PERR
PSYCHO-EDUCATIONAL RESEARCH REVIEWS

Psycho-Educational Research Reviews
11(*1*), 2022, 283-299
www.perrjournal.com

The Relationship between Critical Thinking and Academic Achievement: A Meta-Analysis Study

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Keywords

Critical thinking skills
Critical thinking dispositions
Academic achievement
Meta-analysis
Correlation

Article Info:
Received : 02-07-2021
Accepted : 18-11-2021
Published : 11-04-2022

DOI: 10.52963/PERR_Biruni_V11.N1.18

Abstract

This study aimed to investigate the relationship between critical thinking and academic achievement via meta-analysis. The studies obtained after literature review were reviewed by two researchers according to inclusion criteria and meta-analysis was carried out with 67 data from 47 individual studies. The mean effect size was 0.428 under random effects model. This value indicated that there was a medium relationship between critical thinking and academic achievement. While this effect size did not differ according to sub-groups of critical thinking type, school level, and publication type, it differed according to sub-groups of region, discipline, and outcome type. In the sub-group of region, Asia-Pacific had the greatest mean effect size. In the sub-group of discipline, foreign language had the greatest mean effect size. Besides, the mean effect size of Tests/Exams was greater than GPA.

To cite this article: Orhan, A. (2022). The relationship between critical thinking and Academic achievement: A meta-analysis study. *Psycho-Educational Research Reviews, 11*(1), 283-299. doi: 10.52963/PERR_Biruni_V11.N1.18

INTRODUCTION

Great importance is attached to the enhancing of critical thinking (CT) at each level of education in many countries today (Stassen, Herrington & Henderson, 2011). One of the main reasons behind this trend is the idea that high CT skills are vital for academic achievement (AA). Also, the future of society is depended on individuals with higher CT skills (Tican & Taşpınar, 2015) because when the individuals have higher CT skills, they will not only be more successful academically but also be more positive socially (Kökdemir, 2003). Therefore, CT skills are seen as an increasingly important outcome (Halpern, 1998) and primary goal (Astin, 1993; Stedman & Adams, 2012) of colleges and universities. In this sense, CT has also gained attention in research related to AA (Ghanizadeh, 2017).

CRITICAL THINKING

Philosophy, cognitive psychology, and education research are the three disciplines that dominate the discussion on the definition of CT (Lewis & Smith, 1993; Sternberg, 1986). From a philosophical perspective, CT can be dated back to the times of Socrates and it can be said that with his well-known Socratic dialog method, Socrates was trying to encourage students to query well-known opinions and distinguish between those ideas which are reasonable and those which are not (Paul, 1990). Since CT has flourishing importance in teaching and learning, various researchers have provided different definitions for it. Paul (1990) defined CT as a mode of thinking about an idea or a problem in which the individual evaluates whether the information, evidence, and results are valid, logical, correct or reasonable. During this intellectually well-organized thinking process, the thinker has an active role, takes responsibility, and improves the quality of thinking process by analysing, evaluating, and re-constructing it (Paul & Elder, 2001). CT is a reasonable and reflective thinking process that focuses on making a judgment about the quality of knowledge (Beyer, 1995) and deciding what to believe or to do (Ennis, 1993). CT is the use of mental processes and cognitive skills that would enhance the possibility of desired behaviours (Halpern, 2003) and that people use while solving problems and making decisions (Sternberg, 1986). Some of these cognitive skills or strategies are problem solving, identifying issues and assumptions (Pascarella & Terenzini, 1991), deducing conclusions (Angelo, 1995; Sternberg, 1986), decision making (Halpern, 2003), analysing and evaluation of arguments, and making inferences (Lai, 2011; Facione, 2000). Pintrich (1999) described CT as using existing knowledge in new situations to solve problems or make decisions concerning the standards of excellence.

CT should be conceptualized in two dimensions as skills and dispositions. It can be said that CT dispositions can be seen as a tendency to use CT skills (Pascarella & Terenzini, 1991). Having high CT skills does not guarantee that the individual will use these skills in school or workplace (Paul & Elder, 2001; Siegel, 1988). There are two things that make the individual a successful critical thinker. The first is CT skills, and the second is the dispositions. Therefore, CT dispositions are also essential for students because they ensure that the individual will use CT skills not only in the classroom but also later when they start to work.

