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The Impact of Card-Based Learning Methods on Math Learning

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ABSTRAK

Penerapan metode pembelajaran berbasis kartu dalam dunia pendidikan telah banyak dilakukan, salah satunya dalam pelajaran matematika. Namun belum ada yang membahas lebih spesifik dampak metode pembelajaran berbasis kartu dengan banyak variasi seperti make a math, card sort, index card, flash card dan kartu lainya dalam pelajaran matematika. Tujuan dari penelitian ini yaitu untuk menganalisis metode pembelajaran berbasis kartu memiliki dampak yang signifikan dalam pembelajaran matematika. Metode dalam penelitian ini adalah kuantitatif dan meta-analisis. Sumber data adalah hasil penelitian yang relevan dengan topik penelitian yang memenuhi kriteria inklusi dan eksklusi. Data dianalisis menggunakan software JASP dengan inputan nilai Effect Size (ES) dan Standard Error (SE). Metode pengumpulan data menggunakan studi literatur. Hasil analisis data secara kumulatif metode pembelajaran berbasis kartu dengan banyak variasi dalam pembelajaran matematika dengan sumary effec sebesar 68%. Hasil analisis berdasarkan jenis kartu yang memberikan pengaruh paling tinggi pada pembelajaran matematika adalah card sort dengan persentase sebesar 73% dengan kategori sedang. Hasil tersebut menunjukan bahwa metode berbasis kartu memberikan dampak yang signifikan dalam pembelajaran matematika. Sehingga hasil penelitian ini dapat dijadikan sebagai rujukan dalam penerapan metode berbasis kartu pada pelajaran matematika.

ABSTRACT

There have been many applications of card-based learning methods in education, one of which is in mathematics lessons. However, no one has discussed more specifically the impact of card-based learning methods with many variations, such as making math, card sorting, index cards, flashcards and other cards in mathematics lessons. This research aims to analysed how card-based learning methods significantly impact mathematics learning. The methods used in this research are quantitative and meta-analysis. Data sources are research results relevant to the research topic and meet the inclusion and exclusion criteria. Data were analysed using JASP software by inputting Effect Size (ES) and Standard Error (SE) values. The data collection method uses a literature study. The cumulative data analysis of the card-based learning method showed many variations in mathematics learning, totalling 68%. The analysis results based on the type of card that has the highest influence on mathematics learning is card sort, with a percentage of 73% in the medium category. These results show that the card-based method significantly impacts mathematics learning. So, the results of this research can be used as a reference for applying card-based methods in mathematics lessons.

1. INTRODUCTION

The life aspect of education is inseparable from the learning process that occurs between students and teachers. Teachers have an important role in the learning process, the role of the teacher is to create an interactive situation that is educative and attracts students' learning interests, namely the interaction between teachers and students, students and students, and students with learning resources in supporting the achievement of learning objectives (Sunedi, 2023; Tong & Tobe, 2022). Teachers need to develop and update learning models to provide a different learning atmosphere from before and make student learning outcomes increase (Bordoloi et al., 2021; Sharma & Shree, 2023). This opinion is in line with previous research who stated that a teacher is required to be able to create teaching methods that are following student development so that students can understand the mathematical concepts given by the teacher (Gosachi & Japa, 2020; Riana et al., 2020). Mathematics is one of the sciences that must be mastered. This is because mathematics is a field of science that plays an important role in facing various challenges in life and is the basis for the development of other sciences (Nugraha, 2022; Nurhayati et al.,

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2020). In addition, mathematics is also one of the sciences that can foster various abilities, namely the ability to think critically, creatively, logically, and systematically (Bicer, 2021; Bicer et al., 2022). In line with that, the opinion of state that mathematics plays an important role in developing students' mindset so that the mathematics teaching and learning process is not measured based on students' ability to calculate and memorize formulas alone, but basically measured by students' ability to master concepts and materials, to solve problems, and also based on student learning outcomes (Batubara, 2019; Simamora & Saragih, 2018). Despite its important role, mathematics is still considered difficult for students. In achieving educational goals, it must start with creating quality learning. In the learning process, teachers play a very important role in improving the quality of education (S. Liu et al., 2021; Y. Liu et al., 2021).

So, it requires interactive learning media in delivering material. One of them is through educational games. According to previous research educational games are considered to have the potential to deeply engage learners with any topic, allowing active participation in the learning process (Gris & Bengtson, 2021; Tahir & Wang, 2020). One of the appropriate learning media is card media. The use of card media in learning has several advantages, including being easy to carry, easy to design, easy to present, easy to store, suitable for large and small groups, can involve all students in its presentation, can be used as a fun game, improve relationships between students, stimulate students' thinking skills, and, increase student learning motivation (Alenezi et al., 2023; Haleem et al., 2022). In addition, according to similar research learning media with card games is a learning media that is very interesting for students and easy to understand so it is easy to use as a learning media (Artaga, 2021; Fitria et al., 2021). The learning media applied using the game method is by the characteristics of students aged 7-18 years who tend to like games in the learning process so that it can involve the active participation of students during learning (Hossain & Yasmin, 2022; N. Saputra et al., 2021). Furthermore, games ensure opportunities to adjust and refine player performance because they offer continuous and immediate feedback. The repetitive nature of games ensures perfection and brings mastery in any field.

