

Ricosre Model with Question Formulation Technique (QFT): Enhancing Students' Higher Order Thinking Skills (HOTS) and Science Literacy

Irdalisa^{1*}, Budhi Akbar¹, Tuti Marjan Fuadi², Maesaroh², Eka Kartikawati²

¹ Department of Biology Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Prof. DR. HAMKA, Jakarta, Indonesia.

² Department of Biology Education, Faculty of Teacher Training and Education, Universitas Abulyatama, Aceh, Indonesia.

Received: December 29, 2023

Revised: February 2, 2024

Accepted: March 25, 2024

Published: March 31, 2024

Corresponding Author:

Irdalisa

irdalisa@uhamka.ac.id

DOI: [10.29303/jppipa.v10i3.6764](https://doi.org/10.29303/jppipa.v10i3.6764)

© 2024 The Authors. This open access article is distributed under a (CC-BY License)



Abstract: The 21st-century learning has undergone a paradigm shift in education from teacher-centered to student-centered. It recently emphasises students' critical and creative thinking abilities, effective communication, innovation, problem-solving, and collaboration. This study examined the Ricosre model's effectiveness with the Question Formulation Technique (QFT) in enhancing students' higher-order thinking skills (HOTS) and science literacy. It involved 296 fifth-grade students from three selected state elementary schools, chosen through cluster random sampling. Each group consisted of 148 students divided into control and experimental groups. Data were collected through multiple-choice and essay instruments and subsequently analysed using multivariate analysis of variance (MANOVA). The research variables were students' higher-order thinking skills (HOTS) and science literacy. The results indicated that the Ricosre model with QFT effectively improves students' higher-order thinking skills (HOTS) and science literacy, as it encouraged active participation during the learning process, trained students to develop questioning skills, find answers, analyse, share ideas, and draw conclusions. Thus, it can foster curiosity and metacognitive abilities among students.

Keywords: Higher-order thinking skills (HOTS); Question formulation technique (QFT); Ricosre model; Science literacy

Introduction

Innovations in technology influence human behavior in daily life. The conventional education system in the field of education, there is an increasing emphasis on teachers' multifaceted roles, extending beyond technical expertise. Besides possessing subject knowledge, they are expected to exhibit effective pedagogical skills, integrate technology awareness, and implement appropriate teaching strategies (Hidayati et al., 2016; Irdalisa et al., 2020). Teachers hold a pivotal position as influential agents in students' learning experiences, shaping their understanding of subject matter and nurturing their intrinsic motivation to learn (Ambusaidi et al., 2021). Students' thinking abilities will

be more directed when they can express themselves, voice their opinions, solve problems independently and in groups, thus fostering social interaction among students (Prihatmojo et al., 2019). The success of students is determined by the skills and knowledge they use by adapting to every change in order to achieve mastery of 21st century skills (Hidayati et al., 2023).

High-order thinking skills (HOTS) entail students engaging in mental activities that critically and creatively connect, manipulate, and transform their existing knowledge and experiences. Through these cognitive processes, students can make informed decisions (Dinni, 2018). Furthermore, HOTS empower students to analyse, evaluate, and innovate when

How to Cite:

Irdalisa, Akbar, B., Fuadi, T. M., Maesaroh, & Kartikawati, E. (2024). Ricosre Model with Question Formulation Technique (QFT): Enhancing Students' Higher Order Thinking Skills (HOTS) and Science Literacy. *Jurnal Penelitian Pendidikan IPA*, 10(3), 1175-1178. <https://doi.org/10.29303/jppipa.v10i3.6764>

addressing challenges within their environment (Ichsan et al., 2019). However, field observations reveal a limited range of strategies teachers employ to cultivate students' thinking abilities (Indriyana & Kuswando, 2019). Students are often directed to comprehend and memorize the subject matter, resulting in a deficiency in their higher-order thinking skills. This challenge poses an issue that educators must address in the teaching process. Another contributing factor is teachers' insufficient knowledge of HOTS; not all educators possess a comprehensive understanding of it, and they may struggle to select appropriate methods and instructional models to enhance it (Afifah & Retnawati, 2019). Thus, addressing these issues requires a concerted effort from teachers and the education community to bolster students' HOTS and promote effective learning strategies.

