DOI: https://doi.org/10.33487/edumaspul.v8i1

EDUMASPUL JURNAL PENDIDIKAN

Vol 08 No. 01 (2024) page 2115-2124

p-ISSN 2548-8201 | e-ISSN 2580-0469

https://ummaspul.e-journal.id/maspuljr/

The Influence of the TPACK based Inquiry Teaching Model on Student's Critical Thinking Skills

Mia Aina[1*], Everhard Markiano Solissa[2], Venty Sopacua[3], Elismayanti Rembe[4], Andri Kurniawan[5], Muhammad Nur[6], Bambang Mardi Sentosa[7], Tomi Apra Santosa[8], Aat Ruchiat Nugraha[9]

[1]Universitas Jambi, Indonesia

[2,3]Universitas Pattimura, Indonesia

[3]STIE Wibawa Karta Raharja, Indonesia

[4]STAIN Madailling Natal, Indonesia

[5,6,7]Universitas Islam Syekh Yusuf, Indonesia

[8]Akademi Teknik Adikarya, Indonesia

[9]Universitas Padjadjaran, Indonesia

**Corresponding email:mia.aina@unja.ac.id*

Receive: 11/02/2024	***Accepted: 11/02/2024***	***Published: 01/03/2024***

Abstrak

Tujuan penelitian adalah untuk mengetahui pengaruh model inquiry teaching berbasis TPACK terhadap keterampilan berpikir kritis siswa. penelitian ini merupakan jenis penelitian meta-analisis. sumber data dalam penelitian ini berasal dari analisis 15 jurnal nasional dan internasional yang terbit tahun 2021-2024. kriteria inklusi dalam penelitian adalah penelitian harus terindeks sinta dan scopus, penelitian berasal dari jurnal yang open acces, penelitian memiliki keterkaitan dengan variabel penelitian, data penelitian diakses melalui database jurnal google scholar, wiley, taylor of francis, mendeley dan researhgate serta penelitian harus melampirkan data yang lengkat untuk menghitung nilai effect size. teknik pengampilan data adalah observasi langsung dan dokumentasi. analisis data adalah analisis kuantitatif dengan menghitung nilai effect size dengan sofware JSAP. hasil penelitian menyimpulkan model inquiry teaching berbasis tpack memberikan pengaruh yang signifikan terhadap keterampilan berpikir kritis siswa dengan nilai r_{es} = 0.914; p< 0.001. temuan ini memberikan informasi positif bagi guru untuk mengimplementasikan model ini dalam pembelajaran

Kata Kunci: *Inquiry teaching Model; TPACK; berpikir kritis; meta-analysis*

The Influence of the TPACK based Inquiry Teaching Model on Student's Critical Thinking Skills

Abstract

The purpose of the study was to determine the effect of tpack-based inquiry teaching model on students' critical thinking skills. This research is a type of meta-analysis research. The data sources in this study came from the analysis of 15 national and international journals published in 2021-2024. The inclusion criteria in the study are that the research must be indexed by Sinta and Scopus, the research comes from open access journals, the research has a relationship with the research variables, the research data is accessed through the Google Scholar Journal Database, Wiley, Taylor of Francis, Mendeley and Researhgate and the research must attach sticky data to calculate the effect size value. Data collection techniques are direct observation and documentation. Data analysis is quantitative analysis by calculating the effect size value with JSAP software. the results concluded that the tpack-based inquiry teaching model had a significant effect on students' critical thinking skills with a value of res = 0.914; P < 0.001. this finding provides positive information for teachers to implement this model in learning

***Keywords**: Inquiry Teaching Learning; TPACK; Critical Thinking; Meta-Analysis*

Introduction

In the era of the industrial revolution 4.0 to 5.0, society has a significant impact on students' critical thinking skills (Patandung, 2023; Ichsan et al., 2023; Elfira et al., 2023). Critical thinking skills are key to student success in facing complex challenges in the modern world (Net et al., 2023). Education is no longer just about acquiring knowledge, but also about students' ability to manage, evaluate, and use information critically. Critical thinking skills enable students to understand deeply, connect disparate information, and make informed decisions (Kanmaz, 2022; Fradila et al., 2021). Therefore, students must have the ability to filter, analyze, and synthesize information in learning (Maison, 2022). Critical thinking skills also enable students to tackle problems with creativity and innovation, preparing them to become leaders and innovators in an ever-changing society (Son et al., 2023).