The application of card media is commonly applied in various lessons at school. This can be seen from many previous studies that have applied card-based learning media to overcome student boredom in participating in learning and supporting the learning process. Card-based learning media consists of various types, such as Make a Math, previous research shows the results that 28% can improve math learning outcomes, these results are in line with similar research to with the results of the study showing that there is a positive and significant effect of applying the make a math learning method (Fadilah, 2020; Juniantari, 2019; Nurfiati et al., 2020). According to previous research the results of the study showed that the card sort learning method can improve students' math learning outcomes (Meriyati et al., 2018; Solehah et al., 2023). Furthermore, the index card method in improving math learning outcomes, previous research showed 83.3% that the flash card method improved student learning outcomes (Anggraini & Jufri, 2017; Sudrajat et al., 2023). According to similar research shows the flash card method can influence student learning motivation (Aisah, 2016; Wardani & Setyadi, 2020). Similar research shows an average of 79.06 flash cards improve student learning outcomes (Komalasari, 2016; Muslimin et al., 2021). Other cards such as domino cards, counting cards, and picture cards with the results of research that counting cards are effective in improving students' ability to count (Adawiyah & Kowiyah, 2021; Miftahuddin & Arofah, 2020). Apart from that, the application of card-based media is almost applied at all levels. In elementary school (Anggraeni et al., 2019; Muncarno, 2015; Rizkyani & Amelia, 2020). Junior High School, Senior High School (Ferdiana & Mulyatna, 2020; Muslimin et al., 2021; Ulfa et al., 2018). On the other hand, card-based media can improve students' mathematical communication skills, and increase student activity and learning outcomes (Annisa & Marlina, 2019; D. N. Sari et al., 2014; E. K. Sari, Wardana, & Untari, Asri, 2019). Improve the ability to understand story problems, and increase student learning activeness (Januar et al., 2020; Permatasari & Ahmad, 2022). Its scope is on geometry material, number material, and building space material (Eli et al., 2013; Marwati et al., 2020; Sutopo, 2019).

The findings from previous research indicate that the influence of card-based learning media has a positive impact on mathematics learning. These include methods such as make a math, card sort, flash card, index card, and other cards. Among the numerous studies addressing the effectiveness of card-based learning methods, there hasn't been research specifically examining the overall impact of card-based learning media on mathematics learning. Therefore, the purpose of this research is to conduct a more in-depth analysis of the overall impact of card-based methods, the types of card-based media with the most significant influence, and the impact of card-based media based on moderator variables such as learning outcomes, motivation, mathematical communication, conceptual understanding, material variables, level, publication year, and participant count. Meta-analysis serves as a good solution to determine the cumulative effects of these influences by examining the effect size and standard error of each previous

study's results. It is hoped that the results of this research can serve as a reference for other studies that will conduct research with meta-analysis.

2. METHOD

This research uses a quantitative method and is of the meta-analysis type. The data used in this study are 68 relevant articles that meet the inclusion and exclusion criteria. Meta-analysis is a form of research that utilizes existing research data or is a quantitative research method by analyzing quantitative data from previous studies to either accept or reject the hypotheses proposed in those studies. Meta-analysis is research conducted by researchers by summarizing research data, reviewing, and analyzing research data from several previous studies. The stages in this study are in accordance with Figure 1.