HOTS is influenced by individual literacy capabilities (Indriyana & Kuswando, 2019). There are five steps to enhance HOTS through literacy: setting learning objectives for reading in the classroom, engaging students in interactive questioning, instructing them to practice reviewing and improving comprehension, providing feedback, and assessing their learning progress (Indriyana & Kuswando, 2019). However, Indonesia consistently ranks at the lowest level regarding science literacy (Chasanah et al., 2022). According to the Programme for International Student Assessment (PISA), science literacy among Indonesian students remains below the international average (Winarni et al., 2020). In 2012, Indonesia ranked 64th out of 65 countries with a score of 382. Subsequently 2015, it ranked 64th from 72 participating countries, scoring 403. These survey results indicate that science literacy among Indonesian students falls significantly below the international standard set by the organization (OECD, 2016). PISA's assessment places Indonesia's science literacy at the lowest rank among 64 countries (Rusilowati et al., 2016). This finding highlights Indonesian students' low science literacy level (Azrai et al., 2020).

Science literacy plays a crucial role in applying knowledge and skills among students, as it encourages active participation in constructing knowledge, reflecting on experiences, analyzing the real world, enhancing social negotiation, learning effective communication, and integrating learning experiences (Setyowati et al., 2022). Science literacy directs how science can serve as a solution for decision-making in addressing various issues. With science literacy capabilities, students can analyze, reason, and communicate effectively when confronted with problems, thus enabling them to solve and interpret challenges in diverse situations. Proficiency in science

literacy equips students with the necessary skills to navigate real-life situations in the era of globalization (Winarni et al., 2020).

However, understanding science education that develops students' science literacy has not been entirely effective (Adnan et al., 2021). Not all teachers can create effective learning environments that foster science literacy among students (Winarni et al., 2020). The challenges in education stem from the weaknesses in implementing the teaching and learning process by teachers in schools (Wahyu et al., 2020). Students are not accustomed to working on science problems using discourse, and the learning process remains conventional, primarily focused on conceptual mastery (Windyarani et al., 2017). Another problem is the loss of student interest and motivation in studying science, due to the many difficulties students have in studying science due to the learning model used by teachers being abstract and not directly involving students so that misunderstandings often occur (Windyarani et al., 2017). The resolution of these issues is hoped to be addressed by teachers. As the key figures in achieving learning objectives, teachers should adopt appropriate instructional models to ensure students can learn effectively and efficiently (Muspawi et al., 2019).

The conventional teaching models need to be replaced with creative and innovative approaches (Irdalisa et al., 2023). The Ricosre instructional model has been extensively studied by researchers and proven effective in fostering critical thinking for students of diverse academic abilities (Mahanal et al., 2019), and problem-solving abilities (Putri et al., 2020). Built on the principles of constructivism, the Ricosre model promotes a more active and student-centered classroom environment, leading to increased interest and motivation in learning (Ahmad, 2016). The Ricosre instructional model follows a syntactical structure comprising the following steps: Reading, Identifying the problem, Constructing the solution, Solving the problem, Reviewing the problem-solving process, and Extending the problem-solving to related contexts (Mahanal et al., 2017).

However, combining Ricosre research with the Question Formulation Technique (QFT) is still relatively uncommon. QFT is a technique developed by the Right Question Institute, and several studies have reported its potential implementation as a learning strategy to enhance students' curiosity, engagement, problem-solving skills, and independent thinking. The QFT consists of six stages: A Question Focus (Qfocus), The rules for producing questions and Producing questions, Categorizing questions, Prioritizing questions, Next steps, and Reflection (Mahanal et al., 2017). Each stage of the QFT is designed to facilitate

students in generating numerous questions (Garibay et al., 2020), encouraging them to think more deeply about the questions they create, thereby promoting critical thinking and enhancing students' long-term comprehension.

Therefore, integrating Ricosre principles and the QFT technique can be an innovative instructional model. This model provides a framework for inquiry-based learning guided by students' questions. It is designed to facilitate students in problem-solving through the generation of questions, promoting divergent, convergent, and metacognitive thinking, thus empowering and developing students' higher-order thinking skills (HOTS) and scientific literacy. This study examines the Ricosre model's effectiveness with QFT in enhancing students' higher-order thinking skills (HOTS) and scientific literacy.

Method

This research belongs to a quasi-experiment using a pretest-posttest control group design. The researchers implemented the Ricosre model with the Question

Formulation Technique (QFT) in the experimental group, while the control group received the Direct Instruction model. The sampling technique used was cluster random sampling, resulting in a sample size of 296 students, with 148 students in each control and experimental group. The assessment indicators for higher-order thinking skills (HOTS) and science literacy can be seen in Figure 1.

