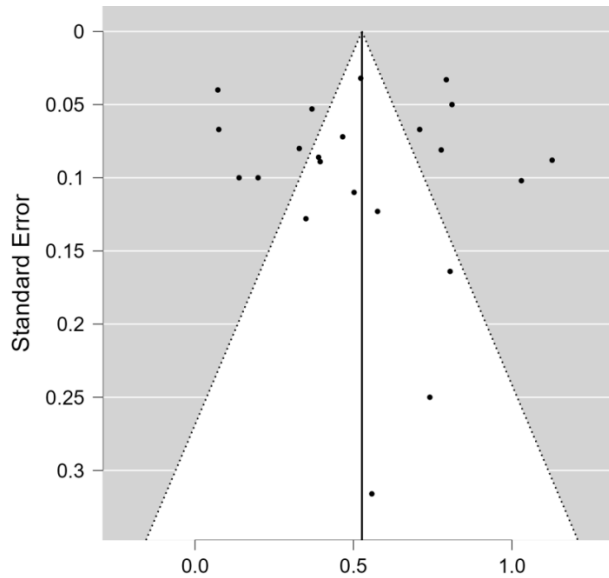


Figure 2: Funnel plot after Trim-Fill diagnosis, 2011-2021 (source: own calculation)

The results of the funnel plot chart had no clear indication of publication bias because the model formed was symmetrical or asymmetrical, so further analysis using Egger's test was necessary. Egger's test results are shown in Table 6.

	Z	p
sei	0.591	0.555

Table 6: Regression test for funnel plot asymmetry (Egger's test), 2011-2021 (source: own calculation)

Table 6 ...menjelaskan sei yaitu ...

shows $Z = 0.591$ with $p > 0.05$. This confirms that the funnel plot is symmetrical. Thus, there is no publication bias problem in this meta-analysis study.

DISCUSSION

Based on the 22 research results which were analyzed through this meta-analysis, there was a significant positive relationship between reflective thinking and learning achievement (p -value < 0.05). The more skilled students reflect the relationship between concepts, causal relationships, analogous relationships, or differences, the more skilled they are in making decisions, conclusions, and working on questions quickly and precisely for better learning achievements (Turan, Fidan & Yildiran, 2019; Isler, Yilmaz & Dogruyol, 2020).

Furthermore, based on the results of the effect size analysis, the 22 studies showed that the relationship between reflective thinking and student achievement was in the moderate category based on Cohen's effect criteria ($r_{RE} = 0.527$). Students' reflective thinking processes affect learning achievement by responding quickly to a problem and linking what is known and asked in the problem with their previous knowledge to reflect on and determine the right strategy to solve the problem with reasoning (Tsingos-Lucas, 2016; Aldahmash, Alshalhoub, & Naji, 2021). Students' reflective thinking processes can be seen from the confusion and doubt in solving a

problem and obstacles that make students quickly investigate it with their knowledge (Turan, Fidan & Yildiran, 2019; Spears et al., 2021).

Reflective thinking allows students to learn to think about the best strategies in achieving learning objectives (Mirzaei, Phang & Kashefi, 2014b). In addition, reflective thinking can help them integrate their thinking skills by conducting assessments (Maksimovic & Osmanovic, 2019). Reflective thinking is important for students to solve problems optimally (Spears et al., 2021). Therefore, it affects the way students decide on everything including cognitive, affective, and psychomotor activities in the components of learning achievement. This is supported by several studies stating the same theory, including Farahian, Avarzamani & Rajabi (2020), Akpur (2020), Pham et al. (2020), and Chen, Hwang, & Chang (2019).

Furthermore, Kholid et al. (2020) state that students should have reflective thinking skills in the learning process to solve problems of everyday life. With reflective thinking, someone can understand, criticize, assess, find alternative solutions, and evaluate the issues being studied. To improve students' reflective thinking skills, teachers can support them to hone their skills by using problem-based learning models, varied approaches, and open-ended essay questions (Killingsworth & Xue, 2015; Toman, 2017; Mirzaei, Phang & Kashefi, 2014b; Yilmaz, 2020).

In this study, no publication bias was found. Publication bias can be detected through analysis of the symmetrical shape of the funnel plot and Egger's test. They have the same conclusion. Analysis of publication bias is needed to determine the level of significance of the sources used, the quality of relevant research methods, accurate study conclusions, and different sample sizes which will affect minimally biased research conclusions (Nair, 2019; Joobar et al. al., 2012). Therefore, the studies that were not included had the same results as those included as a sample in this meta-analysis.

CONCLUSION

From the results and discussion above, it is confirmed that there is an effect of reflective thinking skills on learning achievement, which is indicated by the effect size of 22 publications which are proven to be heterogeneous and have a positive correlation value in the moderate effect category. Furthermore, publication bias does not exist, which means that the publications under review truly reflect the actual situation. The characteristics of the publications studied show the same sample, namely students, even though they are from various scientific fields. It is recommended that future researchers use similar themes by focusing on the sample of the research publications, such as elementary school, junior high school, high school, or non-formal education students. It is intended that there will be more theories on the relationship between reflective thinking skills and student achievement so that teachers will improve their teaching and consider this topic. The limitation in this research is that some publications are not reputable by Scopus, Web of Science, or SINTA. In fact, the better the reputation of the journal being studied is, the higher the quality of the data is presented.

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Dear Muhamad Chamdani, Furtasan Ali Yusuf, Moh Salimi, Laksmi Evasufi Widi Fajari,

Let us inform you that we have reached a decision regarding your manuscript "Meta-Analysis Study: The Relationship Between Reflective Thinking And Learning Achievement" submitted to Journal on Efficiency and Responsibility in Education and Science.

Our decision is: Resubmit

Please follow the reviewers' comments and recommendations and revise carefully your manuscript. After the completed revision, please resubmit your revised manuscript, along with Replies to reviewers' comments document, into the ERIES Journal system.

In case of any question or doubts, please do not hesitate to contact us.

Kind regards

Igor Krejčí

Reviewer A:
Recommendation: Decline Submission

Originality of the work:

Good

Relevance of the work:

Good

Organization of the manuscript:

Good

Research methodology and treatment:

Marginal

Significance of presented results:

Good

Correctness of English:

Acceptable

Clarity in writing, tables and figures:

Good

Citations and references to other works:

Marginal

Text of the review

The manuscript went through some changes. Most of the changes didn't improve the paper at all. On the contrary.

1) The list of references that was quite close to the required referencing style is now changed. Every change performed led to worsening the situation.

2) Authors deleted some parts in the introduction. Without highlighting that or explaining that in the replies.

3) Authors added direct quotation – the journal clearly specifies that the single upper commas are required, and it is necessary to add the page.

4) Authors declare that they use italics for the variables but that simply isn't true. The authors didn't even check that – no change was performed. See page 5. The formulas even do not follow the instructions for authors.

5) Instructions for authors (and also a common scientific approach) clearly state: "All tables and figures must be referred to in the text" It wasn't so in previous versions but now it got even worse.

6) Above all, the authors still „accept the hypothesis“, which is methodologically completely wrong. I stressed that many times before.

As a result of such an unacceptable approach, I recommend declining the paper.

