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Is cabri 3d software effective for teaching geometry materials? A meta-analysis study in Indonesia

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Abstract

This study aims to examine the effect of Cabri 3D software in teaching geometry material and explore some potential factors moderating the heterogeneity of students' mathematical academic outcomes. A meta-analysis by selecting the random effect model was employed in this study. The final literature search and selection process determined eight journal articles and six proceeding articles published from 2016 to 2021 and indexed by Scopus and Google Scholar. Numerical and categorical data of every document were extracted to a coding sheet. Data were analyzed by using the Z-test and the Q Cochran test. The tests were assisted by the Comprehensive Meta-Analysis (CMA) software. The result showed that the overall effect size of the Cabri 3D software in teaching geometry materials was g = 0,635. It meant that Cabri 3D software posed a moderately positive effect on students' mathematical learning outcomes in geometry learning. Moreover, Cabri 3D software was significantly effective for teaching geometry material. Some potential factors, such as education level, participant number, and treatment duration, did not moderate the heterogeneity of students' mathematical academic outcomes. This study suggests that mathematics teachers or lecturers utilize Cabri 3D software to teach geometry materials.

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INTRODUCTION

Mathematical content, such as geometry, should be learned and mastered by students in the mathematics learning process (NCTM, 2000). Geometry materials, such as three-dimensional (3D) geometry and geometry transformation, are geometrical contents that students must understand in geometry learning. However, most of the students experience errors in solving geometry problems. Some empirical studies revealed that students often make errors in solving 3D geometry problems (Hidayati et al., 2020; Riastuti et al., 2017; Sulistyorini, 2018; Widiawati et al., 2020). These reports indicate that most students have not understood the 3D geometry material. Riastuti et al. (2017) state that geometry is one of the problematic mathematical contents because it requires students to have spatial visualization ability. Therefore, mathematics teachers or lecturers should use dynamic geometry software such as GeoGebra, Cabri 3D, and Geometer's Sketchpad since the software can support teachers to teach geometry materials and help students enhance their spatial visualization ability.

Cabri 3D is the first dynamic geometry software to develop students' mathematical ideas, spatial visualization, and discovery (Ertekin, 2014). It is a micro-world that enables students to find several ways in solving 3D geometry problems because it facilitates the user to manipulate, rotate, and construct 3D objects, such as cylinders, cones, pyramids, and prisms (Chang et al., 2016; Ertekin, 2014; Güven & Kosa, 2008; Koklu & Topcu, 2012). Güven and Kosa (2008) state that Cabri 3D allows students to make and test conjectures and explore geometrical objects. Also, Çelİk et al. (2016) reveal that through Cabri 3D, students can see the 3D objects clearly, such as the edges and face angles on the paper. It means that Cabri 3D eases students to visualize solid geometrical objects. Thus, Cabri 3D software is an essential tool for mathematics teachers or lecturers to develop visual 3D geometry objects. Consequently, it is expected to enhance students' mathematical academic outcomes, especially in geometry contents.

The effectiveness of the Cabri 3D software for teaching geometry materials has been researched widely in Indonesia. Some studies revealed that Cabri 3D had a significant positive effect on the students' mathematical academic outcome (Adirakasiwi & Warmi, 2018; Hendriana et al., 2019; Kariadinata et al., 2019; Marlena & Nugrheni, 2019; Saumi & Amalia, 2018; Widiastuti & Kurniasih, 2021). Some studies,

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however, showed that Cabri 3D has an insignificant positive effect on the students' mathematical academic outcomes (Ma'sum et al., 2016; Natalliasari & Mulyani, 2017). Moreover, other studies revealed that Cabri 3D had a significant adverse effect on the students' mathematical academic outcomes (Hartatiana et al., 2017; Yuliardi et al., 2021). These reports indicate an inconsistent impact of Cabri 3D software for teaching geometry material.