Multiple-choice questions were used to collect data on high-order thinking skills (HOTS), while essay questions were used to gather data on students' science literacy. Experts validated both the HOTS multiple-choice questions and the essay questions. The data on high-order thinking skills (HOTS) and science literacy from the students were used to test the proposed hypothesis that the implementation of the Ricosre model with QFT (Question Formulation Technique) was effective in enhancing high-order thinking skills (HOTS) and science literacy among the students. Multivariate analysis of variance (MANOVA) was utilized to test this hypothesis.

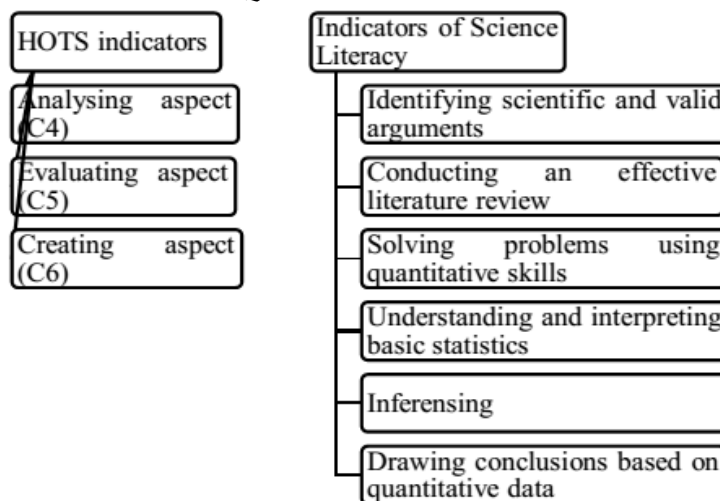


Figure 1. Indicators of HOTS and science literacy assessment

Result and Discussion

Results

The normality test results using the Kolmogorov-Smirnov test with a significance level of 5% indicated that the data followed a normal distribution (Saculinggan & Balase, 2013). Similarly, the results of the homogeneity test using the Barlett test showed that the samples used came from populations with equal variances. Based on the calculation of the Manova test with Wilk Lambda analysis, an F value of 933.976 was obtained with a significance value of 0.000 < 0.05. Furthermore, the tests of between-subject effects

revealed that the relationship between Ricosre and QFT (Question Formulation Technique) used with HOTS resulted in an F value of 1452.109 with a significance value of 0.000, and the relationship between Ricosre and QFT (Question Formulation Technique) used with science literacy yielded an F value of 1775.217 with a significance value of 0.000. These findings indicate significant differences in students' HOTS and science literacy due to the variations of the instructional models.

Table 1. Marginal and Cell Means

Class	Learning Model	Dependent Variable	Low	Moderate	High	Marginal Mean
Experiment	Ricosre Model with QFT (Question Formulation Technique)	High-Order Thinking Skills (HOTS)	81.40	85.00	90.51	85.64
		Science literacy	77.40	84.49	85.00	83.20
Control	Direct Instruction Model	High-Order Thinking Skills (HOTS)	62.60	65.00	71.63	66.41
		Science literacy	64.10	65.00	68.88	65.99
Marginal means		High-Order Thinking Skills (HOTS)	72.00	75.00	81.07	
		Science literacy	70.75	74.75	76.94	

The experimental class employed the Ricosre model with QFT, while the control class utilized the Direct Instruction teaching model. To determine the more effective instructional model, the marginal and cell means for each dependent variable were examined as presented in Table 1.

Discussion

The marginal means of the variables "Higher Order Thinking Skills (HOTS)" and "Science Literacy" for the experimental class were higher compared to the control class. For the variable "Higher Order Thinking Skills (HOTS)," the mean score for students using the Ricosre model with QFT was 85.64, while for those using the Direct Instruction teaching model, it was 66.41. Thus, the average HOTS score with the Ricosre model and QFT was better than that with the Direct Instruction teaching model (Table 1). Similarly, for the variable "Science Literacy," the mean score for students using the Ricosre model with QFT was 83.20, while for those using the Direct Instruction teaching model, it was 65.99. Hence, the average Science Literacy score with the Ricosre model and QFT was superior to that with the Direct Instruction teaching model. Based on these findings, it can be concluded that students' Higher Order Thinking Skills (HOTS) and Science Literacy were better when using the Ricosre model with QFT than the Direct Instruction teaching model.