Editor's note

Dear authors, the reviewer points out some serious issues. Please consider this to be the last round. If all the issues will not be addressed, we will have to decline the paper.

REPLIES TO REVIEWERS' COMMENTS

Title of the paper: META-ANALYSIS STUDY: THE RELATIONSHIP BETWEEN REFLECTIVE THINKING AND LEARNING ACHIEVEMENT

Reviewer 1

Comment 1: The list of references that was quite close to the required >> referencing style is now changed. Every change performed led to >> worsening the situation.

Reply 1: The reference style of this article has been fixed.

Comment 2: Authors deleted some parts in the introduction. Without >> highlighting that or explaining that in the replies.

Reply 2: The missing part of the introduction has been added again and is now fully complete.

Comment 3: Authors added direct quotation – the journal clearly specifies >> that the single upper commas are required, and it is necessary to >> add the page.

Reply 3: Information of the page in direct quote writing has been added.

Comment 4: Authors declare that they use italics for the variables but that >> simply isn't true. The authors didn't even check that – no >> change was performed. See page 5. The formulas even do not follow >> the instructions for authors.

Reply 4: The formulas have followed the instructions for authors and all of the variables have been italicized.

Comment 5: Instructions for authors (and also a common scientific approach) >> clearly state: "All tables and figures must be referred to in the >> text" It wasn't so in previous versions but now it got even >> worse.

Reply 5: All tables and figures are already mentioned in the text completely.

Comment 6: Above all, the authors still „accept the hypothesis", which >> is methodologically completely wrong. I stressed that many times >> before.

Reply 6: We've added information about H_0 and H_a and an explanation of H_0 's rejection.

META-ANALYSIS STUDY: THE RELATIONSHIP BETWEEN REFLECTIVE THINKING AND LEARNING ACHIEVEMENT

ABSTRACT

Reflective thinking is a must-have skill to connect the knowledge obtained with previous knowledge and can be seen from learning achievement. This study aims to prove and determine the relationship between reflective thinking and learning achievement and its effect size. This study used quantitative meta-analysis method. Reflective thinking is the independent variable and learning achievement is the dependent variable. The data sources were obtained from online database searches on Google Scholar and international journal platforms from 2012 to 2021. Based on the search, 22 research publications met the predetermined criteria through a strict screening. Quantitative meta-analysis with correlation meta-analysis type was used to analyze the data. The software used was JASP 0.8 4.0. The results showed that there was a significant relationship between reflective thinking and student achievement ($z = 8.139$; $p < 0.001$; 95%CI [0.400; 0.654]). The effect of reflective thinking on student achievement was in the medium category ($r_{RE} = 0.527$). The findings are consistent with those of previous research on reflective thinking skills and learning achievement.

Keywords: Learning Achievement; Meta-Analysis Study; Reflective Thinking.

Research Highlight:

The assessment of 22 studies about reflective thinking

There is a positive relationship between reflective thinking and learning achievement around the world

The relationship between reflective thinking and learning achievement reflective thinking on student achievement was in the medium category

The evaluation of important aspects of education through comprehensive meta-analysis study

INTRODUCTION

Developing students' higher-order thinking skills (HOTS) is a complex multidimensional educational challenge. This thinking skill is part of the general skills that must be trained to students in all subjects to improve their performance and reduce their weaknesses (Arif, 2019). According to Qasrawi & Beni Abdelrahman (2020), cognitive processes of analysis, evaluation, and creation in Bloom's taxonomy are grouped into HOTS while knowledge, understanding, and application are grouped into LOTS. Yen & Halili (2015) state that thinking skills, especially HOTS, are the main benchmark in achieving learning objectives. Included in HOTS are critical thinking, logical thinking, reflective thinking, metacognition, and creative thinking. One of HOTS is reflective thinking (Setiawan et al., 2021; Dwyer, Hogan & Stewart, 2014).

Reflective thinking is a thinking activity that can make students try to connect the knowledge they have acquired to solve new problems related to their old knowledge (Choy & Oo, 2011). Khalid et al. (2020) state that the process of reflective thinking can be described as information or data that is used to respond, comes from within (internally), can explain what has been done, realize mistakes and correct them, and communicate ideas with symbols or images instead of a direct object. Reflective thinking is part of the critical thinking process which refers to the process of analyzing and making judgments about what has happened. Reflective thinking is the most important skill in encouraging learning during complex problem-solving situations because

it allows students to step back and think about how to solve the problem and how a set of problem-solving strategies is accomplished to achieve their goals (Shavit & Moshe, 2019; Orakci, 2021).

According to Dewey (Ozudogru, 2021), reflective thinking means being active, continuous, persistent, and carefully considering everything that is believed to be true or the format of knowledge with supporting reasons leading to a conclusion. Boody, Hamilton, and Schon (Ozudogru, 2021) explain the characteristics of reflective thinking as follows: (1) reflection as retrospective analysis or recall (ability to judge oneself), (2) reflection as a problem-solving process (awareness of how one learns), (3) self-critical reflection (developing self-improvement continuously), and (4) reflection on self-confidence and success.

Students who have a reflective style tend to spend more time responding and reflecting on the accuracy of answers. Reflective individuals are very slow and careful in responding but tend to give correct answers (Kholid et al., 2020). Reflective students are more likely to perform tasks such as remembering structured information, reading by understanding and interpreting texts, solving problems, and making decisions. They may also determine their own learning goals and concentrate on relevant information. They usually have high work standards (Choy & Oo, 2011; Kablan & Gunen, 2021).

Empowering reflective thinking skills is the task of all levels of education. Belief in reflective thinking plays an important role because it is closely related to how students can evaluate themselves. Reflective thinking can also be used to encourage thinking processes during problem-solving because, with reflective thinking, students can predict the correct answer immediately so that they can explore problems by identifying the concepts involved, using various strategies, building ideas, drawing conclusions, re-examining solutions, and developing alternative strategies (Mirzaei, Phang & Kashefi, 2014a; Kablan & Gunen, 2021).

In addition, Qasrawi & Beni Abdelrahman (2020) state that HOTS is closely related to thinking skills following the cognitive, affective, and psychomotor domains as an integral part of the teaching and learning process. Therefore, reflective thinking skills, one of HOTS, influence learning achievement in terms of cognitive, affective, and psychomotor aspects. Several studies mention that reflective thinking contributes to learning achievement, including the research of Farahian, Avarzamani, & Rajabi (2020), Akpur (2020), Pham et al. (2020), Hsia & Hwang (2020), Aslam et al. (2021), etc.