Some reports showed that Cabri 3D substantially affected the students' mathematical academic outcomes (Adirakasiwi & Warmi, 2018; Hendriana et al., 2019; Kariadinata et al., 2019; Marlena & Nugrheni, 2019; Saumi & Amalia, 2018; Widiastuti & Kurniasih, 2021). Meanwhile, some other reports showed that Cabri 3D had a moderate effect on the students' mathematical academic outcomes (Adirakasiwi, 2016; Apriatna et al., 2020; Batubara & Sari, 2018; Nurjanah et al., 2020). Moreover, other reports showed that Cabri 3D had a weak effect on the students' mathematical academic outcomes (Ma'sum et al., 2016; Natalliasari & Mulyani, 2017). These reports indicated a heterogeneous impact of the Cabri 3D on the students' mathematical academic outcomes. It means a gap in students' mathematical academic outcome levels. Education level, treatment duration, and participant number are predicted as the potential factors in moderating heterogeneity of students' mathematical educational outcomes that must be explored and examined.

Some problems, such as an inconsistent effect of Cabri 3D for teaching geometry materials and a gap in students' mathematical academic outcome level, have to be overcome. A meta-analysis, a series of quantitative synthesis methods to estimate and examine the treatment effect of some relevant studies (Borenstein et al., 2009; Cumming, 2012), can solve the problems. Several meta-analysis studies related to the effectiveness of dynamic geometry software for teaching geometry materials have been carried out massively by some researchers (Cantürk Günhan & Açan, 2016; Juandi, et al,, 2021; Juandi, et al,, 2021b; Li & Ma, 2010; Tamur et al., 2020; Turgut & Turgut, 2018). Some researchers, however, studied the use of GeoGebra software (Juandi, et al., 2021), computer technology (Li & Ma, 2010), and several dynamic geometry software (Cantürk Günhan & Açan, 2016; Juandi, et al,, 2021b; Tamur et al., 2020; Turgut & Turgut, 2018). Meanwhile, this study only focuses on the Cabri 3D software for teaching geometry materials in Indonesia.

This study is expected to provide clear and precise information for mathematics teachers and lecturers regarding the effectiveness of Cabri 3D software for teaching geometry materials. Therefore, this study aims to examine the effect of Cabri 3D on students' mathematical academic outcomes and explore the heterogeneity of students' mathematical educational outcomes across education level, treatment duration, and participant number.

METHOD

The researchers employed a meta-analysis by selecting the random effect model (Borenstein et al., 2009). Some kinds of literature (e.g., Cooper et al., 2013; Hunter & Schmidt, 2004) stated that seven steps need to be taken to conduct the mate-analysis study, as presented in Figure 1.

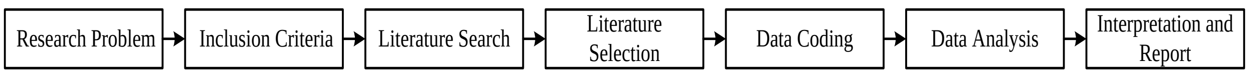

Figure 1. The Meta-Analysis Procedure

Inclusion Criteria

Some inclusion criteria were established to limit the problem breadth of this study. PICOS (Population, Intervention, Comparator, Outcome, and Study design) approach was referred to specify the inclusion criteria (Liberati et al., 2009). The criteria are (1) the intervention in the document was the use of Cabri 3D software; (2) outcome in the document was the mathematical academic outcome; (3) population in the document was secondary students and pre-service teachers; (4) comparator in the document was conventional learning without the use of Cabri 3D software; (5) study design in the document was quasi-experiment with post-test only control group design; (6) every document had sufficient statistical data to compute effect size; and (7) every document was a journal or proceeding article published in 2016 – 2021 and indexed by Scopus and Google Scholar.

Literature Search and Selection

Electronic databases such as Google Scholar and Semantic Scholar were used to search documents. Some combinational keywords such as "dynamic geometry software," "Cabri 3D software", and "mathematical academic outcome" were also employed to ease the search process of the document. In the final search of documents, the researchers found 73 documents from the Google Scholar database and 40 documents from the Semantic Scholar database by using these combinational keywords. Then, these documents were selected by referring to the steps in Moher et al. (2009). The selection process of the document is presented in Figure 2.