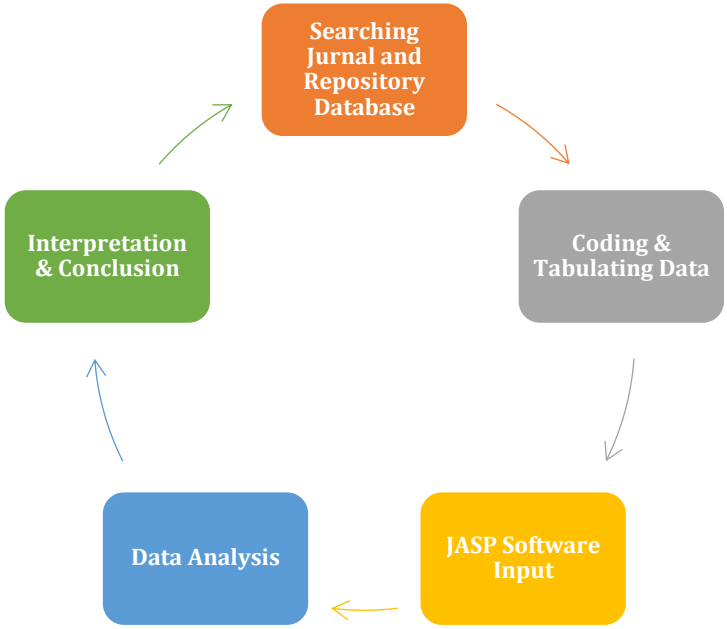

Figure 1. Research Procedure

The data selection was carried out according to the inclusion and exclusion criteria. There are two criteria used to determine which studies are eligible for a systematic review with meta-analysis, namely inclusion criteria (Eligibility criteria) referring to the characteristics of the study related to population issues (Education level, focus area, and moderator variables), related variables "Card-based Learning Methods" OR "Card-based learning methods" OR "In Mathematics Learning" OR "mathematics learning" and the desired research design (systematic review and meta-analysis). The eligibility criteria refer to the characteristics of the publication, the year concerned (the study was published from 2012-2022), the language (using Indonesian and or English), and the type of publication (Article, Journal, Thesis) while the exclusion criteria are used to obtain articles that can be used for statistical analysis of meta-analysis from the articles obtained based on the inclusion criteria. The exclusion criteria are research data in the form of the number of samples (N), the percentage of each error indicator, the Effect Size (ES) value, and the Standard Error (SE). Next, we conducted a literature search study. Meta-analysis in systematic reviews is used as a source of empirical evidence, where authors can summarize and analyze articles using a number of databases such as Scopus, DOAJ, WorldCat, Garuda Portal, and Google Scholar. Through these databases, the main studies were tracked using the keywords "Card-based Learning Methods" OR "Card-based learning methods" OR "In Mathematics Learning" OR "In mathematics learning". Thus, these databases and keywords can help in determining and obtaining various articles contained in online journals that match the inclusion and exclusion criteria. As Table 1 presents the search location data of each indexing database.

Table 1. Database of Indexers and URL's

No	Database Indexers	Url
1	Scopus	https://ww.scopus.com/home.url
2	DOAJ	https://doaj.org/

No	Database Indexers	Url
3	WorldChat	https://www.worldcat.org/
4	Google Scholer	https://scholar.google.com/
5	Portal Garuda	https://garuda.kemdikbud.go.id/

To achieve the goal of high-quality systematic reviews and meta-analyses, Pigott & Polanin (2020) suggest that the main study selection process uses the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) method technique, through four stages, namely: (1) identification; (2) screening; (3) eligibility; and (4) inclusion. Thus, this systematic review and meta-analysis study used these stages in selecting studies. Articles that met the criteria were coded into key information or data that would be used in the meta-analysis process. By categorizing the study name, method, variable, material, sample size, education level, and year of publication. Furthermore, converting the F and t values to the r-value, the following formula is given to find the value of the Fisher test (F), student test (t), and correlation test (r): based on a book written by (Syaharuddin et al., 2021):

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

Used to find the r-count value if the t-count is known.

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

Used to find the r-count value if the f-count is known.

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

Used to find the r-count value if specified as the t-count value.

Calculating the effect size (ES) and standard error (SE) values; each data obtained in the form of a correlation coefficient (r) is then used to find the value of ES and SE with the formula:

$$ES = p = \frac{k}{N} \quad (4)$$

or

$$ES = 0.5 \times \ln \frac{1+r}{1-r} \quad (5)$$

$$SE = \sqrt{\frac{1}{n-3}} \quad (6)$$

The effect size (ES) value = p with k is the number of events out of N events or with the proportion data formula with logit as the purpose of returning the formula from logit to proportion according to formula Number 4. Then calculate the Standard Error (SE) value using the formula as in Number 5 which is calculated based on the ES of each study. In this meta-analysis, researchers used JASP 0.16.0.0 software which is free software that is free to use, flexible, and open source. To operate JASP, prepare Effect Size (ES) and Standard Error (SE) data which are first calculated semi-manually using the Microsoft Excel program and saved with the CSV file type (Macintosh). Effect size is the main unit in meta-analysis studies that describes the strength of the influence, correlation, or association between two variables (Suparman et al., 2021). The Effect Size (ES) intervals and categories can be presented in Table 2.

Table 2. Interval and Category of Effect Size

No	Interval	Category
1	< 0.15	Ignored
2	0.15 – 0.40	Small Effect
3	0.40 – 0.75	Medium Effect
4	0.75 – 1.10	High Effect
5	1.10 – 1.45	Very High Effect
6	> 1.45	Excellent

Table 2 presents intervals that show the value categories of the effect size to determine the practical significance of the research results as a measure of the magnitude of the correlation or difference between one variable and another.

3. RESULT AND DISCUSSION

Result

Data were selected based on predetermined eligibility criteria. 68 articles met the eligibility requirements. To determine the ES and SE value categories using the significance measures in Table 2, so that the calculation results are processed according to Table 3.