CRITICAL THINKING AND ACADEMIC ACHIEVEMENT

Higher-order thinking skills are needed to meet academic goals in every discipline (Facione & Facione, 1997). Including the improvement of these thinking skills like CT, creative thinking or problem solving among the primary goals of educational institutions will both increase the AA of students and make students more equipped individuals (Halpern, 2003). According to Pirozzi (2003), individuals with high CT skills use their time efficiently, skilfully plan and use the limited time and limited knowledge they have, effectively organize the information, problem or decisions, and reach a result. The most basic feature of a critical thinker is self-knowledge. Individuals with CT skills are aware of their strengths and weaknesses, shortcomings, and limitations (Ruggerio, 1990). Besides, the critical thinker can skilfully use existing knowledge and experience in new situations (Pascarella & Terenzini, 1991;

Beyer, 1995; Ennis, 2011). Paul and Elder (2001) defined CT as the skill of analysing and evaluating one's own thinking system. The purpose of this analysis and evaluation is to improve one's own thinking system within the framework of certain standards set by him/her. CT equips students with a necessary lens into their learning and thinking processes and enables them with advanced and complex ability to actively take responsibilities in their learning and helps them to monitor themselves. Therefore, CT makes the individual an experienced and efficient learner (Moon, 2008). CT provides better learning experiences by encouraging the student to examine, evaluate and research the acquired knowledge in depth (Dwyer, Hogan, & Stewart, 2014; Shehab & Nussbaum, 2015) and thus increases AA (Kwan & Wong, 2015). Therefore, it can be said that CT is an important skill for AA (Scott & Markett 1994).

In literature, many studies concluded that CT skills or dispositions are significantly associated with AA (Pitt et al., 2015; Giddens & Gloeckner, 2005; Afshar, Rahimi & Rahimi, 2014; D'Alessio, Avolio & Charles, 2019; Ghanizadeh, 2017). On the contrary, there are also other studies which concluded that CT skills or dispositions are not significantly related to AA (Shirazi & Heidari, 2019; Mahmoud, 2012; Mohammadi, Moslemi & Ghomi, 2016; Ku & Ho, 2010b; Azar, 2010; Tafazzoli et al., 2015). Therefore, it can be said that studies on CT and AA have reached some vague results. Also, the studies concluded varying magnitudes on the relationship between CT (skills and dispositions) and AA. So, meta-analysis studies, which can provide a holistic portrait of the relationship between these two variables, are needed. In the literature, there is a meta-analysis study on the relationship between CT and AA (Fong et al., 2017). However, it can be said that this study has a limitation because it focused on just college students' AA. Also, it included the studies carried out before January 2015. Therefore, it can be said that this study is more inclusive because it investigated the relationship between CT and the AA of students from any school levels. In this study, it was aimed to perform a meta-analysis based on the relationship between CT and AA by combining the results of the previous studies conducted between January 2015 and October 2020. In this sense, answers to the following questions were sought for:

1. What is the relationship (direction and magnitude) between CT and AA?
2. Does this relationship differ by different variables (region, CT type, school level, discipline, publication type and outcome type)?

METHOD

This study is a meta-analysis study. Meta-analysis is a statistical analysis which lets us compare and combine the results of similar research on a certain topic consistently and coherently (Cohen, Manion & Morrison, 2007). Thanks to meta-analysis, we can bring the results of quantitative studies together systematically (Borenstein et al., 2009) and reach a general conclusion. In other words, we can obtain in-depth information (Durlak, 1995) and interpret the knowledge accumulated in a specific area in a consistent way (Schmidt & Hunter, 2015) by statistically combining the results of individual studies on a given topic. When performing meta-analysis in this current study, PRISMA guidelines by Moher et al. (2009) were followed.

COLLECTION OF STUDIES

According to Springer, Stanne & Donovan (1999), studies should be involved in the meta-analysis in consideration of certain criteria. However, these criteria need to be set very carefully because if the criteria are too broad, the qualities of the collected primary studies can decrease. Also, if the criteria are too strict, few studies may be involved in the analysis and it may prevent generalizability of the results. Therefore, after inclusion criteria were determined to examine the studies collected during the literature review, the studies were investigated by two researchers in this current study. Publication bias can be seen as a vital problem while conducting meta-analysis studies (Rosenthal, 1979).