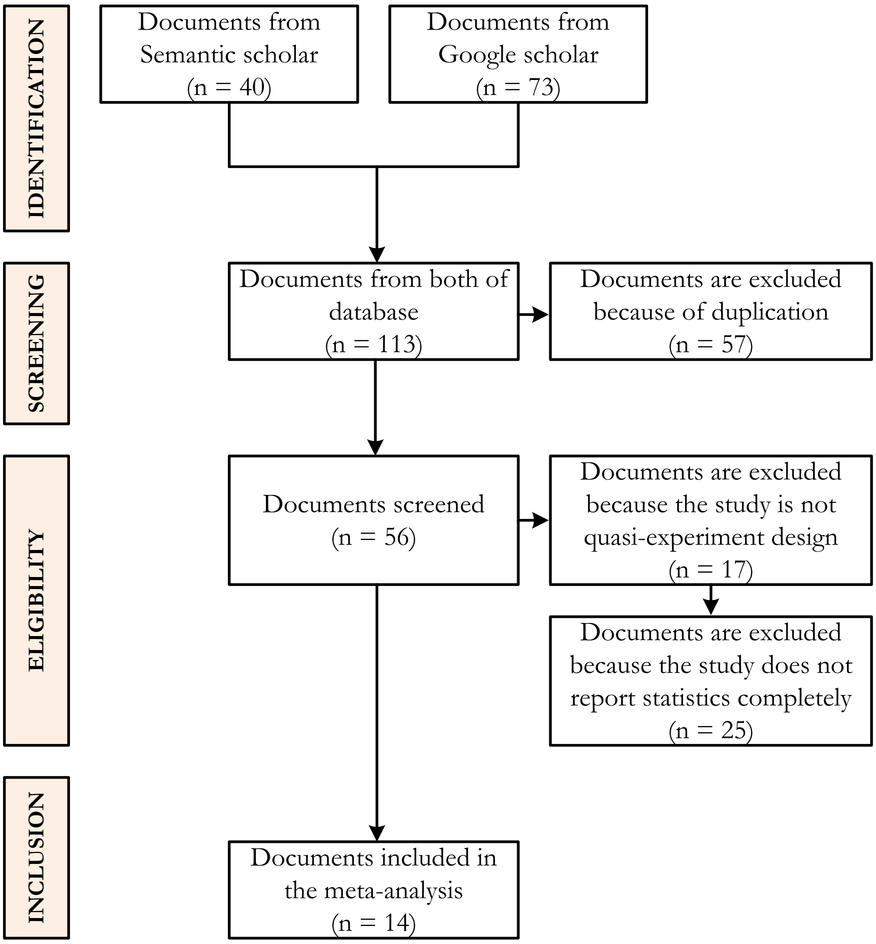

Figure 2. The Document Selection Process

Data Extraction

Statistical data include mean, sample size (N), standard deviation (SD), t-value, and p-value, and some information such as authors, education level, treatment duration, participant number, publication year, indexer, publication type, and database were extracted to a coding form. Communication via email was carried out to some authors to complete the missing data. The involvement of two coders was also conducted to verify the extracted data so that the results of data extraction were valid and credible (Vevea et al., 2019). The distribution of the document is presented in Table 1.

Table 1. Document distribution by education level, treatment duration, participant number, publication year, indexer, publication type, and database

Information	Groups	Frequency	Percentage
Education Level	Secondary Students	12	85,71
	Pre-Service Teachers	2	14,29
Treatment Duration	1 – 4 meetings	1	7,13
	5 – 8 meetings	9	64,29
	9 – 12 meetings	2	14,29
	13 – 16 meetings	2	14,29
Participant Number	$n \leq 30$ participants	7	50,00
	$n > 30$ participants	7	50,00
Publication Year	2016	2	14,29
	2017	2	14,29

Information	Groups	Frequency	Percentage
	2018	2	14,29
	2019	3	21,43
	2020	2	14,29
	2021	3	21,43
Publication Type	Journal Article	9	64,29
	Proceeding Article	5	35,71
Indexer	Scopus	5	35,71
	Google Scholar	9	64,29
Database	Semantic Scholar	7	50,00
	Google Scholar	7	50,00

In addition, some information about the selected paper title, research location, publication year, and publication source are presented in Table 2.