Furthermore, critical thinking skills play an important role in helping students understand different points of view, consider the ethical and social implications of their decisions, as well as actively participate in constructive dialogue and debate (Kusmaryono, 2023). With critical thinking skills, students can develop the ability to craft strong arguments, identify biases, and objectively consider different perspectives (Alqahtani &; The, 2023). 21st-century education should place a strong emphasis on developing these critical thinking skills, not only to prepare students for academic success, but also to help them become open-minded, critical, and responsible citizens in a complex and ever-changing society (Sutoyo et al., 2023; Suryono et al., 2023; Nurtamam et al.,

2023), through the TPACK integrator in learning.

TPACK (Technological Pedagogical Content Knowledge) is a highly relevant framework in the context of modern education as it recognizes the importance of the integration of technology, pedagogy, and content in effective learning (Chaidam &; Poonputta, 2022); Helsa, 2023). In an era where technology continues to evolve and become increasingly affordable, teachers must be able to use technological tools and resources intelligently to improve the learning process. However, the integration of technology must be guided by a deep understanding of effective pedagogy and a solid understanding of the material being taught (Angraini et al., 2023). TPACK helps teachers develop a holistic understanding of how to use technology contextually and meaningfully in support of learning objectives, facilitate student understanding of subject matter, and enhance student learning experiences (Irmita &; Atun, 2018; Rahman et al., 2023). By blending knowledge of technology, pedagogy, and content, teachers can create dynamic and relevant learning environments that prepare students to succeed in an ever-changing world (Jamani et al., 2015).

The integration of TPACK into Students' Critical Thinking Skills lies in the need for a learning approach that can address contemporary challenges in education (Handayani et al., 2023). Although technology has become an integral part of everyday life, not necessarily all uses of technology in the context of learning are effective for improving students' critical thinking skills. Critical thinking skills are becoming increasingly important in this information age, but the lack of proper integration between technology, pedagogy, and content in learning is often an obstacle in developing these skills optimally. Lack of teacher professionalism in utilizing technology to help the learning process. Furthermore, students' ability to analyze and conclude a problem is relatively low. Therefore, there is a need for a learning model that can encourage students' critical thinking skills in learning.

TPACK-based inquiry teaching offers an innovative approach in improving students' critical thinking skills through holistic integration of technology, pedagogy, and content. The inquiry teaching model is a learning model that allows students to be actively involved in the learning process through inquiry, exploration, and discovery (Wang, 2020). In this learning model, the teacher acts as a facilitator who provides direction and support, but gives students the freedom to develop questions, explore concepts, and seek answers independently (Dewi et al., 2017). Through inquiry teaching, students are invited to develop critical thinking skills, collaborate with their peers, and make connections between the concepts learned and the context of their daily lives (Ketsing et al., 2017). This approach not only results in a deeper understanding of the subject matter, but also builds independence, creativity, and an intrinsic interest in learning (Mohammed, 2022). Thus, inquiry teaching is not only about transferring knowledge, but also about forming learners who are active, reflective, and ready to face future challenges.

In this model, the teacher not only acts as a facilitator of learning, but also as a designer of learning experiences that stimulate students' exploration of the subject matter. By using technology as a tool to provide access to diverse and relevant resources, this learning model enables students to conduct in-depth inquiry, encouraging them to ask critical questions, consider multiple perspectives, and formulate informed arguments (Bwalya et al., 2023). Through a structured and guided inquiry process, students learn to critically evaluate information, identify biases, and make informed decisions. Therefore, there is a need for a meta-analysis to determine the application of the TPACK-based inquiry teching model to students' critical thinking skills to get a deep conclusion. So, this study aims to determine the effect of TPACK-based inquiry teaching model on students' critical thinking skills.

Methods

This research is a type of meta-analysis research. Meta-analysis is a type of research that analyzes previous research data quantitatively to obtain a conclusion (Tamur &; Wijaya, 2021; Supriyadi et al., 2023; Razak et al., 2022;Diah et al., 2022; Luciana et al., 2023)The source of data in this study comes from an analysis of 16 national and international journals published in 2021-2024. The inclusion criteria in research are that research must be indexed by Sinta and Scopus, research comes from journals that are open access, research has a relationship with research variables, research data is accessed through the journal database Google Scholar, Wiley, Taylor of Francis, Mendeley and Research and Research must attach extensive data to calculate the value of effect size. Data display techniques are direct observation and documentation. Data analysis is quantitative analysis by calculating the effect size value with JSAP software. Furthermore, the effect size criteria in this study are seen in Table 1.