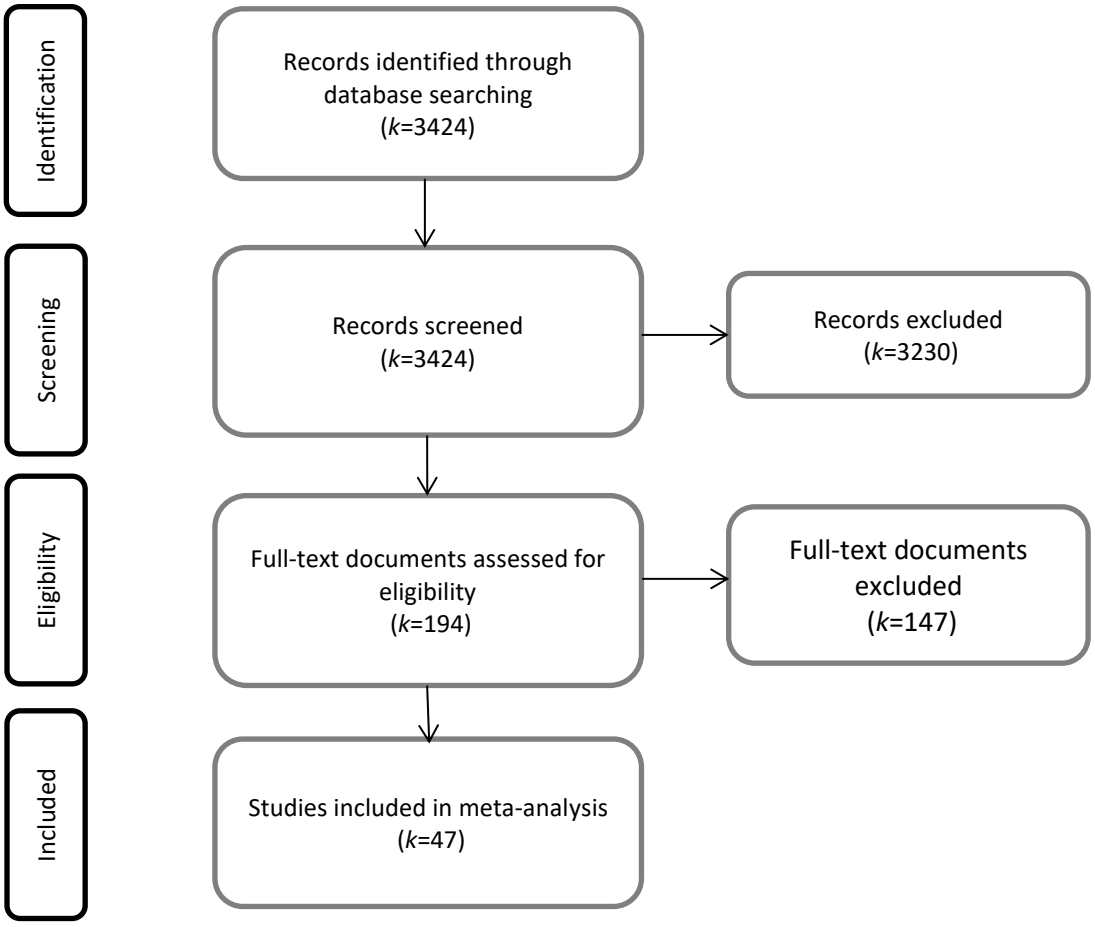
Publication bias can occur when only studies published in research journals are included in meta-analysis because studies which concluded significant results have more chance to be published in the academic journals than the studies that have non-significant results (Rothstein, Sutton & Borenstein, 2005). Therefore, including as many and different types of studies as possible in meta-analysis can prevent this problem. For this reason, the researcher attempted to include all types of studies (i.e. published studies in the research journals, conference papers, book chapters, and unpublished postgraduate theses) that investigated the relationship between CT and AA and reported the necessary data to estimate the ES.

The criteria set for the inclusion of the studies can be seen as follows;

1. The study must be carried out between January 2015 and October 2020.
2. The study must be a correlational one that examines the relationship between CT and AA.
3. The measurement tools must have good psychometric properties.
4. Sufficient statistical data to estimate the ES must be reported.

Some online databases, namely, Google Scholar, Scopus, Web of Science, ULAKBİM, and Turkish National Thesis Centre were searched with “critical thinking” OR “critical thinking skills” OR “critical thinking disposition” AND “academic performance” OR “academic success” OR “academic achievement” search pattern in Turkish and English to find the studies examining the relationship between CT and AA. After the literature review, 3424 studies were found by the last search on the 31st of October 2020. Firstly, the studies were investigated through their titles and abstracts and 3230 studies were excluded because of some reasons (e.g., language of the study, not accessible full text, and duplicates). Then, 194 studies were reviewed by two researchers according to the criteria abovementioned and 147 studies were excluded from the study because of some reasons (e.g., not a correlational study on the relationship between CT and AA, not have sufficient statistical data to estimate the ES) and 47 studies were included. Since more than one data were shared in some of these studies, meta-analysis was carried out with 67 data (from 47 unique studies). Figure 1 shows the flow diagram.

Figure 1. *Flow Diagram*



Also, because some of the studies did not have the necessary statistical data to estimate the ES even if they met the criteria for inclusion, I tried to reach the authors of these studies via e-mail. However, they did not respond. The total sample number of the studies was 13687.

