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The Influence of the ICT- Based Inquiry Based Learning Model on Students' Critical Thinking Skills: Meta-analysis

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Abstrak

Tujuan penelitian ini untuk mengetahui pengaruh model inquiry based learning berbasis TIK terhadap keterampilan berpikir kritis siswa. Penelitian ini adalah jenis penelitian kuantitatif dengan pendekatan meta-analisis. Sumber data dalam penelitian ini berasal dari analisis 16 jurnal nasional terbitan 2020-2024. Kriteria inklusi dalam meta-analisis ini terdiri dari penelitian metode eksperimen atau quasi eksperimen, data berasal dari jurnal atau prosiding terindeks SINTA dan Scopus, Penelitian terkait model inquiry based learning berbasis TIK terhadap kemampuan berpikir kritis siswa, Ukuran sampel > 25 siswa; Data diperoleh dari database terpercaya yaitu sciencedirect, ERIC, Wiley dan Taylor of Francis serta penelitian memaparkan data yang lengkap untuk menghitung nilai effect size (ES). Analisis data dalam penelitian ini adalah analisis kuantitatif dengan menghitung nilai effect size setiap penelitian dengan bantuan sofware OpenMEE. Hasil penelitian menyimpulkan bahwa model inquiry based learning berbasis TIK memberikan pengaruh positif terhadap keterampilan berpikr kritis siswa dengan nilai ES =0.839; z= 6.024; < 0.001. Temuan ini memberikan informasi penting bagi pendidik dalam mengimplementasikan model inquiry based learning berbasis TIK dalam pembelajaran.

Kata Kunci: *Inquiry Based learning; TIK; Effect Size; Berpikir Kritis; Meta-analysis*

Abstract

The purpose of this study was to determine the effect of ICT-based inquiry-based learning model on students' critical thinking skills. This research is a type of quantitative research with a meta-analysis approach. The data in this study came from the analysis of 16 national journals published in 2020-2024. The inclusion criteria in this meta-analysis consisted of experimental or quasi-experimental method research, data derived from SINTA and Scopus indexed journals or proceedings, research related to ICT-based inquiry-based learning models on students' critical thinking skills, sample size> 25 students; Data obtained from trusted databases, namely sciencedirect, ERIC, Wiley and Taylor of Francis and research describing complete data to calculate the effect size (ES) value. Data analysis in this study is quantitative analysis by calculating the effect size value of each study with the help of OpenMEE software. The results concluded that the ICT-based inquiry-based learning model had a positive effect on students' critical thinking skills with an ES value = 0.839; z= 6.024; < 0.001 This finding provides important information for educators in implementing ICT-based inquiry-based learning model in learning.

Keywords: *Inquiry Based learning; ICT; Effect Size; Critical Thinking; Meta-analysis*

Introduction

The development of Information and Communication Technology (ICT) has fundamentally changed the paradigm of education. In this digital age, conventional learning approaches have expanded with the adoption of innovative technologies, allowing for more diverse and interactive use of resources in the teaching and learning process (Utomo et al., 2023; Supriyadi et al., 2023); (Ceci & Razzaq, 2023). The use of ICT in teacher education can create a more engaging and relevant learning experience for students (Zulkifli et al., 2022), by utilizing a variety of media, such as learning videos, interactive simulations, and online learning platforms, to enrich the learning experience (Fradila et al., 2021; Santosa, 2021).

Furthermore, ICT also facilitates access to more inclusive and flexible education. With the existence of online learning platforms (Nurtamam et al., 2023), students are no longer limited by geographical or time restrictions, allowing them to access learning resources from anywhere and anytime (Tao et al., 2023). This provides an opportunity for students who live in remote areas or have limited mobility to stay engaged in the learning process. In addition, ICT also allows for personalized learning, where learning materials can be tailored to the needs and interests of individual students (Zheng et al., 2018), and can increase the effectiveness of learning and facilitate the development of students' potential in critical thinking.

Critical thinking skills become very important in educational contexts because they enable students to develop the evaluation, analysis, and synthesis skills necessary to understand, interpret, and produce information critically (Suharyat et al., 2023; Elfira et al., 2023; Razak et al., 2021). This ability helps students to not only passively accept information, but also dig deeper, ask relevant questions, and craft arguments supported by evidence (Lafifa et al., 2023). Students can become independent learners, able to face complex challenges in an ever-evolving society with critical analytical skills and creative solutions (Munir et al., 2024). Critical thinking skills in the educational curriculum are a must to prepare students to become competent individuals and think critically in facing various problems in real life (Irianti et al., 2024).