Table 3. Effect Size (ES) and Standard Error (SE) Results

Studies	Metode	N	ES	SE	Kategori
Study 1, 2012	Make A Match	31	0.791	0.189	High Effect
Study 2, 2013	Make A Match	54	1.000	0.140	High Effect
Study 3, 2015	Make A Match	37	0.750	0.171	Medium Effect
Study 4, 2015	Make A Match	60	0.256	0.132	Small Effect
Study 5, 2016	Make A Match	17	0.933	0.267	High Effect
Study 6, 2016	Make A Match	32	0.143	0.186	Small Effect
Study 7, 2017	Make A Match	64	0.334	0.128	Small Effect
Study 8, 2017	Make A Match	60	0.306	0.132	Small Effect
Study 9, 2017	Make A Match	20	0.867	0.243	High Effect
Study 10, 2017	Make A Match	55	0.673	0.139	Medium Effect
Study 11, 2018	Make A Match	61	1.602	0.131	Excellent
Study 12, 2018	Make A Match	60	0.275	0.132	Small Effect
Study 13, 2019	Make A Match	30	0.755	0.192	High Effect
Study 14, 2019	Make A Match	43	0.892	0.158	High Effect
Study 15, 2019	Make A Match	28	0.860	0.200	High Effect
Study 16, 2019	Make A Match	27	0.850	0.204	High Effect
Study 17, 2019	Make A Match	26	0.885	0.209	High Effect
Study 18, 2019	Make A Match	105	0.199	0.099	Small Effect
Study 19, 2020	Make A Match	64	0.493	0.128	Medium Effect
Study 20, 2020	Make A Match	54	0.906	0.140	High Effect
Study 21, 2020	Make A Match	84	0.204	0.111	Small Effect
Study 22, 2020	Make A Match	24	0.750	0.218	Medium Effect
Study 23, 2020	Make A Match	48	0.436	0.149	Medium Effect
Study 24, 2020	Make A Match	47	1.000	0.151	High Effect
Study 25, 2020	Make A Match	61	0.218	0.131	Small Effect
Study 26, 2021	Make A Match	30	0.933	0.192	High Effect
Study 27, 2022	Make A Match	25	0.416	0.213	Medium Effect
Study 28, 2022	Make A Match	14	0.929	0.302	High Effect
Study 29, 2012	Card Sort	36	0.917	0.174	High Effect
Study 30, 2013	Card Sort	319	0.313	0.056	Small Effect
Study 31, 2013	Card Sort	31	0.839	0.189	High Effect
Study 32, 2014	Card Sort	27	0.778	0.204	High Effect
Study 33, 2015	Card Sort	40	0.460	0.164	Medium Effect
Study 34, 2015	Card Sort	31	0.807	0.189	High Effect
Study 35, 2017	Card Sort	56	1.056	0.137	High Effect
Study 36, 2018	Card Sort	14	0.786	0.302	High Effect
Study 37, 2019	Card Sort	29	0.897	0.196	High Effect
Study 38, 2019	Card Sort	40	0.541	0.164	Medium Effect
Study 39, 2020	Card Sort	20	0.850	0.243	High Effect
Study 40, 2021	Card Sort	20	0.900	0.243	High Effect
Study 41, 2013	Index Card	80	0.572	0.114	Medium Effect
Study 42, 2014	Index Card	38	0.822	0.169	High Effect
Study 43, 2015	Index Card	38	0.833	0.169	High Effect
Study 44, 2018	Index Card	38	0.816	0.169	High Effect
Study 45, 2019	Index Card	51	0.691	0.144	Medium Effect
Study 46, 2019	Index Card	81	0.234	0.113	Small Effect
Study 47, 2019	Index Card	50	0.876	0.146	High Effect
Study 48, 2020	Index Card	12	0.917	0.333	High Effect
Study 49, 2021	Index Card	50	0.735	0.146	Medium Effect
Study 50, 2021	Index Card	27	0.815	0.204	High Effect

Studies	Metode	N	ES	SE	Kategori
Study 51, 2021	Index Card	15	0.867	0.289	High Effect
Study 52, 2012	Flash Card	32	0.813	0.186	High Effect
Study 53, 2016	Flash Card	60	0.367	0.132	Small Effect
Study 54, 2016	Flash Card	72	0.681	0.120	Medium Effect
Study 55, 2019	Flash Card	32	0.750	0.186	Medium Effect
Study 56, 2019	Flash Card	20	0.568	0.243	Medium Effect
Study 57, 2020	Flash Card	21	0.900	0.236	High Effect
Study 58, 2021	Flash Card	16	0.813	0.277	High Effect
Study 59, 2021	Flash Card	52	0.827	0.143	High Effect
Study 60, 2021	Flash Card	61	0.535	0.131	Medium Effect
Study 61, 2022	Flash Card	32	0.723	0.186	Medium Effect
Study 62, 2013	Other Card	20	0.802	0.243	High Effect
Study 63, 2014	Other Card	22	0.516	0.229	Medium Effect
Study 64, 2016	Other Card	40	0.525	0.164	Medium Effect
Study 65, 2019	Other Card	28	0.945	0.200	High Effect
Study 66, 2020	Other Card	24	0.960	0.218	High Effect
Study 67, 2021	Other Card	21	0.860	0.236	High Effect
Study 68, 2022	Other Card	31	0.440	0.189	Medium Effect
Average			**0.706**	**0.182**	Medium Effect

