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EFFECTIVENESS OF CASE-BASED LEARNING IMPROVING STUDENTS' CRITICAL THINKING: META ANALYSIS

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Abstract. This meta-analysis aims to summarize results of research on the case-based learning method improving students' critical thinking in science learning. The effect of large size (ES) on the average proportion of influence-based learning on the greatest criticism and the relationship between variables on increasing students' critical thinking in science. The research method used is descriptive with form survey research. Within these studies, studies that could be meta-analysis against predefined criteria were examined and 12 studies that met these criteria were identified. The results of the data analysis yielded an effect size of $2.954 \geq 0.80$. It was explained that there was a difference in effectiveness between the experimental class using the case-based learning and the control class without using the case-based learning to increase students' critical thinking. From the results of the value of $p < 0.001 < \alpha$ (0.05) then Ho is rejected. So, it can be concluded that there are significant differences in students' critical thinking learning with the case-based learning. In the future, it is hoped that the results of this research can become a reference for studying the application of the case-based learning to improve students' critical thinking skills in science.

Keywords: Meta analysis, case-based learning, critical thinking

1. Introduction

The skill of concern in 21st century learning is critical thinking. Critical thinking was conceptualised to include cognitive skills and affective dispositions by the American Philosophical Association (APA) (Facione, 1990). Critical thinking is the use of skills and strategies to improve outcomes according to individual goals and values. evaluate our own and others' ideas without prejudice. Critical thinking involves scientific thinking, formal and informal logic, probabilistic thinking, evaluating the quality of information, generating and selecting alternatives and goals, and analysing arguments for conclusions. According to Ennis, critical thinking also involves the ability to assess the credibility of sources, identify inferences, reasons, and assumptions, assess the quality of arguments, develop and defend a position on an issue, ask appropriate clarifying questions, plan experiments and assess experimental designs. Define terms correctly. appropriate to the context, open-ended (Ennis, 1993). Critical thinking is very important to be applied to students, one of the benefits is to prepare individuals to become independent lifelong learners as one of the long-term educational goals.

The case-based learning learning model is a learning model that uses previous cases and is forced to occur today to be used as a medium for students to play a role with the aim that students can solve and be free from the problems/cases experienced (Chen et al., 2006). The teacher acts as facilitator, initiator, director, participant and motivator in the case based learning

learning process. The case based learning was chosen to be applied in overcoming student problems regarding student activeness and learning outcomes. Danilin (2021) reported in his research that the case based learning can develop analytical skills, critical thinking, creative thinking, practical skills, communication skills, social and reflexive skills. Case based learning can be used to improve students' activities and cooperation character.(Nugroho & Bramasta, 2019). Another study revealed that all levels of thinking in Bloom's Taxonomy can be achieved by using case based learning learning (Rugh, 2021).

Case based learning has been recognised as a progressive, student-centred active learning approach where unstructured problems (real-world or simulated complex problems) are used as a starting point for the learning process. In the case based learning model, students work in small collaborative groups and learn what they need to know to solve the problem. Case based learning objectives include content learning, acquisition of process skills and problem-solving skills, and lifelong learning. The term lifelong learning emphasises skills such as self-learning, independent information mining, collaborative learning, and reflective thinking. The steps of case based learning learning consist of introducing problem-based learning, identifying problems, brainstorming and generating ideas, identifying problems learning from hypotheses, self-learning, peer tutors and the role of "experts", synthesis and application, reflection and feedback.

Research has examined the use of case based learning learning as a teaching model to improve critical thinking skills, but in addition to critical thinking skills case based learning learning also improves scientific and information literacy, oral communication. However, some research results report that case based learning learning when compared to conventional classroom learning does not improve critical thinking skills. However, many researchers have found case based learning learning to be more effective in fostering students' critical thinking skills.

A meta-analysis conducted in 2020 (Anggit, 2020) studies conducted in the field of nursing between 1965 and December 2020 showed that the case based learning has an effect on the development of critical thinking of nursing students compared to other teaching methods, with keywords guided in the search are problem-based learning, critical thinking, nursing, and effect. Based on the research that has been done before, it is necessary to study the effectiveness of the case based learning on critical thinking in both higher education in Indonesia. So the purpose of this article review with meta-analysis is to see the effectiveness of the case based learning on student critical thinking. This meta-analysis research combines various kinds of existing research results, focuses on the accumulated impact of previous research results, and can answer questions about the gap in the results that occur from the dependent variable critical thinking.