The Ricosre model with QFT proves effective in enhancing higher-order thinking skills as it actively engages students in the learning process. This approach encourages students to think critically about problems, conduct experiments to find answers, analyse and interpret data, and discuss their findings to draw conclusions (Mairoza & Fitriza, 2021). The Ricosre model actively involves students, allowing them to contribute their ideas (Azizah et al., 2020). The integration of QFT (Question Formulation Technique) within the Ricosre model is particularly effective in fostering students' higher-order thinking skills and science literacy. The learning phases are designed to develop questioning skills through idea generation, categorisation, prioritisation, and group discussions. By employing this model, teachers can support students in developing their questioning, metacognitive, and

interpersonal skills, enabling them to ask relevant questions and developing their curiosity and motivation to learn.

Combining the Ricosre model's learning syntax with QFT empowers students' higher-order thinking skills (HOTS) and science literacy. The "reading" phase in the Ricosre model enables students to comprehend a passage, activating prior knowledge and stimulating them to identify the problems presented by rearticulating the text. During this phase, students focus on formulating questions, categorising them, and prioritising them based on the reading material, thereby improving their reading concentration. Reading is a key strategy in empowering higher-order thinking skills as it assists students in acquiring new information and establishing connections between ideas (Duke & Pearson, 2004). Developing strong reading skills helps students progress academically and enhances their professionalism (Velásquez, 2020).

In the "Identifying the problem" phase, students can recognise issues and deepen their knowledge about a particular problem. Problem identification involves students to clarify unclear and unstructured problems and allow them to search for the required solution criteria (Mahanal et al., 2017). In the "Constructing the solution" phase, students identify and explore the problem to determine the strategies for forming the solution. During the "Solving the problem" phase, students implement strategies to resolve the problem. The selected solutions are based on considerations from previously chosen solutions. In the "Reviewing the problem-solving" phase, students reflect and reevaluate to ensure the selected information is accurate. Lastly, in the "Extending the problem solution" phase, students communicate the results of their discussions. Thus, the learning syntax of the Ricosre model with QFT is designed to activate higher-order thinking skills through problem-solving activities. Consequently, using the Ricosre model with QFT stimulates students to enhance their thinking abilities at higher levels, involving critical thinking skills in digesting various types of information and solving problems. It enables students to construct explanations and connect acquired information to make decisions.

The Ricosre and QFT models also help students to develop important metacognitive skills in HOTS. It refers to the ability to reflect on one's own thinking processes as well as monitor and regulate one's learning. It indicates that Ricosre and QFT models are very suitable to help improve students' higher-order thinking skills. High-order thinking skills refer to students' cognitive process at a higher level of thinking, student skills are built through a process that encourages critical thinking, creative thinking and problem solving skills (Yosepha et al., 2023), extending beyond memorization and restating known information (Mairoza & Fitriza, 2021). These skills are crucial for students to master as they enable them to make decisions, present strong arguments, think broadly from various perspectives to respond to problems effectively, generate problem-solving ideas, and encourage active participation in discussions (Heong et al., 2012). In the domain of analysing, which is a part of HOTS, students are presented with a case or phenomenon to classify information, determine relationships, distinguish causes and effects, and identify and connect elements within the information. In the evaluation domain, students can assess ideas and solutions and can accept or reject statements. In creating domain, students can draw general conclusions from a given concept or perspective on a particular matter.

Scientific literacy is the ability to understand scientific concepts and principles and think scientifically to solve daily problems (Chasanah et al., 2022). Measured scientific literacy consists of identifying valid scientific opinions, conducting effective literature searches, solving problems using quantitative skills, understanding and interpreting basic statistics, making predictive inferences, and drawing conclusions based on quantitative data. Scientific literacy is essential to instill among students in 21st-century learning (Nisa et al., 2021). The existence of scientific literacy can prevent someone from making mistakes in understanding some information (Sharon & Baram-Tsabari, 2020).

Conclusion

Based on the research findings, it can be concluded that the Ricosre model with QFT is effective in enhancing students' HOTS and science literacy. Students who were given the Ricosre learning model and Question Formulation Technique (QFT) showed an increase in Higher-Order Thinking Skills (HOTS) and Science Literacy compared to using the direct introductory learning model. The combination of Ricosre and QFT is an innovative model in line with the

demands of the 21st Century which requires learning with the 4C competencies of creativity, critical thinking, collaboration and communication.