CODING OF THE STUDIES

According to Lipsey and Wilson (2001), the data must be coded correctly to reach valid results. In this current study, the studies were coded with a coding form. The coding form has information such as the name of the study, year published, publication type (article, thesis, and conference paper), author(s), sample characteristics, region, the measurement tool used, and the data required for ES calculations. The author of this study and another researcher who has meta-analysis experience coded the studies independently to increase the reliability. Full consistency was seen between the coders (r=1.00). Table 1 shows the general characteristics of the studies.

Table 1. *Characteristics of the Studies*

		k	%			*k*	%
Region	Africa	9	13.43	Discipline	Education	3	5.26
	America	7	10.45		Sciences	10	17.54
	Asia-pacific	24	35.82		Fine arts	2	3.51
	Europe	27	40.30		Reading comprehension	4	7.02
CT type	Skills	42	62.69		Health sciences	9	15.79
	Dispositions	25	37.31		Social sciences	16	28.07
School level	Primary school	4	6.06		Sports sciences	2	3.51
	Elementary school	17	25.76		Foreign language	11	19.30
	High school	9	13.64	Publication type	Published	45	67.16
	University	36	54.55		Unpublished	22	32.84
Outcome type	GPA	33	50.77				
	Tests/Exams	32	49.23				

As shown in Table 1, most of the studies were carried out in Asia-Pacific (35.82%) and European (40.30%) countries. Also, while measures of CT assessed skills in 42 of the studies (62.69%), 25 of them assessed CT dispositions (37.31%). More than half of the studies were conducted with students enrolled in university (54.55%) and most of the studies were carried out in social sciences disciplines (28.07%). Also, the majority of the studies were published articles (67.16%). Besides, AA outcomes presented in half of the studies were GPA (50.77%).

DATA ANALYSIS AND INTERPRETATION

The data was analysed with Comprehensive Meta-Analysis software. The Pearson correlation coefficient and sample size were used to estimate the ES. While calculating the ES, the Pearson correlation coefficient was first converted to Fisher's Z, and after analyses were made, it was converted back to Pearson correlation coefficient. The confidence interval was determined as 95% for all calculations. The classification set by Cohen (1992) was used for the interpretation of the ES. This classification indicates small, medium, and large ESs with 0.10, 0.30, and 0.50, respectively.

Since publication bias is an important problem that can threaten the reliability of the meta-analysis studies, before calculating the ES, publication bias should be checked firstly (Kromrey & Rendina-Gobioff, 2006; Rothstein, Sutton, & Borenstein, 2005). In this study, publication bias was investigated by funnel plot, Duval and Tweedie's Trim and Fill, Egger's regression intercept, and Rosenthal's fail-safe N test methods.

Some well-known tests such as I^2 value and Q statistics can be used to investigate the heterogeneity in meta-analysis studies (Hedges & Olkin, 1985). When the calculated Q value is higher than the critical limit in X^2 table, we can say that heterogeneity among the studies exists. I^2 value, which takes values from 0% (means no heterogeneity) to 100% (means high heterogeneity), can also be used to check heterogeneity (Cooper, 2017). In this study, heterogeneity was checked with Q statistics and I^2 value.

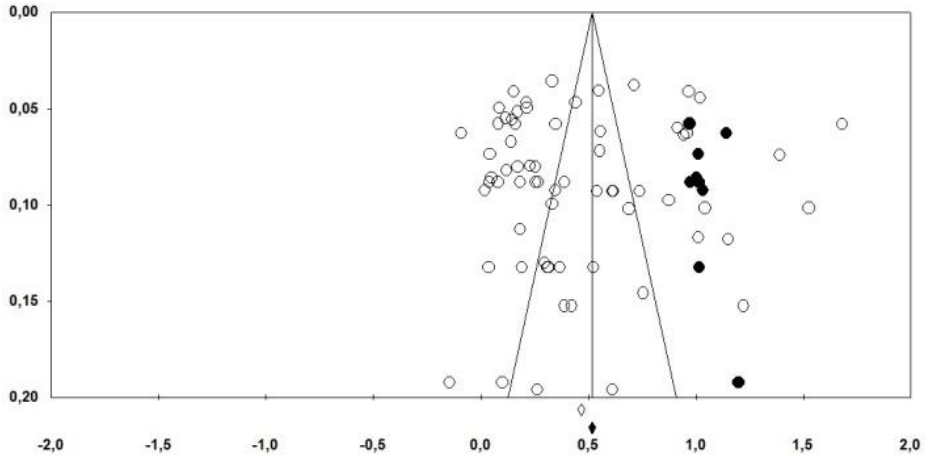
Moderator analyses were carried out with the sub-groups of region (Asia-Pacific, America, etc.), CT type (disposition or skill), school level (primary school, secondary school, etc.), discipline (education, sciences, etc.), publication type (published or unpublished) and outcome type (GPA or test/exams). Moderator analyses were performed with Analog ANOVA. Analog ANOVA provides some Q-statistic values such as between-group (Q_B), within-group (Q_W), and total (Q_{TOTAL}). Q_B statistic can tell us if the categorical variable is a real moderator or not (Lipsey & Wilson, 2001). If Q_B value is significant and higher than the critical limit in X^2 table, we can say that mean ESs differ between categories of the moderator variable.