Table 2. The document by the selected paper title, research location, publication year, and publication source

No	Selected Paper Title	Research Location	Publication Source	Publication Year
1	Computer-assisted learning using the Cabri 3D for improving spatial ability and self-regulated learning	Bandung, West Java	Heliyon	2020
2	Pengaruh model problem-based learning berbantuan software Cabri 3D V2 terhadap kemampuan literasi numerasi siswa	South Tambun, West Java	Jurnal Cendikia: Jurnal Pendidikan Matematika	2021
3	Spatial thinking ability and mathematical character students through Cabri 3D with a scientific approach	Bandung, West Java	Journal of Physics: Conference Series	2019
4	Application of brain-based learning models based on scientific approach with 3D Cabries in geometry material to increase the ability of mathematics communication for students of SMAN 1 Karang Baru	Karang Baru, Aceh	Advances in Social Science, Education and Humanities Research	2018
5	Meningkatkan kemampuan komunikasi matematik siswa SMK melalui pembelajaran software Cabri 3D	Karawang, West Java	Jurnal Edukasi dan Sains Matematika	2016
6	Implementasi pembelajaran investigasi berbantuan software Cabri 3D terhadap kemampuan pemecahan masalah matematis dan kemandirian belajar mahasiswa	Tasikmalaya, West Java	Jurnal Penelitian Pendidikan dan Pengajaran Matematika	2017
7	The effectiveness of problem-based learning assisted by Cabri 3D on students' mathematical communication, writing and drawing skills	Rembang, Central Java	Journal of Physics: Conference Series	2020
8	The influence of brain-based learning model with Cabri 3D on students' ability of spatial mathematics	Jakarta	Jurnal THEOREMS	2019

No	Selected Paper Title	Research Location	Publication Source	Publication Year
9	Probit regression analysis in estimating the effect of learning assisted by Cabri 3D on students' mathematical understanding ability	South Tanggerang, Banten	Al-Jabar: Jurnal Pendidikan Matematika	2019
10	Students' spatial reasoning through model eliciting activities with Cabri 3D	Palembang, South Sumatera	Journal of Physics: Conference Series	2017
11	Implementation of mathematics learning-assisted Cabri 3D software to improve the spatial ability of high school students on three-dimensional geometry	Kuningan, West Java	Journal of Physics: Conference Series	2021
12	Pembelajaran matematika berbantuan software Cabri 3D sebagai upaya peningkatan kemampuan spasial siswa	Sindangsari, West Java	Jurnal Matematika Ilmiah STKIP Muhammadiyah Kuningan	2016
13	Penggunaan software Cabri 3D dalam pembelajaran matematika upaya meningkatkan kemampuan visualisasi spasial matematis siswa	Karawang, West Java	Jurnal Silogisme	2018
14	Improving critical thinking ability through guided discovery methods assisted by Cabri 3D software	Medan, North Sumatera	International Journal of Economics, Technology, and Social Sciences	2021

Data Analysis

The effect size was computed by using Hedge's equation. Borenstein et al. (2009) mentioned that Hedge's equation was formulated as follows:

$$g = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}} \times \left(1 - \frac{3}{4df - 1}\right)$$

The value of effect size was categorized as g = 0,00 – 0,20 (weak effect); g = 0,21 – 0,50 (modest effect); g = 0,51 – 1,00 (moderate effect); and g > 1,00 (strong effect) (Cohen et al., 2018). Furthermore, the Z-test was employed to justify the significance of Cabri 3D software for teaching geometry materials (Borenstein et al., 2009). Some potential factors such as education level, treatment duration, and participant number were grouped to be characteristics (See **Table 1**). The Q Cochran test was used to justify the significance of the potential factors in moderating heterogeneity of students' mathematical academic outcomes (Higgins et al., 2003). Documents such as a journal or proceeding article published in the electronic database had a risk of publication bias (Suparman et al., 2021, 2021; Suparman, Juandi, & Tamura, 2021b, 2021a, 2021c). So, analysis of publication bias should be carried out. The funnel plot and the fill and trim test analyzed publication bias (Rothstein et al., 2005). Figure 3 shows that the distribution of effect size data of every study in the funnel plot was symmetrical. To justify it, the fill and trim test was carried out. The results of the fill and trim test are presented in Table 3.