Table 1. Effect Size Value Category

Effect Size	Criterion
0.0≤ES≤ 0.2	Low
0.2≤ES≤ 0.8	Moderate
ES≥0.2	High

Source:(Cohen et al., 2007;Zulkifli et al., 2022;Sofianora et al., 2023)

Result and Discussion

Hasil From the results of searching data through the Google Scholar journal database, Wiley, Taylor of Francis, Mendeley and Research related to the influence of the TPACK-based inquiry teaching model on students' critical thinking skills were obtained in 203 journals. Furthermore, the research was selected based on the inclusion criteria that had been determined, then 16 journals were included in the meta-analysis data. Furthermore, journals that have met the inclusion criteria are analyzed based on research code, year, source and effect size value which can be seen in Table 2.

Table 2. Analysis of 16 Journals Meeting Inclusion Criteria

Journal Code	Year	Source	Effect Size	Effect Size Criteria
Study 1	2024	Google Scholar	0.72	Moderetae

Study 2	2024	Wiley	1.10	High
Study 3	2021	Wliey	0.99	High
Study 4	2023	Google Scholar	1.02	High
Study 5	2023	Researchgate	2.13	High
Study 6	2022	Google Scholar	1.18	High
Study 7	2024	Taylor Francis	0.69	Moderate
Study 8	2023	Wiley	0.88	High
Study 9	2023	Mendeley	0.95	High
Study 10	2023	Mendeley	0.57	Moderate
Study 11	2022	Mendeley	0.45	Moderate
Study 12	2022	Mendeley	0.91	High
Study 13	2021	Google Scholar	1.03	High
Study 14	2024	Wiley	2.15	High
Study 15	2021	Google Scholar	1.72	Moderate
Study 16	2024	Google Scholar	0.63	Moderate

Table 2, showing the results of the analysis of 16 studies obtained effect values ranging from 0.45 to 2.15. Furthermore, from the data above there is an enama (n = 6) has a medium category effect size value and eleven (n = 11) research has a high criteria effect size value. Furthermore, analyzing the mean effect size or summary effect size value from 16 research journals which can be seen in Table 3.

Table 3. Mean effect Size/summary effect size

	Estimate	**Standard Error**	**Z**	**P**
Intercept	0.914	0.306	7.061	< 0.001

Table 3, describes the mean effect size value of 0.914 with a standard error of 0.306 in the high effect size category. These results suggest that the TPACK-based inquiry teaching model has a positive influence on students' critical thinking skills. Not only that, this model is also significant with a value on critical thinking skills compared to conventional models (z = 7.061 < 0.001). The results of this study are in line with (Adnan et al., 2021) The inquiry teaching model has a positive influence on students' critical thinking skills in learning. This learning model combines Technology, Pedagogy, and Subject Knowledge (TPACK) with an Inquiry approach, which emphasizes exploration, discovery, and problem solving. One important aspect of the study was the ability to measure the effectiveness of this learning model in improving students' critical thinking skills (Koksalan &; Bekiroglu, 2024).

The concept of TPACK and how it is integrated in the Inquiry learning model. TPACK emphasizes the importance of teachers having knowledge on how to effectively integrate technology in learning, along with an understanding of the content and appropriate learning strategies (Alfroni et al., 2019). When coupled with the Inquiry approach, this learning model encourages students to actively engage in the learning process, building their own knowledge through inquiry. TPACK-based Inquiry learning model. Critical thinking skills are important abilities for students to analyze

information, evaluate arguments, and make evidence-based decisions. It is hoped that this learning model can provide an environment that supports the development of critical thinking skills through structured interaction with technology, discussion, and reflection.

One important aspect of the Inquiry-based TPACK learning model is the use of technology as a tool to facilitate the learning process (Mahmud, 2020). By utilizing various platforms and applications relevant to learning materials, students have wider access to information and learning support resources (Kucuk, 2022). This not only increases student motivation but also stimulates their critical thinking through evaluation of the credibility of information sources and the ability to select the most appropriate technological tools for student learning goals. odel TPACK-based Inquiry-based learning promotes collaborative learning and communication between students. In this context, students are invited to work together in groups, share ideas, and solve problems together. This process not only broadens students' perspectives but also enriches their critical thinking through collective discussion, debate, and reflection. The ability to articulate and defend their own ideas while appreciating the viewpoints of others is an indicator of strong critical thinking skills.