RESULTS

RESULTS ON PUBLICATION BIAS

The funnel plot which can be seen below was investigated using the trim-and-fill method.

Figure 2. *Funnel Plot*



Empty circles in the funnel plot show the studies which were involved in the analysis and the full (black) ones show the imaginary studies that must be included to eliminate publication bias totally (Duval & Tweedie, 2000). Symmetrically distributed ESs around the general ES in the funnel plot indicate that publication bias does not exist (Borenstein et al., 2009). As shown in Figure 2, it can be assumed that ESs are distributed symmetrically around the general ES. In addition to this, trim-and-fill method estimated that only nine imaginary studies (black circles in the funnel plot) should be added to eliminate publication bias totally. When number of the ESs computed in this study (*k*:67) is taken into account, it can be said that these imaginary studies can be neglected. Also, fail-safe N number (41952) was much greater than the number (345) calculated by the formula of 5k+10 (Fragkos, Tsagris & Frangos, 2014) and this indicated a lack of publication bias. In addition to these, Egger's intercept was -0.398 (95% CI=-3.855–3.058, p=0.818). So, Egger's test showed that there was no publication bias. Overall, it can be claimed that publication bias was not a critical issue for this study.

RESULTS ON THE ES OF THE RELATIONSHIP BETWEEN CT AND AA

The ESs and the heterogeneity test results can be seen in Table 2.

Table 2. *The Estimated ESs and the Heterogeneity Test Results*

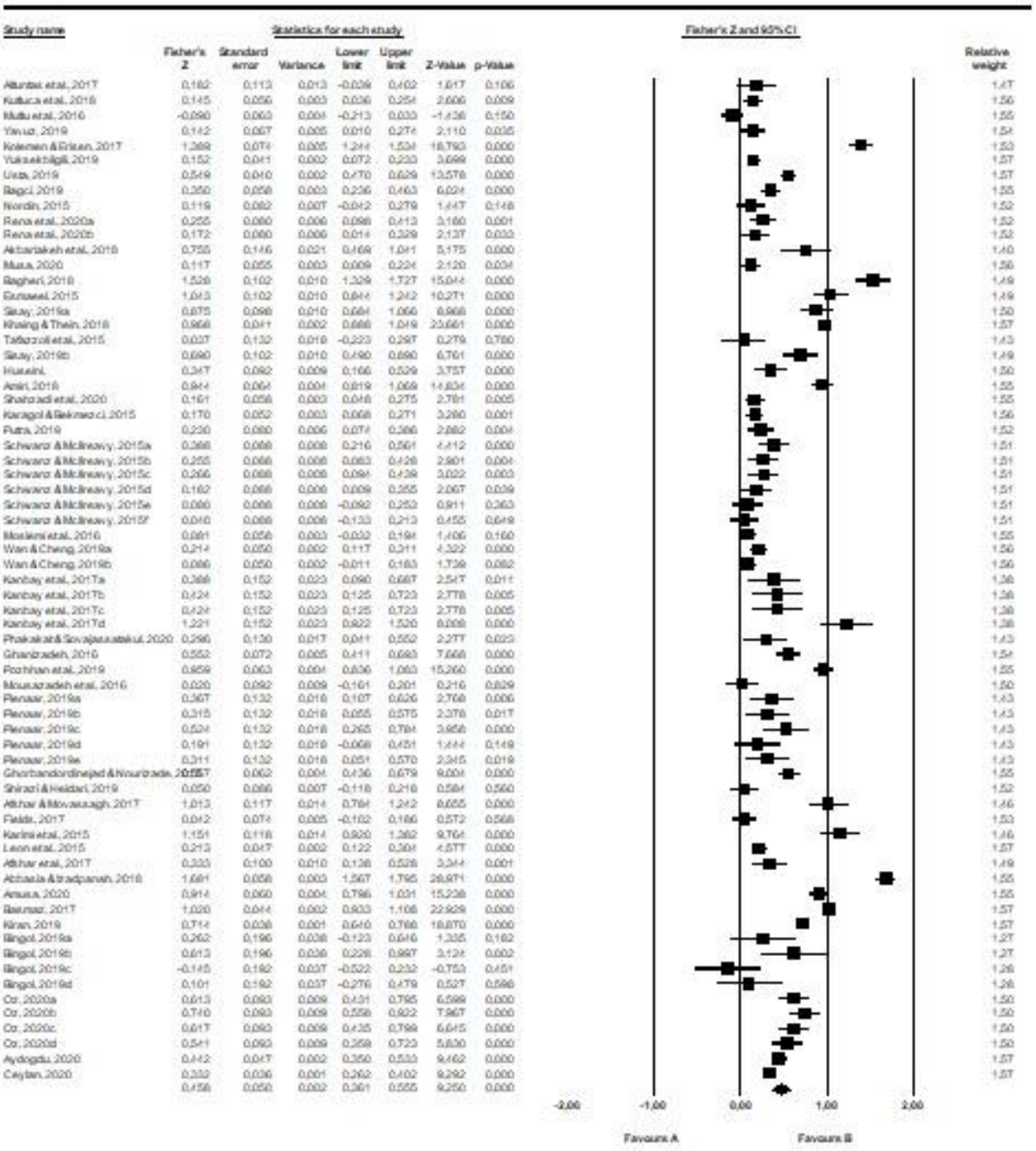
Model	ES	*k*	SE	Z	95% CI		df	Q	p	I^2
					Lower	Upper				
Fixed	0.435	67	0.009	54.140*	0.421	0.449	66	2095.55	0.00*	96.85
Random	0.428	67	0.050	9.250*	0.346	0.504				