Studies related to reflective thinking and its relationship to learning achievement tend to be carried out partially or only part in certain situations, so that it is difficult to see as a whole. For instance: Pham et al. (2020) examines reflective thinking skills and learning achievement only for ELF students in the context of academic writing. Then, Aslam et al. (2021) examines reflective thinking skills and specific learning achievement only for the students of teacher education. Furthermore, Hsia & Hwang's (2020) examines reflective thinking skills, dance learning achievement, self-efficacy and task load, especially in flipped learning conditions. Studies that are not comprehensive and focused specifically on the effect of reflective thinking skills and learning achievement have several shortcomings, such as: the research results are often biased and only applied to certain situations so that these are difficult to apply to other situations. Based on the explanation above, this research hypothesizes that there is a relationship between reflective thinking and learning achievement. To prove this hypothesis, it is necessary to conduct research. One alternative to thoroughly analyze the relationship between reflective thinking and learning achievement is by using meta-analysis study. Meta-analysis is a systematic and quantitative research using the existing studies used by other researchers to obtain accurate

conclusions (Briggs, 2005; Basu, 2017). Malicki et al. (2021: 3) state, “Meta-analysis is a form of research using data from other existing studies (secondary data)”. Therefore, it is a quantitative research method by analyzing quantitative data from the results of previous studies to reject or failed to reject their hypotheses. This type of research method is increasingly popular to summarize research results. Meta-analysis is widely used in the study of research theory. In addition, it can be a source of foundation in policymaking (Borenstein et al., 2009; King & He, 2006).

In the meta-analysis, the data processed are used to make statistical conclusions. The data can be expressed by various measures that are calculated or searched in advance by formulas in various mathematical equations, which are closely related to the research objectives of the meta-analysis carried out (Pereira, 2019; Turner, Bird & Higgins, 2013). This size is known as the effect size. Meta-analysis includes content analysis that encodes the characteristics of a study, such as age, research location, or other domains in a scientific field. Effect sizes with the same characteristics are grouped and compared (Mueller et al., 2018).

Meta-analysis has some advantages, including (1) meta-analysis procedures apply useful disciplines in summarizing research findings; (2) meta-analysis is conducted in a more sophisticated manner than conventional review procedures which tend to rely on qualitative summaries or “vote-counting”; (3) meta-analysis can find influences or relationships that are obscured in other approaches to summarizing research; (4) meta-analysis provides an organized way of dealing with information from a large number of research findings under review (Briggs, 2005; Borenstein et al., 2009; Basu, 2017).

Based on the explanation above, reflective thinking skills are very important for every student at all levels of education. To make an overview of the relationship between reflective thinking and learning achievement around the world, a meta-analysis study is needed. This is the first meta-analysis study that tests the universality of this relationship among participants from different countries. Therefore, this study aims to prove and determine the effect size of the relationship between reflective thinking and learning achievement through a quantitative meta-analysis approach.

MATERIALS AND METHODS

Research Design

Quantitative meta-analysis method was used in this study. Quantitative meta-analysis is a statistical technique that combines two or more similar studies to obtain a quantitative mix of data (Mueller et al., 2018). Viewed from the process, meta-analysis is a retrospective observational study where the researcher recapitulates the data without performing experimental manipulation. The recapitulated data were obtained from research publications related to the relationship between reflective thinking skills and learning achievement at the tertiary level.

Eligibility Criteria

The research publications were selected by several criteria with the aim that the results of this extensive analysis can be more centralized. The studies to be included depend on the purpose of the meta-analysis (Tawfik et al., 2019). Therefore, the meta-analysis study hypothesis is very helpful in determining the inclusion and exclusion criteria that should be used from the outset for the identification of relevant studies (Higgins et al., 2018). The criteria for selecting the research publications studied are (1) publications that can be searched in search databases of online international journals such as Google Scholar, Springer, Eric, Proquest, SAGE, ERIC, et al.; (2)

publications from various countries; (3) publications written in English; (4) publications with Scopus, Web of Science, SINTA indexes; (4) publications with sample students; (5) publications from 2011 to 2021; (6) publications that have a value of (r), (t) or (F) which explains the relationship between reflective thinking skills and learning achievement; and (8) the samples studied ≥ 10 .

Data coding

Malicki et al. (2021: 2) state that coding in meta-analysis is “the most important requirement to facilitate data collection and analysis”. Therefore, the instrument in this meta-analysis was a coding category sheet. The coding describes the characteristics of the publications used, such as the year of publication, country of origin of the study, publication sample (N), correlation value (r_{xy}), t -value, F -value, and remarks containing accreditation/reputation information of the journal. The distribution of publications is presented in Table 1.

Authors	Year	Sample	N	r	t	F	Remarks
Tuncer & Ozeren	2012	University students	356	0.353	7.109		Elsevier
Hsieh & Chen	2012	Management students	13	0.507	1.950		Web of Science (ESCI)
Ambrose & Ker	2013	Medical students	1000	0.480			Scopus Q1
Alatas	2014	Physics students	156	0.651			Science and Technology Index (SINTA 2)
Afshar & Hamzavi	2014	ELF students	223	0.610			Web of Science (ESCI)
Chang & Lin	2014	Student	104	0.196	2.020		Scopus Q1
Yilmaz & Keser	2015	Open students	103	0.138	1.400		Scopus Q1
Laio & Wang	2016	Medical students	86	0.463	4.7994	23.034	Scopus Q1
Elaldi	2016	Medical students	64	0.337	2.815		
Ghanizadeh & Jahedizadeh	2017	Student	196	0.435	6.7298	45.290	Scopus Q2
Kalantari & Kolahi	2017	ELF students	158	0.318			Scopus Q1
Asakereh & Yousofi	2018	ELF students	132	0.810			Scopus Q2
Hosseini, Maktabi, & Manijeh	2018	Student	899	0.660			Scopus Q2
Ramdani & Badriah	2018	Biology students	137	0.371			Science and Technology Index (SINTA 3)
Zulu & Haupt	2018	Graduate students	100	0.774			Proceeding
Chen, Hwang & Chang	2019	Graduate students	19	0.629	3.340		Scopus Q1
Turan & Koc	2019	University students	640	0.071	1.815		Web of Science (ESCI)
Farahian, Avarzamani, &	2020	ELF students	69	0.520			Scopus Q1

Rajabi						
Akpur	2020	ELF students	227	0.074	1.120	Scopus Q1
Pham, Trinh & Thi	2020	Student	40	0.667		Scopus Q2
Hsia & Hwang	2020	Dance students	129	0.375	4.5717	20.900
Aslam et al.	2021	University students	400	0.670		Scopus Q2

Table 1: Comparison of 22 studies based on N , r , t , and F values, 2011-2021 (source: own calculation)

Data Analysis

The data analysis in this study was carried out through the following steps: (1) analysis of the characteristics of the research sample; (2) data coding; (3) conversion of the values of t and F to the value of r correlation with the formula below;

$$F = t^2 \quad (1)$$

$$t = \sqrt{F} \quad (2)$$

$$r = \frac{t}{\sqrt{t^2 + N - 2}} \quad (3)$$

(4) heterogeneity test of effect size; (5) calculation of the summary effect or mean effect size; (6) creating forest plots and funnel plots; (7) hypothesis testing; (8) checking publication bias. The data were analyzed using correlation meta-analysis.

At the hypothesis testing stage, the p-value obtained was used to test the following hypothesis.
 H_0 : There is no significant relationship between the reflective thinking and learning achievement
 H_a : There is a significant relationship between the reflective thinking and learning achievement

Effect size can be categorized into the values of 0–1 based on Cohen's effect size criteria (Cohen et al., 2020). The software used in this research was JASP 0.8 4.0 because it can be installed on various computer operating systems, has Cohen's criteria options, provides assumption testing, and has many helpful features for those who want to learn the analysis and interpretation of statistical results. The Cohen's effect size criteria are presented in Table 2.