Table 3 describes 68 article data, there are 28 data on make a math card articles, 12 data on card sort card articles, 11 data on index card articles, 10 data on flash card articles, and 7 data on other cards, other cards such as domino cards, counting cards, picture cards. The results of the calculation of the effect size (ES) and standard error (SE) of each data, can be seen that there are 11 data with a "small" effect category, 19 data with a "medium" effect category, and 1 data with a "very high" effect category. 39 data with the "High" category and 1 data with the "very high" effect category. With an overall average effect size (ES) of 0.706 and an average standard error (SE) of 0.182 with an effect category of "Medium". The data were further analyzed with the JASP software and showed the results in Table 4, Table 5, and Table 6. In the first stage, the author conducted a heterogeneity test to see the category of data whether using fixed or random effects. The results are according to Table 4.

Table 4. Fixed and Random Effects

Fixed and Random Effects	Q	Df	P
Omnibus test of Model Coefficients	353.849	1	< .001
Test of Residual Heterogeneity	258.813	67	< .001
Note. *p* -values are approximate.			

Based on Table 4, the JASP output results show that the overall data is heterogeneous with a residual heterogeneous test value of Q = 258.813 and with a significance p-value <0.001. Therefore, the appropriate model to use is the Random Effects (RE) model. JASP output results regarding card-based learning methods in math learning as per Table 5.

Table 5. Output JASP Coefficients

Coefficients	Estimate	Standard Error	Z	P
Intercept	0.684	0.036	18.811	< .001
Note. **Wald test.**				

In Table 5 on coefficients, we see a z-value of 18.811 and a p-value of 0.001. This means that the hypothesis is accepted, in other words overall, the card-based learning method has an impact on learning mathematics at 68.4%, while 32.6% is influenced by other factors. This can be seen based on Figure 2. Next, the publication bias test was conducted. This test is conducted to see whether the data that has been collected can be used as a representative sample of the population. This test can be seen using the value in the Rank Correlation output. Based on the results using JASP, the output is obtained according to Table 6.

Table 6. Rank Corelation

Rank correlation test for Funnel plot asymmetry	Kendall's τ	P
Rank test	0.202	0.016

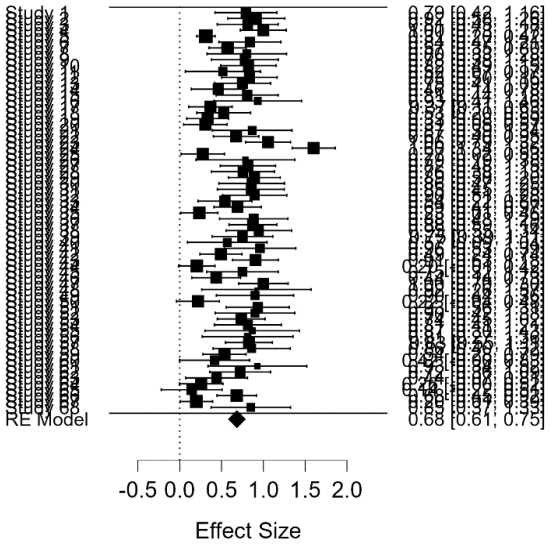

Figure 2. RE Model Forest Plot

Table 6 shows the Rank correlation Kendall's value on the card-based learning method in mathematics learning of 0.202 which shows the large correlation coefficient between effect size and variants. Then the p-value of 0.016> 0.001 shows that the 2nd hypothesis is accepted in other words there is no indication of publication bias. This means that the data from 68 articles is sufficient to make a decision from this study.

Table 7. Fill-safe N

File Drawer Analysis	Fail-safe N	Target Significance	Observed Significance
Rosenthal	27.446	0.050	< .001

Table 7 shows how many studies that have an average effect size equal to 0 must be added to the research sample so that the research results are free from publication bias. Table 6 above shows the Fail-safe N value of 27.446 publications that must be added. This value is not mandatory if based on the Rank Correlation results there is no biased publication identified. In addition, to see the publication bias test can be done with the provision that if the fail-safe N value> 5k + 10 (k = the number of studies), it can be concluded that there is no publication bias. From Table 5, it is obtained 27,446 > 5.68 + 10 ≈ 27,446 > 350. So, the sample used in this study indicated the absence of publication bias. The value of the random effect model according to Figure 3.

Based on the publication plotting results in Figure 3 above, it can be seen that there are no missing studies marked by open circles, all circles are closed. And it can also be seen that almost all circles are inside the graph, and only 15 circles are outside. Furthermore, the data in Table 3 is divided into several parts, namely based on the type of card. The test based on the type of card was conducted to see the difference in the impact of each type of card in learning mathematics. The results are described in Table 8.