Acknowledgments

We would like to thank Unit Pembina dan Pengembangan Peublikasi Ilmiah (UPPI) and Lemlitbang Universitas Muhammadiyah Prof. Dr. Hamka for providing a research grant under the scheme of Major Reputable International Publication (PPIBU) with reference number: 859/F.03.07/2022.

Author Contributions

This article was prepared by five people, namely I,I, B,A, M,M, E,N, and E, K. I,I, B,A, M,M, E,N, and E, K have read and approved the published version of the manuscript.

All research members carried out each stage cooperatively until this article was completed.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

References

- Adnan, Mulbar, U., Sugiarti, & Bahri, A. (2021). Scientific literacy skills of students: Problem of biology teaching in junior high school in South Sulawesi, Indonesia. *International Journal of Instruction*, 14(3), 847-860. <https://doi.org/10.29333/iji.2021.14349a>
- Afifah, I. R. N., & Retnawati, H. (2019). Is it difficult to teach higher order thinking skills? *Journal of Physics: Conference Series*, 1320(1). <https://doi.org/10.1088/1742-6596/1320/1/012098>
- Agustini, F. (2017). Peningkatan kemampuan bertanya dan penguasaan konsep IPA melalui pendekatan Question Formulation Technique (QFT) [Increasing the ability to ask question and mastery of science concepts through the Question Formulation Technique (QFT) approach]. *Jurnal Penelitian Pendidikan*, 17(1). <https://doi.org/10.17509/jpp.v17i1.6633>
- Ahmad, A. M. (2016). Learner-centered instruction in English education: Reality and expectations. *Arab World English Journal (AWEJ)*, 7. <https://dx.doi.org/10.2139/ssrn.2804001>
- Ambusaidi, I., Badiali, B., & Alkharousi, K. (2021). Examining how biology teachers' pedagogical beliefs shape the implementation of the omani reform-oriented curriculum. *Athens Journal of Education*, 8(3), 263-304. <https://doi.org/10.30958/aje.8-3-3>