The problem is that critical thinking skills occur in more traditional educational curricula that tend to emphasize mastery of material and standardized tests. In addition, the widespread use of technology can also be challenging, where uncontrolled access to information from multiple sources can hinder students' ability to sort, evaluate, and use information critically (Sari, 2024; Zulyusri et al., 2023; Rahman et al., 2023). In addition, a lack of training and support for educators in developing learning strategies that encourage critical thinking skills is also a contributing factor to this problem (Muhsin et al., 2024; Oktarina et al., 2021). Therefore, it is important for education to meet these challenges by providing a supportive learning environment, an integrated curriculum, and training for educators in implementing effective strategies to develop students' critical thinking skills (Supriatna et al., 2023). So there needs to be a learning model that can encourage students' critical thinking skills.

Inquiry Based Learning (IBL) is a learning model that places students at the center of the learning process, where students are invited to ask questions, carry out investigations, and find solutions to the problems they face (Safkolam et al., 2024; Hinostroza et al., 2024). Through this

model, students are encouraged to become active in their learning process, developing critical thinking skills, creativity, and communication skills, while gaining a deep understanding of the subject matter. The teacher acts as a facilitator, guiding students in designing questions, collecting data, and analyzing the results of their investigations (Yonwong, 2024). By enabling students to explore concepts independently and work together on problem solving, the IBL model encourages more meaningful and relevant learning for students (Sasanti et al., 2024; Utomo et al., 2023), as well as helping them develop the skills needed to succeed in an ever-evolving world.

Previous research on inquiry-based learning models has a positive influence on students' critical thinking skills (Asyarifah et al., 2024; Sasanti et al., 2024; Antonio & Prudente, 2024). Next, research (Widarti et al., 2024) said the application of the inquiry-based learning model can improve students' critical thinking skills and motivation in learning. However, many studies on inquiry-based learning models have not found the application of in-depth conclusions related to ICT-based inquiey-based learning models in learning. So, it is necessary to conduct meta-analysis research to get in-depth conclusions, so as not to cause double conclusions. Based on these problems, this study aims at the influence of ICT-based inquiry-based learning models on students' critical thinking skills.

Methods

This research is a type of quantitative research using a meta-analysis approach. Meta-analysis is a research approach that collects and analyzes previous research quantitatively to get a conclusion (Juandi et al., 2022; Tamur &; Wijaya, 2021; Luciana et al., 2023; Supriyadi et al., 2023; Ichsan et al., 2023; Balemen, 2018). This meta-analysis found the influence of ICT-based inquiry-based learning models on students' critical thinking skills, as well as providing a strong empirical foundation for students to develop more effective pedagogy in a technological context.

The source of data in this study comes from an analysis of 16 national journals published 2020-2024. The inclusion criteria in this meta-analysis consist of experimental methods research or quasi-experiments, data derived from SINTA and Scopus indexed journals or proceedings, Research related to ICT-based inquiry-based learning models on students' critical thinking skills, Sample size > 25 students; Data obtained from trusted databases namely sciencedirect, ERIC, Wiley and Taylor of Francis and the study presented complete data to calculate the value of effect size (ES). Data analysis in this study is quantitative analysis by calculating the value of effect size of each study with the help of OpenMEE software. Furthermore, the effect size criteria can be seen in Table 1.

Table 1. Effect Size Value Criteria

Effect Size	Criterion
0.00≤ES≤0.20	Low
0.20≤ES≤0.80	Medium
ES≥ 0.80	Large

Source:(Cohen et al., 2007)

Result and Discussion

Result

From the results of searches through the sciencedirect database, ERIC, Wiley and Taylor of Francis related to the effect of ICT-based inquiry-based learning models on students' critical thinking skills obtained 204 studies, but only 16 studies that met the inclusion criteria were included in the meta-analysis data. Data selection process through PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*) method. Furthermore, data that have met

the inclusion criteria can be seen in Table 2.

