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Interplay of Problem-Solving and Decision-Making in STEM Education with Water Pollution Problem

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To cite this article:

Nisrina, N.S., Melinda, M., Anwar, Y., & Kurniawan, D. (2025). Interplay of problem-solving and decision-making in STEM Education with water pollution problem. *International Journal of Research in Education and Science (IJRES), 11*(2), 396-408. https://doi.org/10.46328/ijres.1288

IJRES International Journal of Research in Education and Science
2025, Vol. 11, No. 2, 396-408 https://doi.org/10.46328/ijres.1288

Interplay of Problem-Solving and Decision-Making in STEM Education with Water Pollution Problem

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Article Info

Article History

Received:
19 December 2024
Accepted:
7 March 2025

Keywords

STEM Education
Problem solving
Decision making
Water pollution

Abstract

This pressing issue requires immediate attention and action. Education, particularly STEM education, is one of the key areas that can contribute to addressing this issue. STEM education is an alternative learning strategy that can enhance students' problem-solving and decision-making skills in relation to the challenges posed by the need for clean water. However, the extent to which these two skills are interconnected remains unclear. Therefore, this study was conducted to measure the effect of STEM on problem-solving and decision-making skills, as well as to explore the relationship between these two variables. This study employed a quasi-experimental design with a sample of 54 students, focusing on the topic of water pollution and its solutions. Based on the MANCOVA test, the results showed significant effects of STEM education. In the experimental group, the p-value for problem-solving ability was 0.001, and for decision-making ability, it was 0.000, indicating a substantial impact of STEM education on both skills. Furthermore, a strong correlation between problem-solving and decision-making skills was observed, particularly in the context of water pollution and its solutions. The findings suggest that STEM education effectively supports students in exploring complex issues and equipping them to meet the demands of 21st-century skills, especially those related to environmental challenges.

Introduction

Water is a crucial and essential resource for human health (Wutich et al., 2020). However, the relationship between water availability and population growth is not directly proportional. As the human population increases, the demand for water rises, yet water availability is steadily declining (Vega et al., 2023). This decrease is largely attributed to human activities contributing to water pollution (Bashir et al., 2020). Water contaminated with chemicals or pollutants poses serious health risks, potentially leading to chronic illnesses if consumed (Mutileni et al., 2023). Recognizing the critical importance of water for human survival, preventive measures must be taken, and one key aspect that can contribute significantly to this effort is education.

Education regarding the importance of water use and cleanliness can be effectively delivered to students through formal learning settings (Aminah et al., 2018; Rollwagen-Bollens et al., 2022). Environmental education plays a crucial role in enhancing students' awareness of the significance of environmental hygiene (Zhang, 2023).

Environmental education must be presented in a suitable learning framework to be effective (Summak, 2022). STEM education is particularly recommended as an instructional approach for addressing topics related to water pollution (Yahaya et al., 2022). STEM-based environmental education offers students practical experiences that enable them to tackle environmental issues and develop effective solutions through hands-on learning (Kanaki et al., 2022; Schroth et al., 2021).

Environmental education that addresses real-life issues necessitates the development of problem-solving and decision-making skills during its implementation (Çevik et al., 2024; Gavari-Starkie et al., 2024; Zabasta et al., 2024). This field of education needs student active performance and participation to solve the issue (Susilawati et al., 2019). Problem-solving skills require applying analytical thinking, while decision-making involves understanding the characteristics of the problem and conducting a thorough analysis (Gavari-Starkie et al., 2024).

Research has shown that STEM education can enhance students' problem-solving and decision-making abilities (Adair, 2010; Koculu et al., 2022; Zengin et al., 2022). However, integrating STEM learning with pollution topics remains insufficiently explored (Siribunnam et al., 2019), and there is a lack of research examining the relationship between problem-solving and decision-making skills. Given that problem-solving and decision-making are interconnected processes that often follow similar stages, it is essential to investigate this relationship, particularly in the context of environmental issues. Therefore, this study aims to assess the impact of STEM education on water pollution problems and its effects on problem-solving abilities, decision-making skills, and the interrelationship between these two competencies. Accordingly, the research questions addressed in this article are:

1. How does STEM learning impact students' problem-solving abilities?
2. How does STEM learning influence students' decision-making skills?
3. Is there a relationship between problem-solving and decision-making skills?