- Azizah, N., Mahanal, S., Zubaidah, S., & Setiawan, D. (2020). The effect of RICOSRE on students' critical thinking skills in biology. *AIP Conference Proceedings*, 2215(April). <https://doi.org/10.1063/5.0000562>
- Azrai, E. P., Suryanda, A., Wulaningsih, R. D., & Sumiyati, U. K. (2020). Kemampuan berpikir kritis dan literasi sains siswa SMA di Jakarta Timur [Critical thinking skills and scientific literacy of high school student in East Jakarta]. *Edusains*, 12(1), 89-97. <https://doi.org/10.15408/es.v12i1.13671>
- Chasanah, N., Widodo, W., & Suprpto, N. (2022). Pengembangan Instrumen Asesmen Literasi Sains Untuk Mendeskripsikan Profil Peserta Didik [Development of a science literacy assessment instrument to describe student profiles]. *PENDIPA Journal of Science Education*, 6(2), 474-483. <https://doi.org/10.33369/pendipa.6.2.474-483>
- Dinni, H. N. (2018). HOTS (High Order Thinking Skills) dan kaitannya dengan kemampuan literasi matematika [HOTS (High Order Thinking Skill) and its relation to mathematical literacy ability]. *PRISMA, Prosiding Seminar Nasional Matematika*, 1, 170-176. Retrieved from <https://journal.unnes.ac.id/sju/index.php/prisma/article/view/19597>
- Duke, N. K., & Pearson, P. D. (2009). Effective practices for developing reading comprehension. *Journal of education*, 189(1-2), 107-122. <https://doi.org/10.1598/0872071774.10>
- Garibay, C. T., Kerby, J., & Minigan, A. P. (2020). Implementation of the question formulation technique as a teaching strategy in renewable energy engineering education. *ASEE Annual Conference and Exposition, Conference Proceedings, 2020-June*. <https://doi.org/10.18260/1-2--34777>
- Heong, Y. M., Yunos, J. M., Othman, W., Hassan, R., Kiong, T. T., & Mohamad, M. M. (2012). The Needs Analysis of Learning Higher Order Thinking Skills for Generating Ideas. *Procedia - Social and Behavioral Sciences*, 59(October), 197-203. <https://doi.org/10.1016/j.sbspro.2012.09.265>
- Hidayati, N., Zubaidah, S., & Amnah, S. (2023). Effective learning model bases problem based learning and digital mind maps to improve student's collaboration skills. *International Journal of Evaluation and Research in Education*, 12(3), 1307-1314. <https://doi.org/10.11591/ijere.v12i3.22654>
- Hidayati, S. N., Sabtiawan, W. B., & Subekti, H. (2016). Pengembangan Instrumen Penilaian Otentik: Validitas Teoritis dan Kepraktisan. *Jurnal Penelitian Pendidikan IPA*, 1(1), 22-26. <https://doi.org/10.26740/jppipa.v1n1.p22-26>
- Ichsan, I. Z., Sigit, D. V., Miarsyah, M., Ali, A., Arif, W. P., & Prayitno, T. A. (2019). HOTS-AEP: Higher order thinking skills from elementary to master students in environmental learning. *European Journal of Educational Research*, 8(4), 935-942. <https://doi.org/10.12973/eu-jer.8.4.935>
- Indriyana, B. S., & Kuswandono, P. (2019). Developing Students' Higher Order Thinking Skills (HOTS) in Reading: English Teachers' Strategies in Selected Junior High Schools. *JET (Journal of English Teaching)*, 5(3), 204. <https://doi.org/10.33541/jet.v5i3.1313>
- Irdalisa, I., Amirullah, G., Hanum, E., Elvianasti, M., & Maesaroh, M. (2023). Developing STEAM-based students' worksheet with the ecoprint technique in biology subject. *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, 9(1), 132. <https://doi.org/10.33394/jk.v9i1.6775>
- Irdalisa, Paidi, & Djukri. (2020). Implementation of technology-based guided inquiry to improve tpack among prospective biology teachers. *International Journal of Instruction*, 13(2), 33-44. <https://doi.org/10.29333/iji.2020.1323a>
- Mahanal, S., & Zubaidah, S. (2017). Model pembelajaran ricosre yang berpotensi memberdayakan keterampilan berpikir kreatif [The ricosre learning model has the potential to empower creative thinking skills. *Jurnal Pendidikan*, 2(5), 676-685. Retrieved from <https://journal.um.ac.id/index.php/jptpp/article/view/9180>
- Mahanal, S., Zubaidah, S., Setiawan, D., Maghfiroh, H., & Muhaimin, F. G. (2022). Empowering College Students' Problem-Solving Skills through RICOSRE. *Education Sciences*, 12(3). <https://doi.org/10.3390/educsci12030196>
- Mahanal, S., Zubaidah, S., Sumiati, I. D., Sari, T. M., & Ismirawati, N. (2019). RICOSRE: A learning model to develop critical thinking skills for students with different academic abilities. *International Journal of Instruction*, 12(2), 417-434. <https://doi.org/10.29333/iji.2019.12227a>
- Mairoza, Y., & Fitriza, Z. (2021). Deskripsi Keterampilan Berpikir Tingkat Tinggi (HOIS) Peserta Didik Menggunakan Model Guided Inquiry Pada Materi Hukum Dasar Kimia [Description of student' Higher Order Thinking Skills (HOTS) using the guided inquiry model on basic chemical legal material. *Edukimia*, 3(1), 078-083. <https://doi.org/10.24036/ekj.v3.i1.a214>