Based on Table 8, the card sort method provides the highest impact in learning mathematics with a summary effect value of 73% in a moderate category. And the least impact is shown by the type of make a math with a summary effect value of 65% in a moderate category. Furthermore, the data in Table 3 is divided into several parts based on moderator variables, namely 1. Based on learning outcomes, motivation, and communication skills, 2. Based on material, 3. Based on education level, 4. Based on the year of publication. The results are described in Table 9.

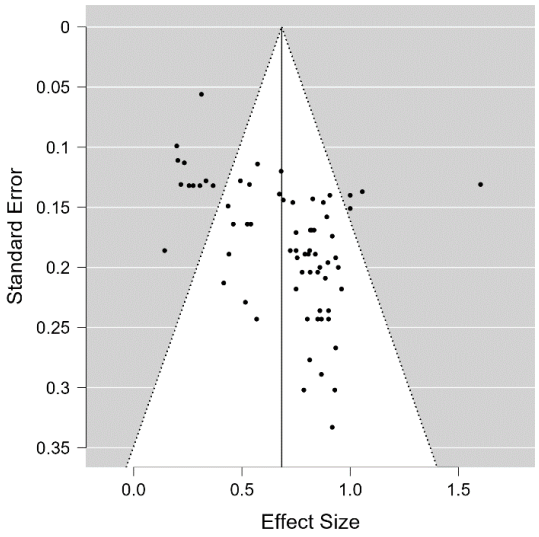

Figure 3. Forest plot of the overall data

Table 8. JASP Output Hypothesis Test based on card method

Method	N	Q_R	Forest Plot	Category	p-Reg. Test	Hipotesis
Make A Math	28	165.423	0.65 [0.52, 0.79]	Medium	0.046	Ha Accepted
Card Sort	12	49.069	0.73 [0.57, 0.89]	Medium	0.028	Ha Accepted
Index Card	11	21.811	0.70 [0.56, 0.85]	Medium	0.041	Ha Accepted
Flash Card	10	9.738	0.67 [0.55, 0.78]	Medium	0.203	Ha Accepted
Other Card	7	7.228	0.70 [0.53, 0.87]	Medium	0.192	Ha Accepted

Table 9. Effect of Card Based Learn Card-Based Based on moderator variable

Variables		N	Q_R	Forest Plot	Category	p-Reg. Test	Hipotesis
Variables	Learning Outcomes	41	95.432	0.70 [0.62, 0.78]	Medium	<0.001	Ha Accepted
	Motivation	5	55.278	0.85 [0.42, 1.28]	High	0.954	Ha Accepted
	Communication	5	9.768	0.59 [0.37, 0.81]	Medium	0.271	Ha Accepted
	Concept Understanding	5	4.541	0.61 [0.42, 0.80]	Medium	0.271	Ha Accepted
	Other Variables	13	63.374	0.61 [0.45, 0.77]	Medium	0.034	Ha Accepted
Material	Numbers	17	31.336	0.72 [0.60, 0.84]	Medium	0.182	Ha Accepted
	Geometry	12	33.610	0.53 [0.37, 0.69]	Medium	0.085	Ha Accepted
	Algebra	4	25.056	0.67 [0.32, 1.03]	Medium	0.029	Ha Accepted
Level	Elementary	33	89.007	0.79 [0.69, 0.90]	High	0.837	Ha Accepted
	Junior High	25	71.684	0.57 [0.48, 0.67]	Medium	<0.001	Ha Accepted
	High School	10	50.646	0.65 [0.45, 0.85]	Medium	0.088	Ha Accepted
Year Published	2012-2019	44	202.275	0.68 [0.59, 0.77]	Medium	0.012	Ha Accepted
	2020-2022	24	55.556	0.69 [0.58, 0.80]	Medium	0.007	Ha Accepted
Data	>50 Participants	21	168.430	0.55 [0.40, 0.71]	Medium	0.056	Ha Accepted
	≤50 Participants	47	41.901	0.76 [0.70, 0.82]	High	0.234	Ha Accepted

Based on Table 9, it can be concluded that the card-based method in learning mathematics has a significant impact on motivation with a percentage of 0.85 or 85% with a high effect category, with the smallest impact shown by understanding concepts and other variables with a percentage of 0.61 or 61% with a moderate effect category. Furthermore, based on the material, the card-based learning method in learning mathematics has a very strong impact on number material with a percentage of 0.72, or 72%, and the smallest impact on geometry material with a percentage of 0.53, or 53%, with a moderate category. Furthermore, the analysis based on the level of education shows that card-based learning methods in learning mathematics have a very strong impact on the elementary level, with a percentage of 0.79, or 79%, in the high effect category. And with the results of the study showing very little impact at the junior

high school level with a percentage of 0.57, or 57%, in the moderate category, Furthermore, the analysis based on the year of publication shows a very strong impact in 2020–2022, with a percentage of 0.69, or 69%, in a moderate category. And based on the number of participants, the strongest impact is seen in the number of participants less than 50 with a percentage of 0.76, or 76% with a moderate success category.