*P<0.05; Note that the Pearson correlation coefficient was first converted to Fisher's Z, and after analyses were made, it was converted back to Pearson's r and ES shows the Pearson's r values.

As seen in Table 2, the ES was calculated as 0.428 with a standard error of 0.050 under the random effects model and lower limit of the ES was 0.346 and upper limit was 0.504 with 95% confidence interval. Also, the ES was 0.435 (lower limit: 0.421 and upper limit: 0.449) with a standard error of 0.009 under the fixed effects model. The data were also tested for heterogeneity and the $Q_{(df=66)}$ value was calculated as 2095.55 (p<0.05). The calculated Q value was higher than the critical limit in X^2 table (df=66, $X^2_{(0.05)}$=85.965). So, it can be said that heterogeneity among the studies existed. This finding was confirmed by the I^2 value (96.85%). So, I used random effects model to calculate the ES in this meta-analysis. Indeed, random effects model should be used for meta-analyses which are performed with the studies from social sciences since it is almost impossible to have homogeneity

among the studies from social sciences (Schmidt & Hunter, 2015). The mean ES was 0.428 according to random effects model. This value showed that there was a medium relationship between CT and AA based on Cohen's (1992) classification. The forest plot presents the distribution of the ESs of the studies.

Figure 3. *Forest Plot*



According to the forest plot, out of 67 ESs, only two were negative. So, we can say that CT is positively related to AA.

RESULTS ON THE MODERATOR ANALYSES

Moderator analyses were performed with the sub-groups of region, CT type, school level, discipline, publication type, and outcome type to determine the sources of heterogeneity.

Table 3. *Results of the Moderator Analyses*

Sub-groups			95% CI		df	Heterogeneity test	
		k	ES	Lower Limit	Upper Limit	Q_B-value	p
Region	Africa	9	0.474	0.308	0.612	19.539	0.000
	America	7	0.174	0.077	0.268		
	Asia-pacific	24	0.501	0.333	0.637		
	Europe	27	0.408	0.294	0.510		
CT type	CT skills	42	0.469	0.367	0.560	1.932	0.165
	CT dispositions	25	0.354	0.215	0.479		
School level	Primary school	4	0.434	0.221	0.607	1.786	0.618
	Elementary school	17	0.452	0.299	0.770		
	High school	9	0.568	0.263	0.653		
	University	36	0.383	0.277	0.480		
Discipline	Education	3	0.160	0.090	0.227	42.025	0.000
	Sciences	10	0.491	0.292	0.650		
	Fine arts	2	0.270	0.143	0.388		
	Reading comprehension	4	0.566	0.364	0.716		
	Health sciences	9	0.346	0.133	0.528		
	Social sciences	16	0.223	0.155	0.289		
	Sports sciences	2	0.015	-0.185	0.215		
	Foreign language	11	0.705	0.509	0.831		
Publication type	Published	45	0.449	0.334	0.551	0.579	0.447
	Unpublished	22	0.390	0.281	0.489		
Outcome type	GPA	33	0.341	0.249	0.426	4.330	0.037
	Tests/Exams	32	0.496	0.377	0.599		

Note that the Pearson correlation coefficient was first converted to Fisher's Z, and after analyses were made, it was converted back to Pearson's r and ES shows the Pearson's r values.