Table 3. The Fill and Trim Test

	Studies Trimmed	Random Effect Model			Q-value
		Effect Size (g)	Lower Limit	Upper Limit	
Observed Values		0,635	0,168	1,101	174,184
Adjusted Values	0	0,635	0,168	1,101	174,184

Table 3 shows that the studies number that had to be removed or added to this study was 0. It indicates that the distribution of effect size data in the funnel plot was symmetrical (Nugraha & Suparman, 2021;

Putra & Suparman, 2021; Suparman et al., 2021). It implies that the collection of effect size data from 14 documents did not indicate publication bias.

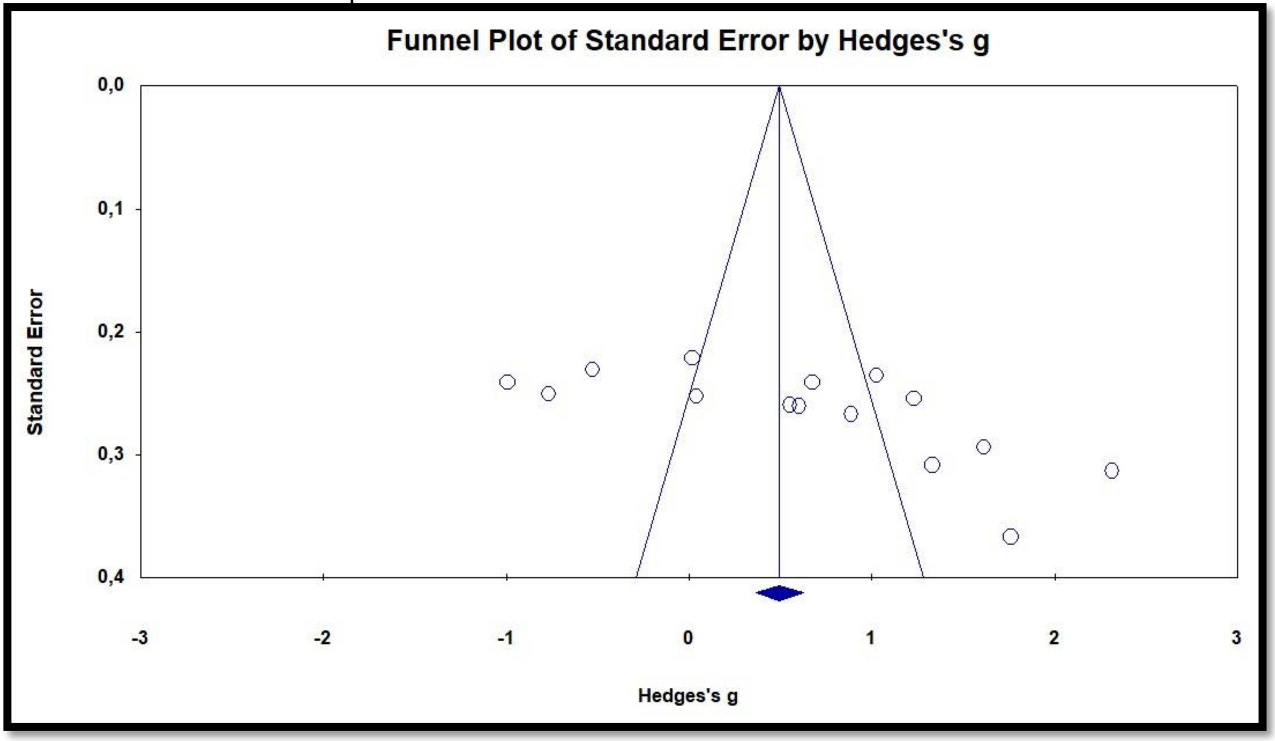

Figure 3. The Distribution of Effect Size

RESULTS and DISCUSSION

Average of Effect Size

Overall, the effect size of the use of Cabri 3D software on the students' mathematical academic outcomes is presented in Figure 4.