Discussion

Based on Table 8, it can be seen that the make a math card method with the number N = 28 data has a QR value of 165.423 (heterogeneous), with a forest plot of 0.65 [0.52, 0.79] or it can be concluded that the make a matching method has an impact in learning mathematics by 65% with a moderate category. p-value regression test of 0.046> 0.01 which means Ho is rejected and Ha is accepted. These results are smaller than the results of the similar research conducted with the results of the study obtaining an average value of 92.86% (Fajarianto et al., 2022; Juliani et al., 2021). Previous study stated that the results obtained F-count of 4.44 and t-count of 1.688 with the conclusion that the make a math method has a significant effect in learning mathematics (Fadilah, 2020; Juniantari, 2019; Nurfiati et al., 2020). Furthermore, the card sort method with the number N = 12 data, has a QR value of 49.069 (heterogeneous), with a forest plot of 0.73 [0.57, 0.89] or it can be concluded that the card sort method has an impact in learning math by 73% with a moderate category. p-value regression test of 0.028> 0.01 which means Ho is rejected and Ha is accepted. These results are the same as the results of research conducted by similar research with the results of the study obtaining an average value of 73% (E. K. Sari, Wardana, & Untari, Asri, 2019). And this result is smaller than the results of research conducted by similar research with the results of the study obtained an average value of 89.65%, 90%, and 78.39% (Meriyati et al., 2018; Muncarno, 2015).

In the index card method with N = 11 data, the QR value is 21.811 (heterogeneous), with a forest plot of 0.70 [0.56, 0.85] or it can be concluded that the index card method has an impact on learning mathematics by 70%. p-value regression test of 0.041> 0.01 which means Ho is rejected and Ha is accepted. These results are corroborated by the results of research conducted by, with the results of the study obtained that the index card method can improve student learning outcomes by 80% with a high category (Amir et al., 2021; Hakiki & Cinta, 2021). Then the flash card method with the number N = 10 data has a QR value of 9.738 (heterogeneous), with a forest plot of 0.67 [0.55, 0.78] or it can be concluded that the card sort method has an impact in learning math by 67% with a moderate category. p-value regression test of 0.203> 0.01 which means Ho is rejected and Ha is accepted. This result is smaller than the results of research conducted by similar research with the results of the study obtained an average value of 90% (Anggraeni et al., 2019; Muncarno, 2015; Rizkyani & Amelia, 2020). In other card methods with N = 7 data, the QR value is 7.228 (heterogeneous), with a forest plot of 0.70 [0.53, 0.87] or it can be concluded that the card sort method has an impact on learning math by 70% with a moderate category. p-value regression test of 0.192> 0.01 which means Ho is rejected and Ha is accepted. These results are corroborated by research conducted by with the results showing that domino cards have a significant effect on student learning outcomes (Herawati, 2017; Nurfitriyanti & Lestari, 2016).

Previous research stated that the results of the study showed that counting cards are effectively applied and can improve the ability of counting operations in math lessons (Adawiyah & Kowiyah, 2021; Miftahuddin & Arofah, 2020). Table 9 explains the impact of card-based learning methods in learning mathematics based on variables. Based on the learning outcomes variable with a total of N = 41 data, with a QR value of 95.432, the percentage of forest plots is 0.70 [0.62, 0.78] or 70% with a moderate category. These results are smaller than the results of research conducted by similar research with the results of the research obtained an average of 93.3% (Fitriana, 2023; Soleha, 2016). Similar research results obtained an average value of 73% (Aprilika & Egok, 2022; E. K. Sari, Wardana, & Untari, 2019). Furthermore, in the motivation variable with the number N = 5 data, with a QR value of 55,278, post float of 0.85 [0.42, 1.28] or 85% with a high category. These results are greater than the results of previous research with the results of the study obtained an average of 65.91% (Anggraeni et al., 2019; Nasution & Prastika, 2020). In the communication variable interval N = 5 data, with a QR value of 9,768, post float of 0.59 [0.37, 0.81] or 59% with a medium category. These results are smaller than the results of the previous research with the results of the study obtaining an average value of 86.67% (Dina et al., 2015; Saptika et al., 2018). After that on the concept understanding variable N = 5 data, the QR value is 4.541, and the forest plot is 0.61 [0.42, 0.80] or 61% with a moderate category. These results are smaller than the results of previous research with the results of the study obtaining an average value of 91.67% (Marwati et al., 2020; Sutopo, 2019). In other variables with N = 13 data, QR is 63,374, the forest plot value is 0.61 [0.45, 0.77] or 61% in the moderate category. These results are greater than the results of similar research with the research results obtained an average of 51.8%. Furthermore, on the material interval. In number material with N = 17 data, the QR value is 31,336, the forest plot is 0.72 [0.60, 0.84] or 72%. This result is smaller than the results of