As shown in Table 3, the calculated heterogeneity values of the sub-group of CT type (Q_B=1.932; p=0.165), school level (Q_B=1.786; p=0.618) and publication type (Q_B=0.579; p=0.447) were less than the critical values in X^2 table. On the other hand, the heterogeneity values of the sub-groups of region (Q_B=19.539; p=0.000), discipline (Q_B=42.025; p=0.000) and outcome type (Q_B=4.330; p=0.037) were higher than the critical values in X^2 table. So, we can say that the difference between the sub-groups of CT type, school level, and publication type was not statistically significant while the difference between the sub-groups of region, discipline, and outcome type was statistically significant. As it can be seen in Table 3, in the sub-group of region, Asia-Pacific (ES=0.501) had the greatest mean ES. Africa (ES=0.474), Europe (ES=0.408), and America (ES=0.174) followed it, respectively. Besides, in the sub-group of discipline, foreign language (ES=0.705) had the greatest mean ES. Reading comprehension (ES=0.566), sciences (ES=0.491), and health sciences (ES=0.346) followed foreign language, respectively. Also, the mean ES of Tests/Exams (ES=0.496) was greater than GPA (ES=0.341).

DISCUSSION, CONCLUSION AND IMPLICATIONS

This study aimed to examine the relationship (direction and magnitude) between CT and AA. For this purpose, the results of the studies investigating the relationship between CT and AA were analysed with meta-analysis. After literature review, 47 studies that met the inclusion criteria were found and since more than one data were shared in some of these studies, meta-analysis was carried out with 67

data. Publication bias was checked with different methods and it was found out that publication bias was not a critical problem for this study.

Under the random effects model, the ES of the relationship between CT and AA was 0.428. This value showed that there was a medium and positive relationship between CT and AA. Fong et al. (2017) conducted a meta-analysis study on the relationship between CT and college students' AA and found out that there was a medium and positive relationship between them. Therefore, it is possible to say that the results obtained by Fong et al. (2017) coincide with the results of this study. Also, according to Ren et al. (2020) who examined the prediction of CT on AA, CT (both skills and dispositions) made an important contribution to the AA of primary school and university students. In his study, Kettler (2014) compared a group of students with high AA and another group of students with average AA and found out that the group with high AA displayed higher levels of CT. In addition, Ghasemi and Dowlatabadi (2018) found out that CT predicted improvement in language achievement in their study which they carried out with 190 participants using the structural equation model. Similarly, León et al. (2015) carried out a study to investigate the relationship between intrinsic motivation, CT, and AA in music using structural equation model and found out that CT dispositions were positively related to AA in music. In her study, Villavicencio (2011) investigated the mediated effects of negative emotions on the link between CT and AA using the structural equation model and found out that CT was a significant and positive predictor of AA. Therefore, this study is in harmony with previous studies using the structural equation model in the literature. These previous studies stated that CT skills and dispositions were important predictors of students' AA. Also, there are many other empirical and correlational studies that concluded a significant relationship between CT (skills and dispositions) and AA (Ghanizadeh & Mirzaee, 2012; Lee & Loughran, 2000; Facione & Facione, 1997; Ghazivakili et al., 2014; Nold, 2017; Taghva et al., 2014; Taube, 1997). So, it can be said that a diverse body of educational research concluded that CT skills and dispositions had a positive effect on learners' AA.

On the contrary, Richardson, Abraham and Bond (2012) performed a meta-analysis study with primary studies between 1997 and 2010 to reveal the antecedents of university students' AA and concluded that there was a small, significant, and positive correlation between students' CT and AA. Stupnisky et al. (2008) carried out a longitudinal study using the structural equation model with 1196 first-year college students to investigate the relationship among CT dispositions, perceived academic control, and AA and found out CT disposition had a significant but small effect on students' GPAs. However, a greater magnitude for the relationship between CT and AA was found in this study.