Value	Criteria
< 0 + / -.1	Weak effect
< 0 + / -.3	Modest effect
< 0 + / -.5	Moderate effect
< 0 + / -.8	Strong effect
≥ + / -.8	Very strong effect

Table 2: Cohen's Effect Size Criteria (Source: Cohen et al., 2020)

RESULTS

Based on the analysis of 22 publications with specific criteria, various values of r , t , and F were obtained for each study. Before performing the heterogeneity test, the researchers converted the

t- or *F*-values of all research publications that have no *r*-value to *r*-value. The results of the heterogeneity test are presented in Table 3 and residual heterogeneity estimates are presented in Table 4.

	<i>Q</i>	<i>df</i>	<i>p</i>
Omnibus Test of Model Coefficients	66.248	1	< 0.001
Test of Residual Heterogeneity	41.734	21	< 0.001

Note. *p*-values are approximate.

Note. The model was estimated using the Restricted ML method.

Table 3: Heterogeneity test, 2011-2021 (source: own calculation)

Estimate	
τ^2	0.081
τ	0.284
I^2 (%)	94.707
H^2	18.892

Table 4: Residual heterogeneity estimates, 2011-2021 (source: own calculation)

The results of the heterogeneity test above showed that $Q = 411.734$ with $p < 0.001$; τ^2 or $\tau > 0$; I^2 (%) is close to 100%; it means that the 22 effect sizes of the analyzed studies were heterogeneous. Furthermore, an analysis of the estimation of the summary effect or mean effect size was carried out, and a publication bias test was performed using a random effect approach. The results of the analysis of the summary effect or mean effect size is presented in Table 5.

	Estimate	Standard Error	<i>z</i>	<i>p</i>	95% Confidence Interval	
					Lower	Upper
intercept	0.527	0.065	8.139	< 0.001	0.400	0.654

Note. Wald test

Table 5: Summary effect or mean effect size, 2011-2021 (source: own calculation)

The results of the analysis using the random effect model showed a significant positive correlation between reflective thinking and student achievement ($z = 8.139$; 95%CI [0.400; 0.654]). The *p*-value which shows < 0.001 proves that this research H_0 is rejected. It can be concluded that there is a significant relationship between the reflective thinking and learning achievement. The relationship between reflective thinking and student achievement was included in the moderate category ($r_{RE} = 0.527$).

Furthermore, the analysis results are presented using a visually attractive graphical method, referred to as forest plots. Forest plots allow us to know the estimated combined effect depicted by plots (dots) at certain intervals at the same time to make comparisons between studies clearer. A chart of the forest plots of the 22 analyzed studies is presented in Figure 1.

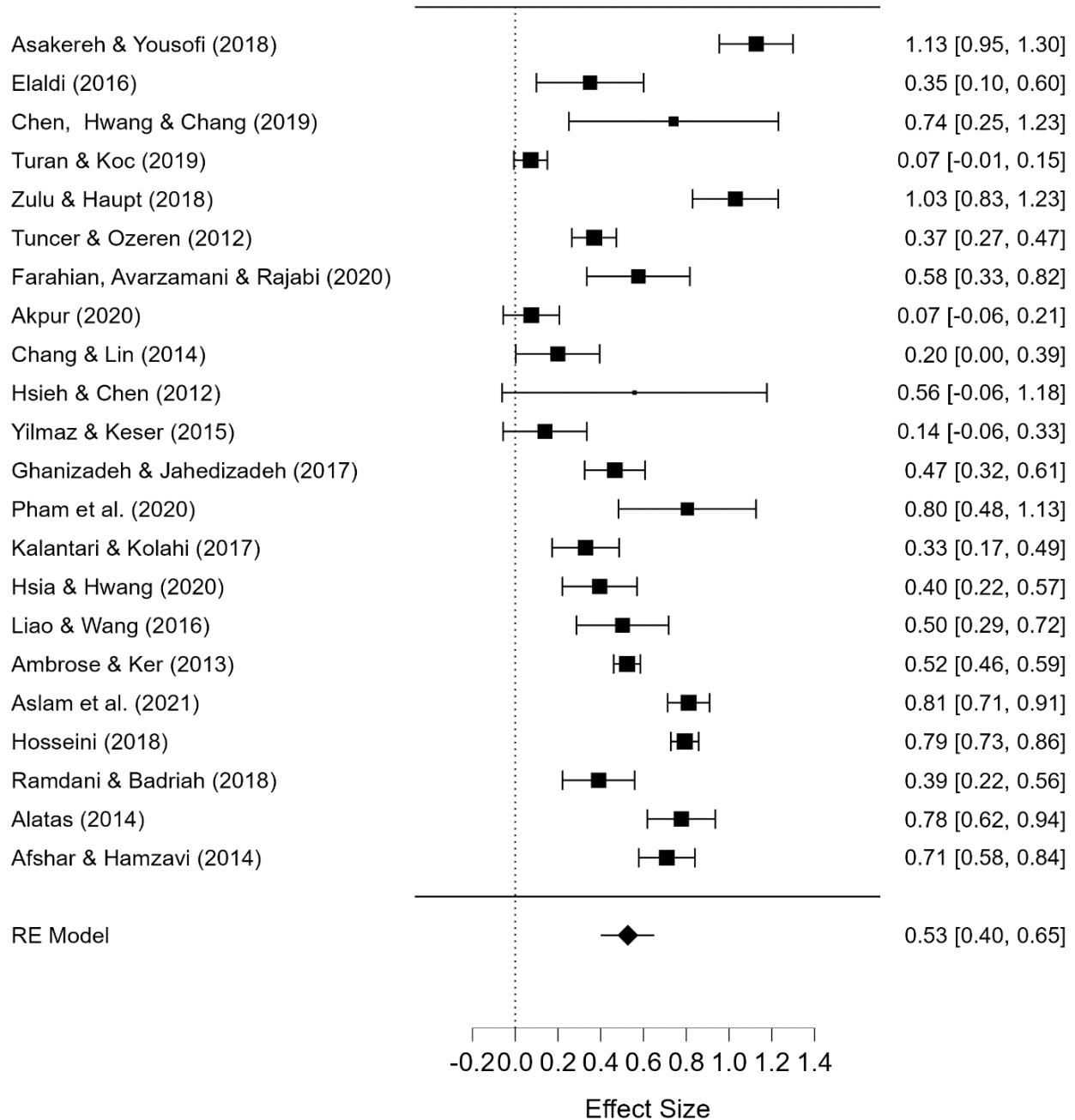


Figure 1: Meta-analysis forest plot, 2011-2021 (source: own calculation)

Based on the forest plot chart, the effect sizes of the analyzed studies vary from -0.06 to 1.30. Furthermore, the funnel plot was made. Begg's funnel plot is a scatter diagram used in meta-analysis to visually detect the possibility of publication bias (symmetrical or asymmetrical research sample). A funnel plot chart for the 22 studies analyzed is presented in Figure 2.