- Manisa, T., Mahanal, S., & Rohman, F. (2020). Empowering problem-solving skills through RICOSRE learning model. *Jurnal Pendidikan Sains*, 8(1), 12–15. <https://doi.org/10.13140/RG.2.2.27283.20002>
- Mannion, J. M. (2019). The effectiveness of the question formulation technique on open-ended, written response questions in mathematics. *Rowan Thesis and Dissertations*.
- Mawaddah, K., Mahanal, S., Gofur, A., Setiawan, D., & Zubaidah, S. (2021). RICOSRE: An innovative learning model to promote scientific literacy. *AIP Conference Proceedings*, 2330(March). <https://doi.org/10.1063/5.0043303>
- Muspawati, M., Suratno, S., & Ridwan, R. (2019). Upaya Peningkatan Higher Order Thinking Skills (HOTS) Siswa Melalui Penerapan Model Inquiri di SMA Negeri 9 Tanjung Jabung Timur [Efforts to increase students' Higher Order Thinking Skills (HOTS) through the implementation of the inquiry model at SMA Negeri]. *Jurnal Ilmiah Universitas Batanghari Jambi*, 19(2), 208. <https://doi.org/10.33087/jjubj.v19i2.653>
- Nisa, K., Wiyanto, W., & Sumarni, W. (2021). Sistematis literatur review: literasi sains dan sets (science, environment, technology, and society). *EDUSAINS*, 13(1), 74–82. <https://doi.org/10.15408/es.v13i1.18717>
- OECD. (2016). *Results from PISA 2015: Indonesia*. OECD Publishing.
- Prihatmojo, A., Mulia Agustin, I., Ernawati, D., & Indriyani, D. (2019). Implementasi pendidikan karakter di abad 21 [Implementation of character education in the 21st century]. In *Seminar Nasional Pendidikan. Fakultas Ilmu Pendidikan. Universitas Muhammadiyah Jakarta*. Retrieved from <https://jurnal.umj.ac.id/index.php/SEMNASFIP/article/view/5125>
- Putri, R. R., Mahanal, S., & Rohman, F. (2020). The Potential of RICOSRE in Improving Scientific Reasoning of Students with Different Academic Ability. *Jurnal Pendidikan Sains*, 8(1), 16–21. Retrieved from <http://journal.um.ac.id/index.php/jps/article/view/13659>
- Rusilowati, A., Kurniawati, L., Nugroho, S. E., & Widiyatmoko, A. (2016). Developing an instrument of scientific literacy assessment on the cycle theme. *International Journal of Environmental and Science Education*, 11(12), 5718–5727. Retrieved from http://www.ijese.net/makale_indir/IJESE_736_article_57af271992c81.pdf
- Saculinggan, M., & Balase, E. A. (2013). Empirical power comparison of goodness of fit tests for normality in the presence of outliers. *Journal of Physics: Conference Series*, 435(1). <https://doi.org/10.1088/1742-6596/435/1/012041>
- Sari, T. M., Mahanal, S., & Zubaidah, S. (2018). Empowering Critical Thinking with Ricosre Learning Model. *Jurnal Pendidikan Sains*, 6(1), 1–5. Retrieved from <http://journal.um.ac.id/index.php/jps/article/view/10648>
- Setyowati, A. P., Gunarhadi, G., & Musadad, A. A. (2022). Profile and Factors Influencing Students' Scientific Literacy. *Journal of International Conference Proceedings*, 5(1), 314–323. <https://doi.org/10.32535/jicp.v5i1.1481>
- Sharon, A. J., & Baram-Tsabari, A. (2020). Can science literacy help individuals identify misinformation in everyday life? *Science Education*, 104(5), 873–894. <https://doi.org/10.1002/sc.21581>
- Velásquez, E. (2020). The effect of discipline-related knowledge on heritage language learners' reading comprehension. *Athens Journal of Education*, 7(1), 31–48. <https://doi.org/10.30958/aje.7-1-2>
- Wahyu, Y., Suastra, I. W., Sadia, I. W., & Suarni, N. K. (2020). The effectiveness of mobile augmented reality assisted STEM-based learning on scientific literacy and students' achievement. *International Journal of Instruction*, 13(3), 343–356. <https://doi.org/10.29333/iji.2020.13324a>
- Winarni, E. W., Hambali, D., & Purwandari, E. P. (2020). Analysis of language and scientific literacy skills for 4th grade elementary school students through discovery learning and ict media. *International Journal of Instruction*, 13(2), 213–222. <https://doi.org/10.29333/iji.2020.13215a>
- Windyariani, S., Setiono, S., & Sutisnawati, A. (2017). Pengembangan model asesmen literasi sains berbasis konteks bagi siswa sekolah dasar. In *Prosiding Seminar Nasional Pendidikan Berkemajuan dan Menggembirakan (The Progressive & Fun Education Seminar) ke-2*. Retrieved from <https://publikasiilmiah.ums.ac.id/xmlui/handle/11617/9565>
- Yosepha, A., Ali, M., Wahyudin, D., & Rusman. (2023). The Role of Multi-dimensional Curriculum Design in Improving Higher-Order Thinking Skills. *International Journal of Learning, Teaching and Educational Research*, 22(7), 219–239. <https://doi.org/10.26803/ijlter.22.7.12>