STEM Education

STEM education encompasses the disciplines of science, technology, mathematics, and engineering, all of which must be integrated into the learning process. The primary goal of STEM education is to enhance and address the demands associated with technical skills, thereby equipping learners to confront the challenges of the 21st century (Artika et al., 2023).

Objectives of STEM Learning

According to the book What is STEM Education, the objectives of STEM learning include (Bybee, 2010):

1. Solving real-world problems based on factual information;
2. Engaging in problem-solving grounded in knowledge and investigation;
3. Establishing an environment conducive to intellectual growth within STEM disciplines;
4. Developing citizens capable of applying the concepts of science, technology, engineering, and mathematics.

Problem Solving

Problem-solving is the process of diagnosing complex issues, particularly those characteristic of 21st-century challenges, before devising solutions (Bybee, 2013). Problem-solving activities represent the application of knowledge acquired by students to real-life situations, making them essential in both professional environments and daily life (Aranda et al., 2022; Carr, 2024). This ability encompasses several stages, including analysis, interpretation, critical thinking, hypothesis formulation, evaluation, and reflection (McCormick et al., 2015). Students equipped with strong problem-solving skills are better prepared for success at various life stages; when confronted with challenges, they actively seek and devise innovative solutions (Eshrati Fard et al., 2014).

Decision Making

Decision-making is a fundamental process that involves selecting actions from multiple known and evaluated options (Loedige et al., 2024). This process is critical for human survival, as individuals frequently face numerous choices (Liu, 2023). The ability to make informed decisions requires analytical skills to evaluate options and the capacity to assess the potential outcomes of those choices (Gavari-Starkie et al., 2024).

Method

Research Design

This research employed a nonequivalent control group design, utilizing both experimental and control groups that were directly selected. The researchers implemented different treatments for the two groups while maintaining the same subject matter, which focused on water pollution. The experimental group followed a STEM learning framework, while the control group utilized the 5E learning model.

The STEM learning process comprises the following steps (National Research Council, 2012):

1. The teacher poses questions and presents problems.
2. Students coordinate their research efforts.
3. Students generalize the data they have collected.
4. Students identify potential solutions.
5. Students present the results of their discussions.
6. Students engage in self-evaluation.

In contrast, the 5E instructional model, as discussed in *The BSCS 5E Instructional Model: Origins and Effectiveness* (Bybee et al., 2006), follows these steps:

1. Engagement: The teacher facilitates the discovery of new concepts to stimulate curiosity and promote knowledge acquisition.
2. Exploration: The teacher allows students to explore previously identified concepts, allowing for conceptual clarification.
3. Explanation: The teacher and students interact to articulate the concepts and processes derived from their

exploration.

4. Elaboration: The teacher extends students' understanding and skills through additional activities that build on prior knowledge.
5. Evaluation: The teacher assesses students' progress concerning their understanding and skills.