previous research with the results of the study obtaining an average value of 80% with a high category (Ramadhani & Indrawati, 2020; Wulan et al., 2013). In geometry material with N = 12 data, QR of 33.610, forest plot value of 0.53 [0.37, 0.69] or 53%. This result is smaller than the similar research results with the previous research results obtaining an average value of 83.3% with a high category by (Cahyawati & Eminita, 2021; Ningsih, 2012). At the interval of algebraic material with the number N = 4 data, with a QR of 25.056, the forest plot is 0.67 [0.32, 1.03] or 67% in the medium category. This result is smaller when compared to the previous research results with the similar research results obtaining an average value of 100% with a high category (Anggraeni et al., 2019; Nasution & Prastika, 2020). Based on education level. At the elementary level, the number of N = 33 data, the QR value is 89.007, and the forest plot is 0.79 [0.69, 0.90] or 79% with a high category.

This value is smaller than the previous research results obtained with the results obtained an average value of 92.86% with a high category (Fajarianto et al., 2022; Juliani et al., 2021). Junior high school level with N = 25 data, QR of 71.684, forest plot of 0.57 [0.48, 0.67] or 57%. This result is smaller than the results of the similar research obtained with the average value obtained 75% with a high category (Manurung et al., 2022; A. Saputra et al., 2019). At the high school level N = 10 data, QR is 50.646, and forest plot is 0.65 [0.45, 0.85] or 65% in the medium category. These results are in line with the results of previous research with the results of the study obtained a t-count of 2.369 with the conclusion that there is a significant effect on the mathematical communication skills of high school students on the quadratic equation material (Sarah et al., 2021; Yanti, 2024). Based on the year of publication. In the interval 2012-2019 before covid-19 hit Indonesia with N = 44 data, the QR value was 202.275, the forest plot was 0.68 [0.59, 0.77] or 68%. This result is smaller than the research results obtained by previous research with the research results obtained an average value of 86% (Budiarti, 2016; Khasanah, 2020). And in the interval 2020-2022 after covd-19 entered Indonesia with N = 24 data, the QR value was 55,556, the forest plot was 0.69 [0.58, 0.80] or 69% with a moderate category. These results are smaller than the results obtained by previous research with the results of the study obtained an average value of 86.5 (Lubis et al., 2023; Sehartian & Adriyani, 2023). Furthermore, based on the number of participants, the interval in the number of participants is more than 50 with the number N = 21 data, the QR value is 168.430, and the0 forest plot is 0.55 [0.40, 0.71] or 55%. These results are smaller than previous results of the study obtained an average value of 76.9 with 60 students participating (Damayanti et al., 2024; Hendra & Rahayu, 2020). And with the number of participants less than 50 with the number N = 47 data, QR of 41.901, forest plot of 0.76 [0.70, 0.82] or 76% with a moderate category. Previous research with the results of the study obtained an average value of 82.2% with 38 students participating (Fahrul et al., 2021; Zainal et al., 2024).

Based on the results of the data analysis, it is stated that the card-based learning method has a significant effect on student learning motivation with a percentage of 0.85%, at the elementary level with a percentage of 0.79%, and with number subject matter with a percentage of 0.72%. This method can be designed with attractive visual elements and colorful and entertaining images. This can make learning a more interactive and fun experience for children, which can increase their motivation to learn. Learning cards can be used to visualize mathematical concepts, helping children to more easily understand abstractions and difficult concepts. For students with learning difficulties, this method can be used as an additional tool to provide a deeper understanding of difficult topics. The learning cards can be designed according to students' ability levels and interests. Teachers can easily customize learning materials to meet individual or group needs. In some cases, learning cards can be used as a tool to measure student progress. Teachers can see how students organize and use the cards to identify understanding or difficulties. In addition to academic material, this method can also be used to teach life skills such as recognizing numbers, letters, colors, and shapes, which are important in children's early development. So in the future, card-based learning methods are highly recommended to be applied at the elementary level. It is recommended for future researchers to investigate the factors that cause the card method to be less influential when applied at the junior or senior high school level.

4. CONCLUSION

Based on the cumulative data analysis results regarding card-based learning methods with various variations in mathematics education, it is evident that there is a 68% effect with a moderate category. The analysis based on the type of card indicates that the card sort method has the highest impact on mathematics education, reaching a percentage of 73% in the moderate category. This suggests that card-based learning methods significantly influence mathematics education and are therefore worthy of implementation. For future research, it is recommended to further explore the aspects that influence the effectiveness of card-based learning methods in the context of mathematics education. Additionally,

subsequent studies could identify the factors affecting the acceptance and implementation of these methods in educational settings. By considering additional variables and involving a larger sample size, future research is expected to provide deeper insights into the effectiveness of card-based learning methods in enhancing mathematics education.

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