Table 2. Data from 16 Journals that Meet the Inclusion Criteria

Journal Code	Year	Bound Variables	Effect Size	Journal Index	Criterion
Study 1	2022	Critical Thinking	0.59	Sinta	Medium
Study 2	2023	Critical Thinking	0.90	Sinta	High
Study 3	2024	Critical Thinking	1.02	Scopus	High
Study 4	2024	Critical Thinking	2.19	Scopus	High
Study 5	2020	Critical Thinking	0.82	Sinta	High
Study 6	2022	Critical Thinking	0.41	Sinta	Medium
Study 7	2021	Critical Thinking	0.52	Scopus	Medium
Study 8	2021	Critical Thinking	0.77	Sinta	Medium
Study 9	2024	Critical Thinking	0.94	Scopus	High
Study 10	2023	Critical Thinking	1.16	Scopus	High
Study 11	2023	Critical Thinking	0.65	Sinta	Medium
Study 12	2024	Critical Thinking	0.37	Sinta	Medium
Study 13	2024	Critical Thinking	0.91	Sinta	High
Study 14	2022	Critical Thinking	1.27	Sinta	High
Study 15	2020	Critical Thinking	0.68	Sinta	Medium
Study 16	2023	Critical Thinking	1.34	Scopus	High

Table 2. Explaining the effect size value of 16 studies ranged from 0.37 – 2.19. According to the criteria of effect size value (Sun, 2015) Seven (n = 7) studies that have medium effect size criteria and nine (n = 9) studies that have high effect size criteria are obtained. Next, analyze all 16 effect sizes to determine the effect of ICT-based inquiry-based learning models on students' critical thinking skills. The results of the overall effect size analysis can be seen in Table 3.

Table 3. Summary Effect Size

	Estimate	Standard Error	z	p
Intercept	0.839	0.31	6.024	< 0.001

Based on Table 3. The summary effect size value is 0.834 and the standard error is 0.31. These results conclude that the application of ICT-based inquiry-based learning models has a significant influence on the critical thinking skills of students with the High category with a value of z = 6,024; P< 0.001.

Discussion

The inquiry-based learning model is implemented by utilizing this technology as a means to facilitate students' exploration, analysis, and reflection on the subject matter. The inquiry-based learning model is emerging as an interesting approach to improving students' critical thinking skills (Rahman et al., 2023). By encouraging students to question, investigate, and conclude based on self-discovered evidence, the model enables a more interactive and challenging learning process for students, while fostering critical thinking skills needed in problem-solving and decision-making (Antonio et al., 2024).

The application of ICT technology in the context of inquiry learning provides a new dimension that enriches the student learning experience. Through the utilization of various digital media, simulations, and online resources, students can access information more dynamically and participate in learning activities that are more interesting and relevant to their daily lives (Oktarina et al., 2021). This provides an opportunity for students to develop their critical thinking skills in the face of real situations and challenges. This

research is expected to provide a deeper understanding of the extent to which the application of ICT-based learning models in the context of inquiry can affect the development of students' critical thinking skills (Campo et al., 2023). The findings of this study can be an important foundation for the development of curricula and learning strategies that are more effective in equipping students with the critical thinking skills needed to face future challenges.

In addition, this research also makes an important contribution in exploring the potential of ICT technology as a supporting tool in improving the quality of learning (Oztürk et al., 2022; Zahra, 2024). By better understanding how the integration of ICT technology with inquiry learning models can affect students' learning and development of critical thinking skills, educators can design learning strategies that are more innovative and relevant to the needs of the times. The importance of critical thinking skills is undeniable in the context of modern education (Mbay et al., 2017). The ability to critically analyze, evaluate, and synthesize information is fundamental to students' ability to make intelligent decisions, solve complex problems, and actively participate in a changing society. Therefore, research exploring the relationship between inquiry-based learning models that integrate ICT with students' critical thinking skills is highly relevant and valuable (Stoilescu, 2014).

Furthermore, the research also provides valuable insights into how innovative, technology-driven learning approaches can shape the future of education (Wahyuningsih et al., 2019). By better understanding the factors that affect students' critical thinking skills, educators can design learning strategies that are more effective and relevant to the needs of the times. This will help ensure that education not only provides knowledge, but also equips students with the skills and understanding necessary to succeed in an increasingly complex and rapidly changing world.

Conclusion

From the results of this study, it can be concluded that the ICT-based inquiry-based learning model has a positive influence on students' critical thinking skills with an ES value = 0.839; z= 6.024; < 0.001. These findings provide important information for educators in implementing ICT-based inquiry-based learning models in learning. The integration of ICT technology in the context of inquiry learning encourages students to be active, creative, and critical in their learning process, thus strengthening critical thinking skills that are critical in facing complex challenges in this digital age. These results have important implications for the development of curriculum, instructional strategies, and teaching practices that are more effective in preparing students for success in an increasingly complex and digitally connected society.

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