To find out and verify the success of the application of a learning model can be done by using various methods, one of which is by analysing various studies that have been conducted by previous researchers, then interpreted and then drawn conclusions. This method is often called meta-analysis. The results of the research analysis will then be used as a basis or reference to accept or even support the hypothesis, and can also be used to reject or abort the hypothesis that has been proposed by several other researchers before.

Meta-analysis research can also be said to be a technique of combining several results from 2 or even more similar studies, so as to obtain quantitative data results. This meta-analysis technique can also be carried out with various other types of studies to get conclusions from combining several research results. (Phasa, 2020). In general, meta-analysis does not have a research basis, so the value of the effect size incorporated into the meta-analysis research will be the same as the articles combined. Effect size is the difference of the effect between control groups using certain statistics. The effect that will be contained in the meta-analysis in medicine can be ordinal, ratio, number and interval scales.

2. Methodology

This meta-analysis research method consists of several steps, namely problem formulation, data collection (study), data coding, and data analysis and interpretation. Meta analysis is a form of research, using data from other existing studies. Therefore, meta-analysis is a quantitative research method by analysing quantitative data from previous studies to accept or reject the hypotheses proposed in these studies. (Retnawati et al., 2018). The procedure for this meta-analysis method is as follows:

2.1. Literature search procedure

The studies analysed in this research were conducted using several approaches. Searches were conducted on electronic databases using the keywords case based learning, critical thinking. The first search was conducted using electronic databases, including google scholar, ERIC, DOAJ, Sciencedirect, and Reseachgate, both in the form of national and international journals. The overall database of literature came from secondary schools and some universities in Indonesia. Inclusion criteria was done by synthesising studies that investigated the effectiveness of case based learning learning in higher education. The studies included in this analysis were experimental and quasi-experimental studies that compared students taught with the case based learning learning model and students taught conventionally.

2.2. Data Coding

A code sheet was prepared to translate the information into coded form. Using this sheet, variable and effect size information was coded for each study with respect to the variable, learning strategy (model or approach or case-based learning), dependent variable (critical thinking), treatment duration (less than or equal to four weeks, more than four weeks), school level (college, high school), publication year (20015-2023), sample size (more than or equal to 30 people), publication source (journal article, ERIC document), measurement tool (test).

2.3. Metrics for Expressing Effect size

The metric used to estimate and describe small group effects is the standardised difference effect size (d-index). For two-sample analyses, the effect size is calculated by subtracting the mean score of the control group from the mean score of the experimental group and dividing by the mean difference of the two standard deviations. (Karada Ğ, 2015). This study used a random effect size with the aim of producing research results to a population.

3. Results

Data from case based learning articles to improve critical thinking were collected and systematically analysed based on inclusion and exclusion criteria. (Karada Ğ, 2015). The results that were processed by summarising the results of the case based learning model that had an experimental research design were analysed to determine the required research results in the form of posttest mean scores on the case based learning learning model to improve critical thinking. Twelve studies were quality assessed by the coder using Microsoft Excel and also provided an assessment of the twelve studies. The coding data for the twelve studies analysed are as follows.

AUTOR (TH)	Research	EXPERIMENT			CONTROL		
		N	M	SD	N	M	SD
(Hamiyati et al., 2022)	Study 1	58	72,1207	2	58	44,3278	2
(Fauzi et al., 2023)	Study 2	29	84,31	5,46	29	45,17	8,39
(Lia et.al., 2019)	Study 3	40	322,82	29,07	40	269,58	31,44
(Haryanti et al., 2019)	Study 4	35	70,02	19,4	35	59,35	19,4
(Rivas & Saiz, 2023)	Study 5	110	18,93	1,775	110	20,14	2,929
(Dharmayanthi, 2023)	Study 6	40	63,3	16,16	40	43,77	16,46
(Citrawathi & Adnyana, 2023)	Study 7	24	86	1,94	24	70	1,21
(Rahayu & Zutiasari, 2022)	Study 8	36	80,56	4	36	75,03	4,03
(Rihadatul, A. G., & Nani, 2022)	Study 9	36	75,11	5	36	72,22	5,24
(Yusnidar & Syahri, 2022)	Study 10	25	89,11	5,96	25	72,33	1,62
(Mahdi et al., 2020)	Study 11	42	4,74	0,12	42	3,4	0,75
(Suwono et al., 2017)	Study 12	33	86,79	4	29	49,87	4,24

Table 1. Data Coding Research study

From the data above, it is found that all the number of respondents (N) is more than 30 respondents, this means that all the articles to be analysed are adequate research for the number of respondents. Judging from the Mean, SD, all articles have complete mean and SD data so that they can be continued to be analysed to get the effect size of all these articles. Furthermore, the authors analysed the data to get the effect size results. The following data is the result of the analysis for effect size.