The Inquiry-based TPACK learning model emphasizes learning that is relevant to real life and contextual situations. By introducing issues that are authentic and relevant to everyday life (Oktarina et al., 2021), this model invites students to apply their knowledge in a meaningful context. Through hands-on experience and reflection on the experience, students are exposed to critical thinking challenges that require in-depth analysis and creative solutions (Hasanah et al., 2023; Sharen & Kirk, 2023). Furthermore, the Inquiry-based TPACK Learning Model also helps develop students' metacognitive skills. By stimulating their awareness of their own thought processes, the model allows students to identify effective learning strategies, monitor their own understanding, and reflect on their learning process on a regular basis (Asamoah, 2019). Thus, students can develop the ability to improve and improve the quality of their critical thinking independently.

Conclusion

From the results of this study, it can be concluded that the TPACK-based inquiry teaching model has a significant influence on students' critical thinking skills with a res value = 0.914; P< 0.001. These findings provide positive information for teachers to implement this model in learning. The use of technology as a learning tool and the emphasis on the relevance of content to real life are also key factors in strengthening critical thinking skills. Thus, the Inquiry-based TPACK Learning Model offers a holistic and effective approach in improving the quality of education by preparing students to become active, reflective, and critical learners in the face of the complexities of the modern world.

Reference

Abdul Razak, Lufri Lufri, & Irdawati Irdawati. (2022). The Influence of the Science Technology Engineering and

Mathematics Approach with Mind Maps on the Higher Order Thinking Skills (HOTS) of Students in Biology Learning Class X SMA N 4 Kerinci. *International Journal of Education and Literature*, *1*(2), 77–82. https://doi.org/10.55606/ijel.v1i2.34

Adnan et al. (2021). Impacts of inquiry learning model on students' cognitive and critical thinking ability. *Cypriot Journal of Educational Sciences*, *16*(3), 1290–1299.

Alfroni, Y. F., Batlolona, J. R., & Mahapoonyanont, N. (2019). INQUIRY-SCAFFOLDING LEARNING MODEL : ITS EFFECT ON CRITICAL THINKING SKILLS AND CONCEPTUAL. *Jurnal Ilmiah Pendidikan Fisika*, *08*(October), 249–259. https://doi.org/10.24042/jipfalbiruni.v8i2.4214

Alqahtani, G. A., & The, M. A. (2023). The Effectiveness of a Training Program Based on Multimedia on Enhancing the Teaching Process and Critical Thinking Skills of Teachers of the Deaf and Hearing-impaired in Secondary Schools To cite this article : The Effectiveness of a Training Program Bas. *International Journal of Education in Mathematics, Science, and Technology (IJEMST)*, *11*(5), 1173–1183.

Angraini et al. (2023). TPACK-based Active Learning to Promote Digital and Scientific Literacy in Genetics. *Pegem Journal of Education and Instruction*, *13*(2), 50–61. https://doi.org/10.47750/pegegog.13.02.07

Asamoah, M. K. (2019). TPACKEA Model for Teaching and Students ' Learning. *Journal of Academic Ethics*.

Bwalya, A., Rutegwa, M., Tukahabwa, D., & Mapulanga, T. (2023). Enhancing Pre-Service Biology Teachers' Technological Pedagogical Content Knowledge Through a Tpack-Based Technology Integration Course. *Journal of Baltic Science Education*, *22*(6), 956–973. https://doi.org/10.33225/jbse/23.22.956

Chaidam, O., & Poonputta, A. (2022). Learning Achievement Improvement of 1st Grade Students by Using Problem-Based Learning (PBL) on TPACK MODEL. *Journal of Education and Learning*, *11*(2), 43–48. https://doi.org/10.5539/jel.v11n2p43

Cohen, L., Manion, L., Lecturer, P., Morrison, K., & Lecturer, S. (2007). *Research Methods in Education*. Routledge is an imprint of the Taylor & Francis Group, an informa business.

Diah, H. R., Dayurni, P., Evasufi, L., & Fajari, W. (2022). Meta-Analysis Study : The Effect of Android-Based Learning Media on Student Learning Outcomes. *INTERNATIONAL JOURNAL OF ASIAN EDUCATION*, *3*(4), 253–263.

Elfira, I., & Santosa, T. A. (2023). Literature Study : Utilization of the PjBL Model in Science Education to Improve Creativity and Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 133–143. https://doi.org/10.29303/jppipa.v9i1.2555

Fradila, E., Razak, A., Santosa, T. A., Arsih, F., & Chatri, M. (2021). Development Of E-Module-Based Problem Based Learning (PBL) Applications Using Sigil

The Course Ecology And Environmental Education Students Master Of Biology. *International Journal of Progressive Sciences and Technologies (IJPSAT)*, *27*(2), 673–682.