Study name	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
	Statistics for each study						
Nurjanah et al., 2020	0,675	0,242	0,058	0,201	1,148	2,793	0,005
Widiastuti & Kurniasih, 2021	1,023	0,236	0,056	0,561	1,485	4,341	0,000
Kariadinata et al., 2019	1,332	0,309	0,095	0,727	1,936	4,315	0,000
Saumi & Amalia, 2018	1,760	0,367	0,135	1,040	2,479	4,793	0,000
Adirakasiwi, 2016	0,887	0,267	0,072	0,363	1,411	3,317	0,001
Nataliasari & Mulyani, 2017	0,041	0,253	0,064	-0,455	0,536	0,161	0,872
Apriatna et al., 2020	0,604	0,261	0,068	0,093	1,115	2,316	0,021
Hendriana et al., 2019	1,231	0,255	0,065	0,731	1,730	4,831	0,000
Marlena & Nugraheni, 2019	2,311	0,313	0,098	1,697	2,925	7,375	0,000
Hartatiana et al., 2017a	-0,991	0,241	0,058	-1,463	-0,518	-4,107	0,000
Hartatiana et al., 2017b	-0,766	0,251	0,063	-1,258	-0,274	-3,051	0,002
Yuliardi et al., 2021	-0,529	0,231	0,053	-0,982	-0,076	-2,289	0,022
Ma'sum et al., 2016	0,019	0,221	0,049	-0,415	0,454	0,088	0,930
Adirakasiwi & Warmi, 2018	1,614	0,294	0,087	1,037	2,191	5,483	0,000
Batubara & Sari, 2021	0,554	0,260	0,068	0,045	1,063	2,132	0,033
	0,635	0,238	0,057	0,168	1,101	2,667	0,008

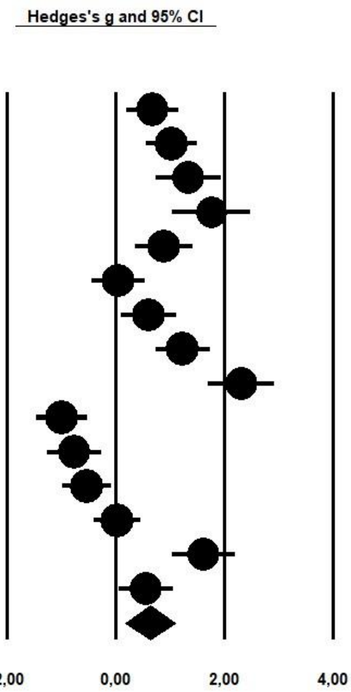

Figure 4. The Overall Effect Size of Every Document

Four documents reported that Cabri 3D software had a moderately positive effect on the students' mathematical academic outcomes (Adirakasiwi, 2016; Apriatna et al., 2020; Batubara & Sari, 2018;

Nurjanah et al., 2020). Moreover, six documents reported that the use of Cabri 3D had a strong positive effect on the students' mathematical academic outcome (Adirakasiwi & Warmi, 2018; Hendriana et al., 2019; Kariadinata et al., 2019; Marlena & Nugrheni, 2019; Saumi & Amalia, 2018; Widiastuti & Kurniasih, 2021). However, two documents reported that the use of Cabri 3D had a weak positive effect on the students' mathematical academic outcomes (Ma'sum et al., 2016; Natalliasari & Mulyani, 2017). Moreover, two documents reported that the use of Cabri 3D had a moderate negative effect on the students' mathematical academic outcomes (Hartatiana et al., 2017; Yuliardi et al., 2021). So, overall, the effect size of Cabri 3D software on the students' mathematical academic outcome was g = 0,635, and it was categorized as a moderate effect. In addition, the Z-test showed that the p-value of the Z statistic was less than 0,05. It indicates that the use of Cabri 3D software has a significant positive effect on the students' mathematical academic outcomes. It means that Cabri 3D software is effective for teaching geometry materials.