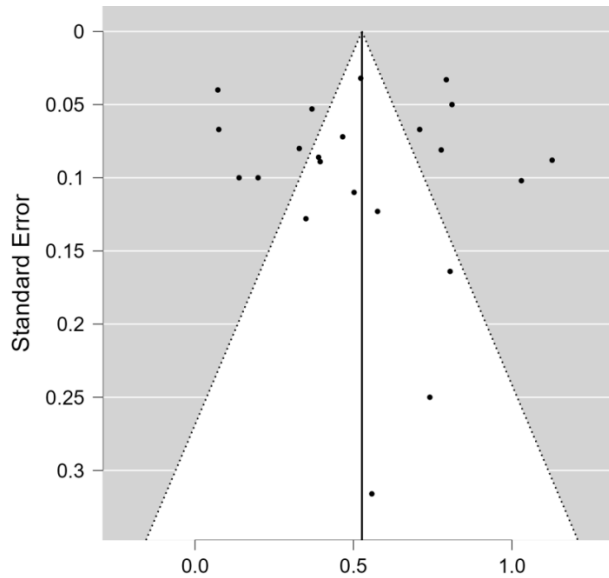


Figure 2: Funnel plot after Trim-Fill diagnosis, 2011-2021 (source: own calculation)

The results of the funnel plot chart had no clear indication of publication bias because the model formed was symmetrical or asymmetrical, so further analysis using Egger's test was necessary. Egger's test results are shown in Table 6.

	<i>Z</i>	<i>p</i>
sei	0.591	0.555

Note. Sei = predictor or standard error

Table 6: Regression test for funnel plot asymmetry (Egger's test), 2011-2021 (source: own calculation)

Table 6 shows $Z = 0.591$ with $p > 0.05$. This confirms that the funnel plot is symmetrical. Thus, there is no publication bias problem in this meta-analysis study.

DISCUSSION

Based on the 22 research results which were analyzed through this meta-analysis, there was a significant positive relationship between reflective thinking and learning achievement (p -value < 0.05). The more skilled students reflect the relationship between concepts, causal relationships, analogous relationships, or differences, the more skilled they are in making decisions, conclusions, and working on questions quickly and precisely for better learning achievements (Turan, Fidan & Yildiran, 2019; Isler, Yilmaz & Dogruyol, 2020).

Furthermore, based on the results of the effect size analysis, the 22 studies showed that the relationship between reflective thinking and student achievement was in the moderate category based on Cohen's effect criteria ($r_{RE} = 0.527$). Students' reflective thinking processes affect learning achievement by responding quickly to a problem and linking what is known and asked in the problem with their previous knowledge to reflect on and determine the right strategy to solve the problem with reasoning (Tsingos-Lucas, 2016; Aldahmash, Alshalhoub, & Naji, 2021). Students' reflective thinking processes can be seen from the confusion and doubt in solving a

problem and obstacles that make students quickly investigate it with their knowledge (Turan, Fidan & Yildiran, 2019; Spears et al., 2021).

Reflective thinking allows students to learn to think about the best strategies in achieving learning objectives (Mirzaei, Phang & Kashefi, 2014b). In addition, reflective thinking can help them integrate their thinking skills by conducting assessments (Maksimovic & Osmanovic, 2019). Reflective thinking is important for students to solve problems optimally (Spears et al., 2021). Therefore, it affects the way students decide on everything including cognitive, affective, and psychomotor activities in the components of learning achievement. This is supported by several studies stating the same theory, including Farahian, Avarzamani & Rajabi (2020), Akpur (2020), Pham et al. (2020), and Chen, Hwang, & Chang (2019).

Furthermore, Kholid et al. (2020) state that students should have reflective thinking skills in the learning process to solve problems of everyday life. With reflective thinking, someone can understand, criticize, assess, find alternative solutions, and evaluate the issues being studied. To improve students' reflective thinking skills, teachers can support them to hone their skills by using problem-based learning models, varied approaches, and open-ended essay questions (Killingsworth & Xue, 2015; Toman, 2017; Mirzaei, Phang & Kashefi, 2014b; Yilmaz, 2020).

In this study, no publication bias was found. Publication bias can be detected through analysis of the symmetrical shape of the funnel plot and Egger's test. They have the same conclusion. Analysis of publication bias is needed to determine the level of significance of the sources used, the quality of relevant research methods, accurate study conclusions, and different sample sizes which will affect minimally biased research conclusions (Nair, 2019; Joobar et al. al., 2012). Therefore, the studies that were not included had the same results as those included as a sample in this meta-analysis.

CONCLUSION

From the results and discussion above, it is confirmed that there is an effect of reflective thinking skills on learning achievement, which is indicated by the effect size of 22 publications which are proven to be heterogeneous and have a positive correlation value in the moderate effect category. Furthermore, publication bias does not exist, which means that the publications under review truly reflect the actual situation. The characteristics of the publications studied show the same sample, namely students, even though they are from various scientific fields. It is recommended that future researchers use similar themes by focusing on the sample of the research publications, such as elementary school, junior high school, high school, or non-formal education students. It is intended that there will be more theories on the relationship between reflective thinking skills and student achievement so that teachers will improve their teaching and consider this topic. The limitation of this research is that some publications are not reputable by Scopus, Web of Science, or SINTA. In fact, the better the reputation of the journal being studied is, the higher the quality of the data presented.

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META-ANALYSIS STUDY: THE RELATIONSHIP BETWEEN REFLECTIVE THINKING AND LEARNING ACHIEVEMENT

ABSTRACT

Reflective thinking is a must-have skill to connect the knowledge obtained with previous knowledge and can be seen from learning achievement. This study aims to prove and determine the relationship between reflective thinking and learning achievement and its effect size. This study used quantitative meta-analysis method. Reflective thinking is the independent variable and learning achievement is the dependent variable. The data sources were obtained from online database searches on Google Scholar and international journal platforms from 2012 to 2021. Based on the search, 22 research publications met the predetermined criteria through a strict screening. Quantitative meta-analysis with correlation meta-analysis type was used to analyze the data. The software used was JASP 0.8 4.0. The results showed that this research H_0 is rejected. It can be concluded that there was a significant relationship between reflective thinking and student achievement ($z = 8.139$; $p < 0.001$; 95%CI [0.400; 0.654]). The effect of reflective thinking on student achievement was in the medium category ($r_{RE} = 0.527$). The findings are consistent with those of previous research on reflective thinking skills and learning achievement. **Keywords:** Learning Achievement; Meta-Analysis Study; Reflective Thinking.

Research Highlight:

The assessment of 22 studies about reflective thinking
There is a positive relationship between reflective thinking and learning achievement around the world
The relationship between reflective thinking and learning achievement reflective thinking on student achievement was in the medium category
The evaluation of important aspects of education through comprehensive meta-analysis study

INTRODUCTION

Developing students' higher-order thinking skills (HOTS) is a complex multidimensional educational challenge. This thinking skill is part of the general skills that must be trained to students in all subjects to improve their performance and reduce their weaknesses (Arif, 2019). According to Qasrawi and Beni Abdelrahman (2020), cognitive processes of analysis, evaluation, and creation in Bloom's taxonomy are grouped into HOTS while knowledge, understanding, and application are grouped into LOTS. Yen and Halili (2015) state that thinking skills, especially HOTS, are the main benchmark in achieving learning objectives. Included in HOTS are critical thinking, logical thinking, reflective thinking, metacognition, and creative thinking. One of HOTS is reflective thinking (Setiawan et al., 2021; Dwyer, Hogan and Stewart, 2014).