STUDY NAME	EFFECTIZE	SD
(Hamiyati et al., 2022)	14,249	3,775
(Fauzi et al., 2023)	5,455	2,336
(Lia et.al., 2019)	1,741	1,320
(Haryanti et al., 2019)	0,544	0,738
(Rivas & Saiz, 2023)	1,605	1,267
(Dharmayanthi, 2023)	1,186	1,089
(Citrawathi & Adnyana, 2023))	9,734	3,120
(Rahayu & Zutiasari, 2022)	1,363	1,167
(Rihadatul, A. G., & Nani, 2022)	0,558	0,747
(Yusnidar & Syahri, 2022)	3,782	1,945
(Mahdi et al., 2020)	2,472	1,572
(Suwono et al., 2017)	8,862	2,977

Data above was then analysed using the JASP application to analyse the meta-analysis of the *case based learning* to improve *critical thinking*. The following are the results of the effect size analysis.

Coefficients						
					95% Confidence Interval	
	Estimate	Standard Error	z	P	Lower	Upper

intercept	2.954	0.827	3.572	< .001	1.333	4.574
Notes. **Wald test.**						

The magnitude of the effect size is classified as large if it has an effect size value of 2.954 ≥ 0.80 (Lipsey & Wilson, 2001). It is concluded that there is a difference in effectiveness between the experimental class using the case-based learning model and the control class without using the case based learning in improving students' critical thinking.

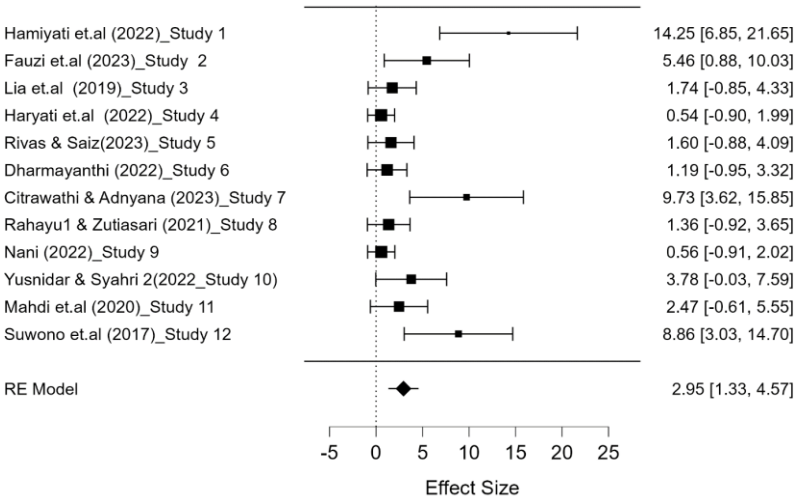
Residual Heterogeneity Estimates			
		95% Confidence Interval	
	Estimate	Lower	Upper
τ^2	5.252	2.171	47.312
T	2.292	1.473	6.878
I^2 (%)	75.248	55.682	96.477
H^2	4.040	2.256	28.387

Data collected in this study are presented in Table 2, I^2 = 75.248% > 25%, meaning that heterogeneity is reported to be high so that the selection of the random effect model fulfils the criteria.

File Drawer Analysis			
	Fail-safe N	Target Significance	Observed Significance
Rosenthal	168.000	0.050	< .001

Since K=12, so 5K+10 = 5(12) + 10=70. The Fail-safe N value obtained was 168, with a target significance of 0.05 and p < 0.001. Fail-safe N value >5K+10, namely 168 > 75, it can be concluded that there is no publication bias problem in the meta-analysis study.