Analysis of Moderating Factor

The results of the heterogeneity analysis of some potential factors such as education level, participant number, and treatment duration are presented in Table 4.

Table 4. Analysis of heterogeneity

Factors	Groups	Studies Number	Effect Size & the Z-test			The Q Cochran Test		
			Hedge's	Z-value	P-value	Q-value	df(Q)	P-value
Education Level	Secondary Students	12	0,689	2,601	0,009	0,294	1	0,588
	Pre-Service Teacher	2	0,297	0,442	0,659			
Treatment Duration	1 – 4 Meetings	1	0,019	0,019	0,985	0,844	3	0,839
	5 – 8 Meetings	9	0,705	2,183	0,029			
	9 – 12 Meetings	2	0,963	1,328	0,184			
	13 – 16 Meetings	2	0,297	0,413	0,680			
Participant Number	n ≤ 30 Participants	7	0,957	2,786	0,005	1,635	1	0,201
	n > 30 Participants	7	0,359	1,132	0,258			

Results of the Q Cochran test for every factor revealed that the p-value of the Q statistic was more than 0,05. These results interpret that education level, treatment duration, and participant number are not the significant factors in moderating heterogeneity of students' mathematical academic outcomes. It means another potential factor in affecting the gap of students' mathematical academic outcome level.

DISCUSSION

The Effectiveness of the Use of Cabri 3D Software for Teaching Geometry Materials

This study revealed that the use of Cabri 3D software had a significant positive effect on the students' mathematical academic outcomes, specifically in geometry materials. Some similar studies also reported that dynamic geometry software had a significant positive effect on the students' mathematics achievement (Cantürk Günhan & Açan, 2016; Juandi, et al,, 2021b; Tamur et al., 2020; Turgut & Turgut, 2018). Moreover, specifically, GeoGebra software effectively enhanced students' mathematics achievement (Juandi, et al., 2021). In addition, Li and Ma (2010) revealed that computer technology had a significant positive effect on developing students' academic in mathematics learning. These reports strengthened that the use of Cabri 3D software was effective for teaching geometry materials.

The effectiveness of Cabri 3D software in supporting mathematics teachers to teach geometry materials was because it helped teachers construct concept images of geometric concepts for students (Ertekin, 2014). Ertekin (2014) also argued that Cabri 3D software could be a powerful tool to improve the visual teaching of geometry concepts. In addition, Güven and Kosa (2008) argued that Cabri 3D software provided convenience for students to learn geometry concepts and geometry relationships. Specifically, it helped students enhance their spatial visualization ability (Koklu & Topcu, 2012). So, mathematics learning using Cabri 3D software effectively enhanced students' mathematical academic outcomes, especially in geometry materials.

Heterogeneity of Students' Mathematical Academic Outcome by Using Cabri 3D Software

This study revealed that education level was not a significant factor in moderating the heterogeneity of students' mathematical academic outcomes. Some similar studies also showed that students' mathematics achievement heterogeneity using dynamic geometry software was not moderated by the factor of education level (Juandi, et al,, 2021; Turgut & Turgut, 2018). It provided rigorous evidence that education level did not moderate heterogeneity of students' mathematical academic outcomes. It means that the gap in students' mathematical academic outcomes is not affected by the education level factor. Furthermore, Cabri 3D software was effective for secondary students in learning geometry concepts. In contrast, for pre-service teachers, the use of Cabri 3D did not provide a significant positive effect in learning geometry concepts (See Table 3). In addition, the effect size of Cabri 3D software on the secondary students was larger than on the pre-service teachers. Some kinds of literature (e.g., Juandi, et al,, 2021b; Turgut & Turgut, 2018) also reported that the effect size of the use of dynamic geometry software, especially GeoGebra software, on secondary students was higher than on the college students. It means that the use of Cabri 3D is more effective in enhancing secondary students' mathematical academic outcomes than in enhancing pre-service teachers' mathematical academic outcomes. So, the use of Cabri 3D software was more effective for teaching geometry materials at the secondary school level than for teaching geometry materials in the college.