Reflective thinking is a thinking activity that can make students try to connect the knowledge they have acquired to solve new problems related to their old knowledge (Choy and Oo, 2011). Khalid et al. (2020) state that the process of reflective thinking can be described as information or data that is used to respond, comes from within (internally), can explain what has been done, realize mistakes and correct them, and communicate ideas with symbols or images instead of a direct object. Reflective thinking is part of the critical thinking process, which refers to the process of analyzing and making judgments about what has happened. Reflective thinking is the

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most important skill in encouraging learning during complex problem-solving situations because it allows students to step back and think about how to solve the problem and how a set of problem-solving strategies is accomplished to achieve their goals (Shavit and Moshe, 2019; Orakcı, 2021).

According to Dewey (Ozudogru, 2021), reflective thinking means being active, continuous, persistent, and carefully considering everything that is believed to be true or the format of knowledge with supporting reasons leading to a conclusion. Boody, Hamilton, and Schon (Ozudogru, 2021) explain the characteristics of reflective thinking as follows: (1) reflection as retrospective analysis or recall (ability to judge oneself), (2) reflection as a problem-solving process (awareness of how one learns), (3) self-critical reflection (developing self-improvement continuously), and (4) reflection on self-confidence and success.

Students who have a reflective style tend to spend more time responding and reflecting on the accuracy of answers. Reflective individuals are very slow and careful in responding but tend to give correct answers (Kholid et al., 2020). Reflective students are more likely to perform tasks such as remembering structured information, reading by understanding and interpreting texts, solving problems, and making decisions. They may also determine their own learning goals and concentrate on relevant information. They usually have high work standards (Choy and Oo, 2011; Kablan and Gunen, 2021).

Empowering reflective thinking skills is the task of all levels of education. Belief in reflective thinking plays an important role because it is closely related to how students can evaluate themselves. Reflective thinking can also be used to encourage thinking processes during problem-solving ~~because,~~ With reflective thinking, students can predict the correct answer immediately so that they can explore problems by identifying the concepts involved, using various strategies, building ideas, drawing conclusions, re-examining solutions, and developing alternative strategies (Mirzaei, Phang and Kashefi, 2014a; Kablan and Gunen, 2021).

In addition, Qasrawi and Beni Abdelrahman (2020) state that HOTS is closely related to thinking skills following the cognitive, affective, and psychomotor domains as an integral part of the teaching and learning process. Therefore, reflective thinking skills, one of HOTS, influence learning achievement in terms of cognitive, affective, and psychomotor aspects. Several studies mention that reflective thinking contributes to learning achievement, including the research of Farahian, Avarzamani, and Rajabi (2020), Akpur (2020), Pham et al. (2020), Hsia and Hwang (2020), Aslam et al. (2021), etc.

Studies related to reflective thinking and its relationship to learning achievement tend to be carried out partially or only part in certain situations, so that it is difficult to see as a whole. For instance: Pham et al. (2020) examine reflective thinking skills and learning achievement only for ELF students in the context of academic writing. Then, Aslam et al. (2021) examines reflective thinking skills and specific learning achievement only for the students of teacher education. Furthermore, Hsia and Hwang (2020) examine reflective thinking skills, dance learning achievement, self-efficacy and task load, especially in flipped learning conditions. Studies that are not comprehensive and ~~focused specifically~~ explicitly focused on the effect of reflective thinking skills and learning achievement have several shortcomings, such as: the research results are often biased and only applied to certain situations so that these are difficult to apply to other situations.

One alternative to thoroughly analyze the relationship between reflective thinking and learning achievement is by using a meta-analysis study. Meta-analysis is a systematic and quantitative research using the existing studies used by other researchers to obtain accurate conclusions

(Briggs, 2005; Basu, 2017). Malićki et al. (2021: 3) state, “Meta-analysis is a form of research using data from other existing studies (secondary data)”. Therefore, it is a quantitative research method by analyzing quantitative data from the results of previous studies to reject or failed to reject their hypotheses. This type of research method is increasingly popular to summarize research results. Meta-analysis is widely used in the study of research theory. In addition, it can be a source of foundation in policymaking (Borenstein et al., 2009; King and He, 2006).

In the meta-analysis, the data processed are used to make statistical conclusions. The data can be expressed by various measures that are calculated or searched in advance by formulas in various mathematical equations, which are closely related to the research objectives of the meta-analysis carried out (Pereira et al., 2019; Turner, Bird and Higgins, 2013). This size is known as the effect size. Meta-analysis includes content analysis that encodes the characteristics of a study, such as age, research location, or other domains in a scientific field. Effect sizes with the same characteristics are grouped and compared (Mueller et al., 2018).

Meta-analysis has some advantages, including (1) meta-analysis procedures apply useful disciplines in summarizing research findings; (2) meta-analysis is conducted in a more sophisticated manner than conventional review procedures, which tend to rely on qualitative summaries or “vote-counting”; (3) meta-analysis can find influences or relationships that are obscured in other approaches to summarizing research; (4) meta-analysis provides an organized way of dealing with information from a large number of research findings under review (Briggs, 2005; Borenstein et al., 2009; Basu, 2017).

Based on the explanation above, reflective thinking skills are very important for every student at all levels of education. To make an overview of the relationship between reflective thinking and learning achievement around the world, a meta-analysis study is needed. This is the first meta-analysis study that tests the universality of this relationship among participants from different countries. Therefore, this study aims to prove and determine the effect size of the relationship between reflective thinking and learning achievement through a quantitative meta-analysis approach.

MATERIALS AND METHODS

Research Design

~~Quantitative~~ The quantitative meta-analysis method was used in this study. Quantitative meta-analysis is a statistical technique that combines two or more similar studies to obtain a quantitative mix of data (Mueller et al., 2018). Viewed from the process, meta-analysis is a retrospective observational study where the researcher recapitulates the data without performing experimental manipulation. The recapitulated data were obtained from research publications related to the relationship between reflective thinking skills and learning achievement at the tertiary level.

Eligibility Criteria

The research publications were selected by several criteria with the aim that the results of this extensive analysis can be more centralized. The studies to be included depend on the purpose of the meta-analysis (Tawfik et al., 2019). Therefore, the meta-analysis study hypothesis is very helpful in determining the inclusion and exclusion criteria that should be used from the outset ~~for the identification of~~ to identify relevant studies (Higgins et al., ~~2018~~2019). The criteria for selecting the research publications studied are (1) publications that can be searched in search databases of online international journals such as Google Scholar, Springer, Eric, Proquest,

SAGE, ERIC, et al.; (2) publications from various countries; (3) publications written in English; (4) publications with Scopus, Web of Science, SINTA indexes; (4) publications with sample students; (5) publications from 2011 to 2021; (6) publications that have a value of (r), (t) or (F) which explains the relationship between reflective thinking skills and learning achievement; and (8) the samples studied ≥ 10 .

Data coding

Malički et al. (2021: 2) state that coding in meta-analysis is 'the most important requirement to facilitate data collection and analysis'. Therefore, the instrument in this meta-analysis was a coding category sheet. The coding describes the characteristics of the publications used, such as the year of publication, country of origin of the study, publication sample (N), correlation value (r_{xy}), t -value, F -value, and remarks containing accreditation/reputation information of the journal. The distribution of publications is presented in Table 1.