Pintrich et al. (1993) described CT as one of the five cognitive strategies which may affect learning. When the relevant literature is examined, it can be said that learning materials oriented towards CT can improve students' AA (Wicaksana, Widoretno & Dwiastuti, 2020; Hairida, 2016; The, Isa, & Omar, 2018). So, it can be said that learning materials and content with specific activities that can advance CT skills such as analysis, deduction, inference, etc. can also improve student's AA. Therefore, as in this study, these results concluded in some prior research revealed the significant relationship between CT and AA. Indeed, learners with high CT (both skills and dispositions) attempt to understand and think about what they are learning (Lee, 2013), can critically analyse and evaluate what they are learning (Phan, 2010), are more inclined to use high-level planning strategies (Ku & Ho, 2010a) and these are associated with AA. CT can improve students' cognitive processes (Adams, 1989; Saido et al., 2015) and they can learn many abilities that can improve their learning. Thanks to high CT skills and dispositions, students can have better abilities of some cognitive skills such as organizing and deeper understanding the information, deduction, explanation, exploring, and inference, etc. (Assaly & Smadi, 2015). Therefore, we can say that students who have high CT skills and dispositions are more likely to have better AA (Khasanah, Sajidan, & Widoretno, 2017; Pitt et al., 2015; D'Alessio, Avolio & Charles, 2019).

MODERATOR ANALYSES

In this study, it was found out that the ES of the relationship between CT and AA did not differ according to sub-groups of CT types, school level, and publication type while it differed according to sub-groups of region, discipline, and outcome type. In the sub-group of region, Asia-Pacific (ES=0.501) had the greatest mean ES. Africa (ES=0.474), Europe (ES=0.408), and America (ES=0.174) followed it, respectively. Besides, in the sub-group of discipline, foreign language (ES=0.705) had the greatest mean ES value. Reading comprehension (ES=0.566), sciences (ES=0.491), and health sciences (ES=0.346) followed foreign language, respectively. Also, the mean ES of Tests/Exams (ES=0.496) was greater than GPA (ES=0.341). According to Fong et al. (2017), the magnitude of the relationship between CT and AA of college students did not differ significantly according to the CT types and publication types. Also, in their study, Ren et al. (2020) conducted a multiple regression analysis to investigate the prediction of CT (skills and dispositions) on AA and concluded that CT skills and dispositions of primary school students (10%) and university students (11%) explained a similar portion of variance in AA. It shows the insignificant difference between the prediction of CT on AA of primary and university students. Therefore, the results of these two studies are in harmony with this study. CT (skills and dispositions) is strongly related to AA and this relationship is constant for all school levels. Based on this result, we can say that including CT instruction in the curriculum can contribute to AA at all school levels. Also, it was found out that, foreign language (ES=0.705) had the greatest mean ES value in the sub-group of discipline and it was followed by reading comprehension (ES=0.566). Having a good verbal ability enables an individual to better understand, interpret and make inferences of the material they interact with (Vukovic & Lesaux, 2013). Also, Facione and Facione (1997) concluded that there was a correlation between CT dispositions and nursing students' verbal scores. CT can be seen as one of the main competences for foreign language learners to be successful (Ghanizadeh & Mirzaee, 2012). In this sense, it can be said that the fact that CT was mostly related to AA of foreign language and reading comprehension is in line with these views in the literature. In this study, it was found out that CT skills (ES=0.469) had a larger association with AA than CT dispositions (ES=0.354) even if the difference between skills and dispositions was not significant. In a similar vein, Facione and Facione (1997) found out that CT skills had a larger correlation with achievement than CT dispositions. Therefore, it may be said that CT skills (such as deduction, explanation, and inference, etc.) are better reflected in AA.

In short, this study concluded that there was a medium and positive relationship between CT and AA. Also, the ES of the relationship between CT and AA did not differ according to sub-groups of CT types, school level, and publication type while it differed according to sub-groups of region, discipline, and outcome type. It can be said that there is a notable theoretical and empirical background in the literature demonstrating the relationship between CT and AA. Learners with high CT skills and dispositions can critically analyse the learning materials and evaluate information and thanks to this invaluable ability, the learners can take an active role in the learning process, evaluate their learning process, dedicate themselves to their tasks, engaged in learning content, thereby become more successful learners. The results of this meta-analysis study also support and contribute to this theoretical relationship.

LIMITATIONS AND IMPLICATIONS FOR OTHER STUDIES

There were several limitations to this study. Therefore, these limitations should be considered while interpreting the results. Firstly, it is not possible to detect the direction of the relationship between two variables with correlation studies. So, this can be shown as the first limitation. It is impossible to answer the question of whether the students' AA is high because of high CT skills or whether the CT skills are high because of high AA with this meta-analysis study. Therefore, other studies should be carried out to appropriately infer causal impact relationship between CT and AA. Secondly, this study is limited in its scope because it only included the studies carried out between January 2015 and October 2020. Lastly, it can be said that this study may have method bias because it

was conducted with only correlational studies. So, the results of intervention studies should also be used in future meta-analyses.

FUNDING

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

DECLARATIONS OF INTEREST

Author(s) declare that they have no conflict of interest.

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APPENDIX

STUDIES INCLUDED IN THE META-ANALYSIS

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