Hasanah, D., Prihatni, Y., & Purwanto, J. (2023). How did problem-based learning with the TPACK approach (PBL-TPACK) enhance physics learning outcomes ? *Jurnal Riset Dan Kajian Pendidikan Fisika*, *10*(2), 36–45. https://doi.org/10.12928/jrkpf.v10i2.543

Helsa, Y. (2023). TPACK-based hybrid learning model design for computational thinking skills achievement in mathematics. *Journal on Mathematics Education*, *14*(2), 225–252.

Ichsan, Yayat Suharyat, Tomi Apra Santosa, E. (2023). The Effectiveness of STEM-Based Learning in Teaching 21 st Century Skills in Generation Z Student in Science Learning : A. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 150–166. https://doi.org/10.29303/jppipa.v9i1.2517

Irmita, L., & Atun, S. (2018). The influence of Technological Pedagogical and Content Knowledge (TPACK) approach on science literacy and social skills. *Journal of Turkish Science Education*, *15*(3), 27–40. https://doi.org/10.12973/tused.10235a

Jaipal-jamani, K., Figg, C., Gallagher, T., Scott, R. M., & Ciampa, K. (2015). Collaborative Professional Development in Higher Education : Developing Knowledge of Technology Enhanced Teaching. *The Journal of Effective Teaching an Online Journal Devoted to Teaching Excellence*, *15*(2), 30–44.

Jeerawan Ketsing1 *, Noriyuki Inoue2, S. B., & 1Department. (2017). Enhancing Pre-service Teachers' Reflective Quality on Inquiry-based Teaching Through a Community of Practice. *Science Education International*, *31*(4), 367–378.

Kanmaz, A. (2022). Middle school teacher' critical thinking skills and awareness towards teaching critical thinking skills. *International Online Journal of Education and Teaching (IOJET)*, *9*(4), 1648–1671.

Koksalan, S., & Ogan-bekiroglu, F. (2024). Examination of Effects of Embedding Formative Assessment in Inquiry-Based Teaching on Conceptual Learning. *Science Insights Education Frontiers*, *20*(2), 3223–3246. https://doi.org/10.15354/sief.24.or512

Kucuk, A. (2022). Which Is More Valuable In Constructing Cognitive Structures - Teaching Science Through Creative-Drama Activities Or Student- Centred Inquiry-Based Teaching ? *Journal of Turkish Science Education*, *19*(2), 699–717.

Kusmaryono, I. (2023). How are Critical Thinking Skills Related to Students ' Self-regualtion and Independent Learning ? *Pegem Journal of Education and Instruction*, *13*(4), 85–92. https://doi.org/10.47750/pegegog.1

Mahmud, M. (2020). TPACK MODEL BASED INSTRUCTION IN TEACHING WRITING : AN ANALYSIS ON TPACK LITERACY.

International Journal of Language Education, *4*(1), 129–140. https://doi.org/10.26858/ijole.v4i2.12441

Maison. (2022). International Journal of Educational Methodology How Critical Thinking Skills Influence Misconception in Electric Field. *International Journal of Educational Methodology Volume*, *8*(2), 377–390.

Mohammed, S. M. (2022). Teachers ' Beliefs : Positive or Negative Indicators of Inquiry-Based Science Teaching ? *World Journal of Education*, *12*(1), 17–33. https://doi.org/10.5430/wje.v12n1p17

Net, W. W. W. P., Setiawati, H., Setiawati, A., Ismirawati, N., & Syam, A. (2023). *Development of Student Worksheets (LKPD) Based on Critical Thinking Skills Environmental Change and Waste Recycling Materials*. *13*(4), 1–12. https://doi.org/10.47750/pegegog.1

Nurtamam, M. E., Santosa, T. A., Aprilisia, S., Rahman, A., & Suharyat, Y. (2023). Meta-analysis : The Effectiveness of Iot-Based Flipped Learning to Improve Students ' Problem Solving Abilities. *Edumaspul :Jurnal Pendidikan*, *7*(1), 1491–1501.