Authors	Year	Sample	N	r	t	F	Remarks
Tuncer and Ozeren	2012	University students	356	0.353	7.109		Elsevier
Hsieh and Chen	2012	Management students	13	0.507	1.950		Web of Science (ESCI)
Ambrose and Ker	2013	Medical students	1000	0.480			Scopus Q1
Alatas	2014	Physics students	156	0.651			Science and Technology Index (SINTA 2)
Afshar and Hamzavi	2014	ELF students	223	0.610			Web of Science (ESCI)
Chang and Lin	2014	Student	104	0.196	2.020		Scopus Q1
Yilmaz and Keser	2015	Open students	103	0.138	1.400		Scopus Q1
Laio and Wang	2016	Medical students	86	0.463	4.7994	23.034	Scopus Q1
Elaldi	2016	Medical students	64	0.337	2.815		
Ghanizadeh and Jahedizadeh	2017	Student	196	0.435	6.7298	45.290	Scopus Q2
Kalantari and Kolahi	2017	ELF students	158	0.318			Scopus Q1
Asakereh and Yousofi	2018	ELF students	132	0.810			Scopus Q2
Hosseini, Maktabi, and Manijeh	2018	Student	899	0.660			Scopus Q2
Ramdani and Badriah	2018	Biology students	137	0.371			Science and Technology Index (SINTA 3)
Zulu and Haupt	2018	Graduate students	100	0.774			Proceeding
Chen, Hwang and Chang	2019	Graduate students	19	0.629	3.340		Scopus Q1
Turan and Koc	2019	University students	640	0.071	1.815		Web of Science (ESCI)
Farahian,	2020	ELF students	69	0.520			Scopus Q1

Avarzamani, and Rajabi							
Akpur	2020	ELF students	227	0.074	1.120		Scopus Q1
Pham, Trinh and Thi	2020	Student	40	0.667			Scopus Q2
Hsia and Hwang	2020	Dance students	129	0.375	4.5717	20.900	Scopus Q1
Aslam et al.	2021	University students	400	0.670			Scopus Q2

Table 1: Comparison of 22 studies based on N , r , t , and F values, 2011–2021 (source: own calculation)

Data Analysis

The data analysis in this study was carried out through the following steps: (1) analysis of the characteristics of the research sample; (2) data coding; (3) conversion of the values of t and F to the value of r correlation with the formula below;

$$F = t^2 \quad (1)$$

$$t = \sqrt{F} \quad (2)$$

$$r = \frac{t}{\sqrt{t^2 + N - 2}} \quad (3)$$

(4) heterogeneity test of effect size; (5) calculation of the summary effect or mean effect size; (6) creating forest plots and funnel plots; (7) hypothesis testing; (8) checking publication bias. The data were analyzed using correlation meta-analysis.

At the hypothesis testing stage, the p-value obtained was used to test the following hypothesis.

H_0 : There is no significant relationship between the reflective thinking and learning achievement

H_a : There is a significant relationship between the reflective thinking and learning achievement

Effect size can be categorized into the values of 0–1 based on Cohen's effect size criteria (Cohen et al., 2020). The software used in this research was JASP 0.8 4.0 because it can be installed on various computer operating systems, has Cohen's criteria options, provides assumption testing, and has many helpful features for those who want to learn the analysis and interpretation of statistical results. The Cohen's effect size criteria are presented in Table 2.

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Value	Criteria
< 0 + / -.1	Weak effect
< 0 + / -.3	Modest effect
< 0 + / -.5	Moderate effect
< 0 + / -.8	Strong effect
≥ + / -.8	Very strong effect

Table 2: Cohen's Effect Size Criteria (Source: Cohen et al., 2020)

RESULTS

Based on the analysis of 22 publications with specific criteria, various values of r , t , and F were obtained for each study. Before performing the heterogeneity test, the researchers converted the t - or F -values of all research publications that have no r -value to r -value. The results of the heterogeneity test are presented in Table 3 and residual heterogeneity estimates are presented in Table 4.

	Q	df	p
Omnibus Test of Model Coefficients	66.248	1	< 0.001
Test of Residual Heterogeneity	41.734	21	< 0.001

Note. p -values are approximate.

Note. The model was estimated using the Restricted ML method.

Table 3: Heterogeneity test, 2011–2021 (source: own calculation)

Estimate	
τ^2	0.081
τ	0.284
I^2 (%)	94.707
H^2	18.892

Table 4: Residual heterogeneity estimates, 2011–2021 (source: own calculation)

The results of the heterogeneity test above showed that $Q = 411.734$ with $p < 0.001$; τ^2 or $\tau > 0$; I^2 (%) is close to 100%; it means that the 22 effect sizes of the analyzed studies were heterogeneous. Furthermore, an analysis of the estimation of the summary effect or mean effect size was carried out, and a publication bias test was performed using a random effect approach. The results of the analysis of the summary effect or mean effect size is presented in Table 5.

	Estimate	Standard Error	z	p	95% Confidence Interval	
					Lower	Upper
intercept	0.527	0.065	8.139	< 0.001	0.400	0.654

Note. Wald test

Table 5: Summary effect or mean effect size, 2011–2021 (source: own calculation)

The results of the analysis using the random effect model showed a significant positive correlation between reflective thinking and student achievement ($z = 8.139$; 95%CI [0.400; 0.654]). The p -value which shows < 0.001 proves that this research H_0 is rejected. It can be concluded that there is a significant relationship between the reflective thinking and learning achievement. The relationship between reflective thinking and student achievement was included in the moderate category ($r_{RE} = 0.527$).

Furthermore, the analysis results are presented using a visually attractive graphical method, referred to as forest plots. Forest plots allow us to know the estimated combined effect depicted by plots (dots) at certain intervals at the same time to make comparisons between studies clearer. A chart of the forest plots of the 22 analyzed studies is presented in Figure 1.