Forest Plot



Funnel Plot

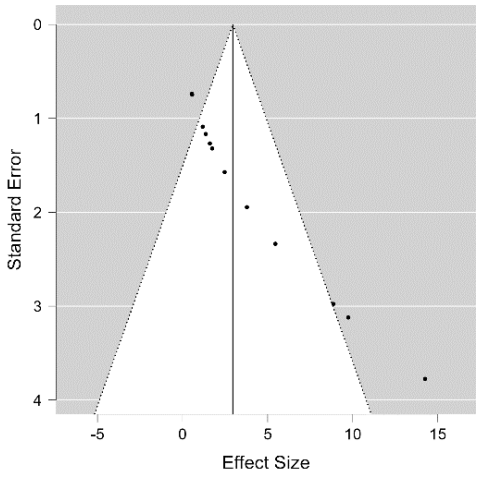


Figure 2 shows that there are no open points in the funnel plot with the random effects model. Its appearance suggests that no missing (unpublished) studies were found. To strengthen this argument, the results of the initial forest plot in Figure 1 will be compared with the forest plot using the Trim and Fill method. The results of the forest plot analysis using the trim and fill method show exactly the same picture as Figure 2. There is no difference in the selected sample data intervals between the initial forest plot picture and the forest plot picture using the trim and fill method. This comparison reinforces the previous argument that there is no indication of bias in the meta-analysis. Thus, the conclusion that the case based learning enhances critical thinking effectively.

Coefficients						
					95% Confidence Interval	
	Estimate	Standard Error	z	p	Lower	Upper
intercept	2.954	0.827	3.572	< .001	1.333	4.574

Notes. **Wald test.**

Hypothesis testing results, Ho = there is no significant difference in critical thinking of students learning with case based learning and H1 = there is a significant difference in critical thinking of students learning with case based learning. From the table above, it can be seen that the p value is <0.001 < α (0.05), so Ho is rejected. So it can be concluded that there is a significant difference in critical thinking of students learning with the case based learning.

4. Discussion

Case based learning is a constructivist learning approach where problems are presented in case. Case based learning is often defined as a teaching method requires students to actively participate in real or hypothetical problem situations, which reflects the type of experience naturally experienced in the discipline being studied. The situations presented in case based learning must be directly related to students' daily experiences, so that the connection between CBL learning and its use in students' lives is visible.

Case-based learning provides the opportunity to analyze content first introduces core knowledge domains and encourages students to search for other knowledge domains may be relevant to the problem given in this case. A case is the definition of problem scenarios that are realistic and relevant to the part of the material. Case based learning contains problems related to the environment, conditions, situations, or picture of the student's future. Cases are stories with a message that students can analyze and consider solutions to the story.

Critical thinking ability is an intellectual thinking process in which thinkers deliberately assess the quality of their thinking, thinkers use reflective, independent, clear, and rational thinking. When students get used to thinking critically, students can be rational in determining and choosing the best alternative choices for themselves. Critical thinking is thinking rationally in assessing something by gathering information before making decisions on certain issues. This supports the application of the character value-based case method learning model because the case based learning model makes it possible to find cases and students focus on solving these focuses by having critical thinking skills and are also able to increase the final grade which is greater than the conventional method (Djawa, et al 2022; Nantara, 2022).

Based on the results of the research conducted, namely: the effectiveness of the case based learning on students' critical thinking. In general, the articles that have been analysed have an effect size value with a very high category. For effect size with a very high category 2.954 ≥ 0.80. Based on these data, we can know that the case based learning model has a very high impact on critical thinking. This is in line with what was stated by Yosiwita et al (2013) which stated that the results of critical thinking increased by 32.57% by using the case based learning model. The same statement was also stated by Ayuningrum (2015), learning using the case based learning model in the experimental class increased critical thinking more than the control class. The effectiveness of the case based learning model on student critical thinking based on learning materials, the results of meta-analysis show that the highest effect of using the case based learning model on student critical thinking is obtained. This is in line with what was stated by (Riyadi et al., 2015) that the application of the case based learning model can have a positive effect on students' critical thinking.

5. Conclusion

Based on the results and discussion, it can be concluded that the application of Case based learning has a positive impact in improving students' critical thinking from the synthesis of 12 relevant primary studies. Publication characteristics are one of the factors that affect heterogeneous effect size data, therefore this 8 meta-analysis study provides information to lecturers that Case based learning is an alternative learning that effectively solves problems

related to student critical thinking. Lecturers can consider case based learning as an alternative solution to improve students' critical thinking. From these conclusions the researcher has suggestions, namely; (1) It is hoped that teachers can make materials, media and teaching materials well (2) Students must participate in learning actively to improve creative thinking (3) Schools are expected to support learning activities by providing complete materials used for learning so that learning objectives can be met . (4) Researchers should study learning models case based learning recommendations to teachers regarding effective learning models to apply in learning.

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