This study also revealed that the factor of treatment duration did not moderate heterogeneity of students' mathematical academic outcomes using Cabri 3D software. Turgut and Turgut (2018) also reported that the implementation period did not moderate students' mathematics achievement heterogeneity. The report supported this study that the factor of treatment duration did not moderate heterogeneity of students' mathematical academic outcomes. Consequently, treatment duration did not affect the gap of students' mathematical academic outcomes using Cabri 3D software. Juandi, Kusumah, Tamur, Perbowo, & Tanu (2021) reported that the duration of treatment moderated the heterogeneity of students' mathematics achievement significantly. The difference of reports between this study and another study was caused by the focus on dynamic geometry software studied. Juandi, Kusumah, Tamur, Perbowo, & Tanu (2021) focused on GeoGebra software, while this study focused on Cabri 3D software.

In addition, the Cabri 3D software with a treatment duration of 4 – 8 meetings was effective for teaching geometry materials. Meanwhile, the use of Cabri 3D software with treatment duration of 1 – 4 meetings, 9 – 12 meetings, and 13 – 16 meetings did not provide a significant positive effect for teaching geometry materials (See Table 3). On the other hand, the effect size of Cabri 3D software with a treatment duration of 9 – 12 meetings was higher than with a treatment duration of 1 – 4 meetings, 5 – 8 meetings, and 13 – 16 meetings. It means that Cabri 3D software was more effective for teaching geometry materials with the duration of 9 – 12 meetings than for teaching geometry materials with the duration of 1 – 4 meetings, 5 – 8 meetings, and 13 – 16 meetings. Juandi, Kusumah, Tamur, Perbowo, & Tanu (2021) revealed that the use of GeoGebra software was more effective for teaching geometry materials with the duration of ≤ 4 weeks than for teaching geometry materials with the duration of > 4 weeks. In addition, this study revealed that the factor of participant number did not moderate the heterogeneity of students' mathematical academic outcomes. A similar study also revealed that heterogeneity of students' mathematics achievement was not moderated by the factor of participant number (Turgut & Turgut, 2018). It provided strong evidence that heterogeneity of students' mathematical academic outcomes using Cabri 3D software was not moderated by participant number. It means that the factor of participant number did not affect the gap of students' mathematical academic outcomes. Furthermore, Cabri 3D software with the participant number of ≤ 30 was effective for teaching geometry materials. Meanwhile, the use of Cabri 3D software with a participant number of > 30 did not provide a significant positive effect for teaching geometry materials (See Table 3). It means that the use of Cabri 3D software positively affected the mathematical academic outcome in the class with the participant number of ≤ 30 students. Also, the effect size of Cabri 3D software with the participant number of ≤ 30 students was higher than with the participant number of > 30 students. Several studies also revealed that the effect size of the use of dynamic geometry software with the participant number of ≤ 30 students was higher than with the participant number of > 30 students (Juandi, et al,, 2021; Juandi, et al,, 2021b; Tamur et al., 2020). It supported this study that Cabri 3D software was effective for teaching geometry materials in the class with the participant number of ≤ 30 students than for teaching geometry materials in the class with the participant number of > 30 students. So, mathematics teachers and lecturers should use Cabri 3D software to teach geometry materials with the participant number of ≤ 30 students.

CONCLUSION

This study provides clear and precise information that Cabri 3D software is effective for teaching geometry materials. Moreover, the use of Cabri 3D software had a moderately positive effect on the students' mathematical academic outcomes. Consequently, this study suggests mathematics teachers or lecturers use Cabri 3D software for teaching geometry materials because it supports students to visualize 3D geometry objects in geometry learning. It eases students to master the concept image of geometry concept to enhance their mathematical academic outcomes. Furthermore, some factors such as education level, treatment duration, and participant number do not affect the gap of students' mathematical academic outcome level. It means that some potential factors have not been explored, and these have the opportunity to affect the gap in students' mathematical academic outcomes. So, for further similar meta-analysis study, researchers should investigate other potential factors in moderating heterogeneity of students' mathematical academic outcome such as geometry topic, students' demography, and the ratio between computer and user.

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