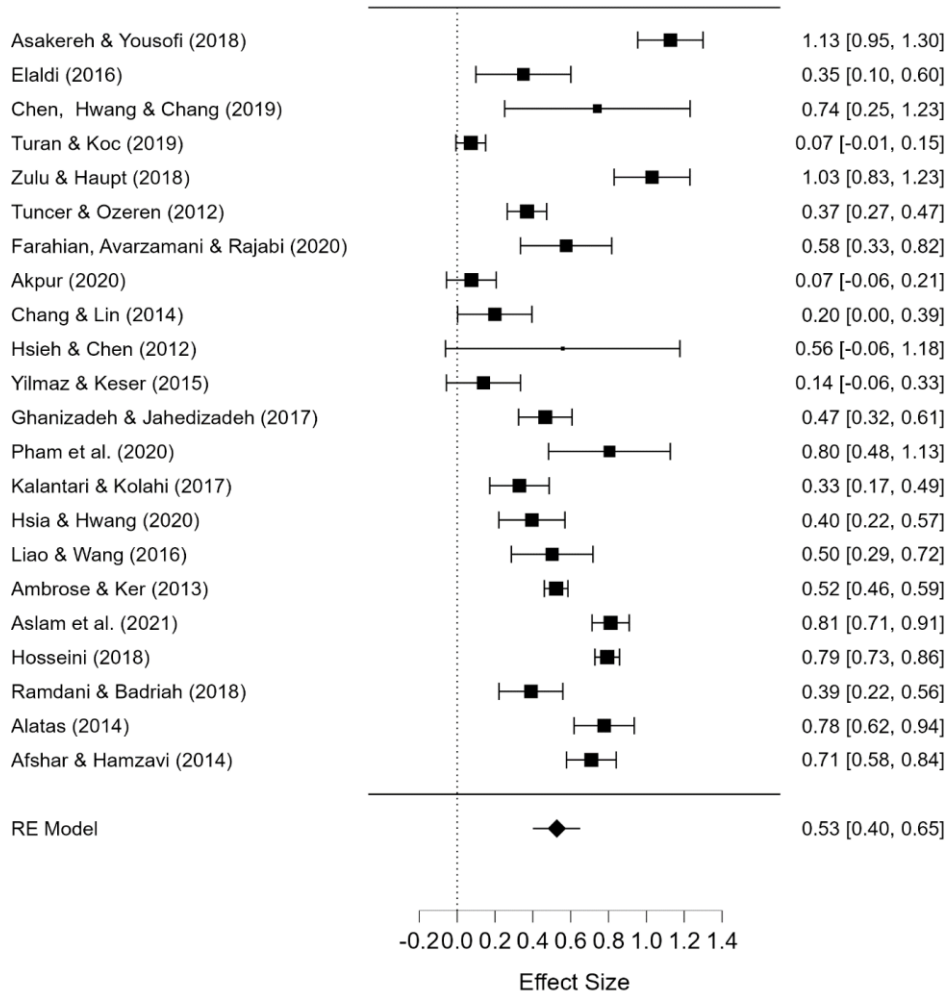


Figure 1: Meta-analysis forest plot, 2011-2021 (source: own calculation)

Based on the forest plot chart, the effect sizes of the analyzed studies vary from -0.06 to 1.30. Furthermore, the funnel plot was made. Begg's funnel plot is a scatter diagram used in meta-analysis to visually detect the possibility of publication bias (symmetrical or asymmetrical research sample). **A funnel plot chart for the 22 studies analyzed is presented in Figure 2.**

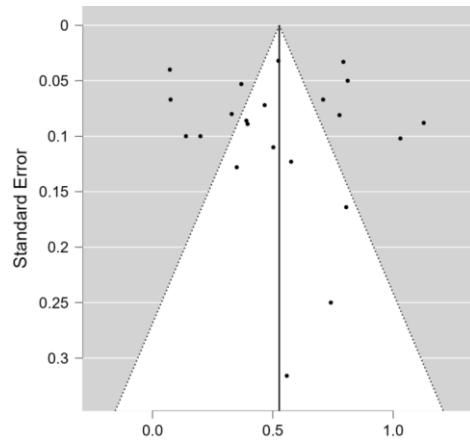


Figure 2: Funnel plot after Trim-Fill diagnosis, 2011-2021 (source: own calculation)

The results of the funnel plot chart had no clear indication of publication bias because the model formed was symmetrical or asymmetrical, so further analysis using Egger's test was necessary. Egger's test results are shown in Table 6.

	<i>Z</i>	<i>p</i>
sei	0.591	0.555

Note. Sei = predictor or standard error

Table 6: Regression test for funnel plot asymmetry (Egger's test), 2011-2021 (source: own calculation)

Table 6 shows $Z = 0.591$ with $p > 0.05$. This confirms that the funnel plot is symmetrical. Thus, there is no publication bias problem in this meta-analysis study.

DISCUSSION

Based on the 22 research results which were analyzed through this meta-analysis, there was a significant positive relationship between reflective thinking and learning achievement (p -value < 0.05). The more skilled students reflect the relationship between concepts, causal relationships, analogous relationships, or differences, the more skilled they are in making decisions, conclusions, and working on questions quickly and precisely for better learning achievements (Turan, Fidan and Yildiran, 2019; Isler, Yilmaz and Dogruyol, 2020).

Furthermore, based on the results of the effect size analysis, the 22 studies showed that the relationship between reflective thinking and student achievement was in the moderate category based on Cohen's effect criteria ($r_{RE} = 0.527$). Students' reflective thinking processes affect learning achievement by responding quickly to a problem and linking what is known and asked in the problem with their previous knowledge to reflect on and determine the right strategy to solve the problem with reasoning (Tsingos-Lucas et al., 2016; Aldahmash, Alshalhoub, and Naji, 2021). Students' reflective thinking processes can be seen from the confusion and doubt in

solving a problem and obstacles that make students quickly investigate it with their knowledge (Turan, Fidan and Yildiran, 2019; Spears et al., 2021).

Reflective thinking allows students to learn to think about the best strategies in achieving learning objectives (Mirzaei, Phang and Kashefi, 2014b). In addition, reflective thinking can help them integrate their thinking skills by conducting assessments (Maksimović and Osmanovic, 2019). Reflective thinking is important for students to solve problems optimally (Spears et al., 2021). Therefore, it affects the way students decide on everything including cognitive, affective, and psychomotor activities in the components of learning achievement. This is supported by several studies stating the same theory, including Farahian, Avarzamani and Rajabi (2020), Akpur (2020), Pham et al. (2020), and Chen, Hwang, and Chang (2019).

Furthermore, Kholid et al. (2020) state that students should have reflective thinking skills in the learning process to solve problems of everyday life. With reflective thinking, someone can understand, criticize, assess, find alternative solutions, and evaluate the issues being studied. To improve students' reflective thinking skills, teachers can support them to hone their skills by using problem-based learning models, varied approaches, and open-ended essay questions (Killingsworth and Xue, 2015; Toman, 2017; Mirzaei, Phang and Kashefi, 2014b; Yilmaz, 2020).

In this study, no publication bias was found. Publication bias can be detected through analysis of the symmetrical shape of the funnel plot and Egger's test. They have the same conclusion. Analysis of publication bias is needed to determine the level of significance of the sources used, the quality of relevant research methods, accurate study conclusions, and different sample sizes which will affect minimally biased research conclusions (Nair, 2019; Joobar et al. al., 2012). Therefore, the studies that were not included had the same results as those included as a sample in this meta-analysis.

CONCLUSION

From the results and discussion above, it is confirmed that ~~there is an effect of reflective thinking skills on~~ reflective thinking skills affect learning achievement, which is indicated by the effect size of 22 publications which are proven to be heterogeneous and have a positive correlation value in the moderate effect category. Furthermore, publication bias does not exist, which means that the publications under review truly reflect the actual situation. The characteristics of the publications studied show the same sample, namely students, even though they are from various scientific fields. It is recommended that future researchers use similar themes by focusing on the sample of the research publications, such as elementary school, junior high school, high school, or non-formal education students. It is intended that there will be more theories on the relationship between reflective thinking skills and student achievement so that teachers will improve their teaching and consider this topic. The limitation of this research is that some publications are not reputable by Scopus, Web of Science, or SINTA. In fact, the better the reputation of the journal being studied is, the higher the quality of the data presented.

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