Occe Luciana1*, Tomi Apra Santosa2, Agus Rofi'i3, Taqiyuddin4, B. N. (2023). Meta-analysis: The effect of problem-based learning on students' critical thinking skills. *Edumaspul: Jurnal Pendidikan*, *7*(2), 2058–2068. https://doi.org/10.1063/1.5139796

Oktarina, K., Santosa, T. A., Razak, A., & Ahda, Y. (2021). Meta-Analysis : The Effectiveness of Using Blended Learning on Multiple Intelligences and Student Character Education during the Covid-19 Period. *IJECA International Journal of Education & Curriculum Application*, *4*(3), 184–192.

Patandung, Y. (2023). Adolescence Students' Critical Thinking Skills in The Context of Christian Education. *International Journal of Asian Education*, *4*(3), 150–156. https://doi.org/10.46966/ijae.v4i3.349

Putra, M., Rahman, A., Suhayat, Y., Santosa, T. A., & Putra, R. (2023). The Effect of STEM-Based REACT Model on Students ' Critical Thinking Skills : A Meta-Analysis Study. *LITERACY : International Scientific Journals Of Social, Education and Humaniora*, *2*(1), 207–217.

Rahman, A., Santosa, T. A., Sofianora, A., Oktavianti, F., & Alawiyah, R. (2023). Systematic Literature Review : TPACK-Integrated Design Thinking in Education. *International Journal of Education and Literature (IJEL)*, *2*(1), 65–77.

Ratna Dewi1), Retni S. Budiarti2), M. A. (2017). THE DEVELOPMENT OF LEARNER ACTIVITY SHEET- CHARGED CHARACTER EDUCATION WITH A LEARNING MODEL OF GUIDED INQUIRY ON MATERIAL OF BACTERIA FOR STUDENTS OF CLASS X HIGH SCHOOL. *Biodik*, *3*(1), 17–26.

Sharen, C. M., & Kirk, H. (2023). It ' s Complicated : Instructors ' Perception of their Teaching Roles Online. *IJ-SoTL*, *17*(1), 1–18.

Sofianora, A., Suharyat, Y., & Santosa, T. A. (2023). *PENGARUH PROFESIONALITAS*

GURU MATEMATIKA DALAM MENINGKATKAN KOMPETENSI SISWA ERA REVOLUSI INDUSTRI 5 . 0 DI INDONESIA : SEBUAH META-ANALISIS. *10*(2).

Sri Handayani1*, Muhammad Hussin2, H. N. (2023). Technological Pedagogical Content Knowledge (TPACK) Model in teaching: A Review and Bibliometric Analysis. *Pegem Journal of Education and Instruction*, *13*(3), 176–190. https://doi.org/10.47750/pegegog.13.03.19

Supriyadi, A., Suharyat, Y., Santosa, T. A., & Sofianora, A. (2023). The Effectiveness of STEM-Integrated Blended Learning on Indonesia Student Scientific Literacy : A Meta-analysis. *International Journal of Education and Literature (IJEL)*, *2*(1), 41–48.

Suryono, W., Haryanto, B. B., Santosa, T. A., Suharyat, Y., & Sappaile, B. I. (2023). The Effect of The Blended Learning Model on Student Critical Thinking Skill : Meta-analysis. *Edumaspul - Jurnal Pendidikan*, *7*(1), 1386–1397.

Suyatno Sutoyo1*, Rudiana Agustini1, A. F. (2023). Online Critical Thinking Cycle Model to Improve Pre-service Science Teacher ' s Critical Thinking Dispositions and Critical Thinking Skills. *Pegem Journal of Education and Instruction*, *13*(2), 173–181. https://doi.org/10.47750/pegegog.13.02.21

Tamur, M., & Wijaya, T. T. (2021). Using Problem-Based Learning to Enhance Mathematical Abilities of Primary School Students : A Systematic Review and Meta-Analysis. *JTAM (Jurnal Teori Dan Aplikasi Matematika)*, *5*(1), 144–161.

Wang, J. (2020). Validating a 3E Rubric Assessing Pre-service Science Teachers ' Practical Knowledge of Inquiry Teaching. *EURASIA Journal of Mathematics, Science and Technology Education, 16*(2).

Zulkifli Zulkifli, Agus Supriyadi, Erwinsyah Satria, & Tomi Apra Santosa. (2022). Meta-analysis: The Effectiveness of the Integrated STEM Technology Pedagogical Content Knowledge Learning Model on the 21st Century Skills of High School Students in the Science Department. *Psychology, Evaluation, and Technology in Educational Research*, *1*(2), 68–76. https://doi.org/10.55606/ijel.v1i2.32