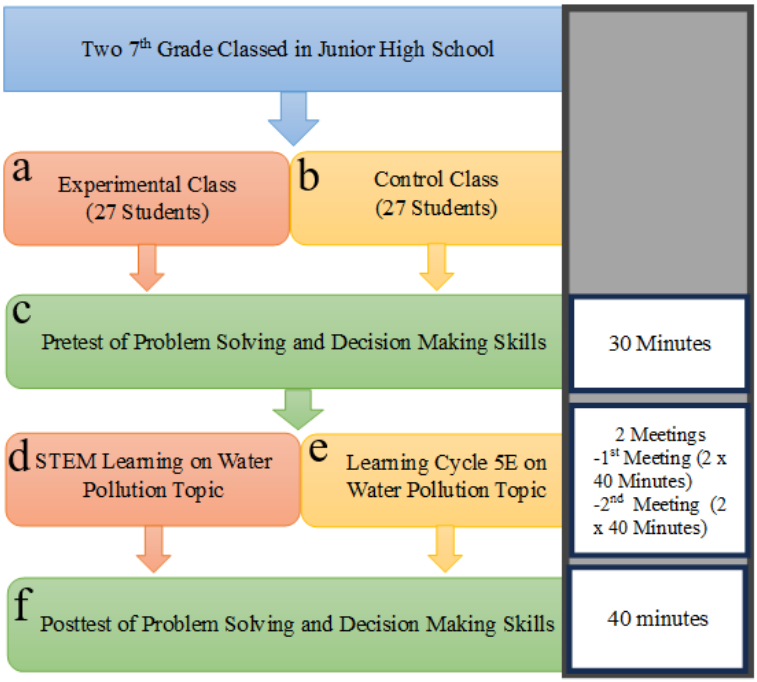

Figure 1. Research Implementation

a. Experimental class with 27 students, b. control class with 27 students, c. Pre-test for both of experimental and control class 1 week before the research, d. Experimental class have 2 meetings of STEM learning with water pollution topic, e. Control class have 2 meetings of Learning Cycle 5E with water pollution topic, f. Post-test with the same question with pre-test 1 day after the STEM and Learning Cycle 5E.

Participant

This study involved 54 students, 30 males, and 24 females, from a school in the Bangka Belitung Islands Province of Indonesia. The school was selected due to its location in a village within Bangka Regency that faces significant challenges related to clean water shortages, relying primarily on the river for public bathing and other household activities.

Data Collection and Research Instrument

Data collection in this study utilized a testing system that included both pretest and posttest phases. The test instruments were based on questions derived from Putri's research (Putri, 2019), which were subsequently modified to align with the problem-solving indicators established by (Abazov, 2016) and the decision-making criteria outlined by (Andreis, 2020). Each variable—problem-solving and decision-making skills—was assessed using five questions. The pretest was administered one week before the STEM and 5E learning treatments were implemented, while the posttest was conducted one day after the treatment.

5. Observe the effectiveness of the water filtration system your group has created.

Water filter picture	Screening Quality Poor Quality Excellent Quality 1 2 3 4 5 Observation:

6. Evaluate your group's design, is the materials chosen produced clear water? If not, what are the mistakes in your design and suggest the improvements?

After you have finished making your water filter, answer the question below:

1. What is the primary issue faced by the community surrounding the Baturusa River?
2. What are the causes of this issue?
3. What are the potential dangers posed by this issue?
4. Why is a water filter an appropriate solution for this problem?
5. Is it possible for the local community to construct a larger water filter to address the widespread turbidity of the river? Share your thoughts on the feasibility of this larger filtration system, particularly if the community seeks government involvement.
6. Propose an effective solution to address the issue of water pollution in the Baturusa River. Outline a step-by-step process for transforming the turbid river water into clean water.

Figure 2. Worksheet
Modified from (Hidayani et al., 2023)

Data Analysis

The data for this study were obtained from the pretest and posttest assessments of problem-solving and decision-making skills. Statistical analysis compared the differences between the pretest and posttest scores in both the control and experimental groups. Each correct answer received a score of 20 points for each student. The results of the MANCOVA test analysis for problem-solving and decision-making skills are presented in Tables 1 and 2, which indicate significant findings.

Results

Research Question 1: How Did STEM Learning Impact Student Problem Solving?

Figure 1 illustrates the outcomes of the N-Gain score calculation for problem-solving ability. The N-Gain scores were derived from the control and experimental groups' pretest and posttest data. As shown in Figure 3, the problem-solving ability in the experimental class, which received the STEM learning treatment, exhibited a medium average, whereas the control class had a low average.

Problem-solving skills were assessed using five indicators: identifying problems, identifying sources of problems, considering solutions, taking action to solve issues, and evaluating the essence of learning. Figure 4 illustrates

that the highest indicators identified in this study were "identifying problems" and "identifying sources of problems," while the lowest indicator was "taking the essence of learning."

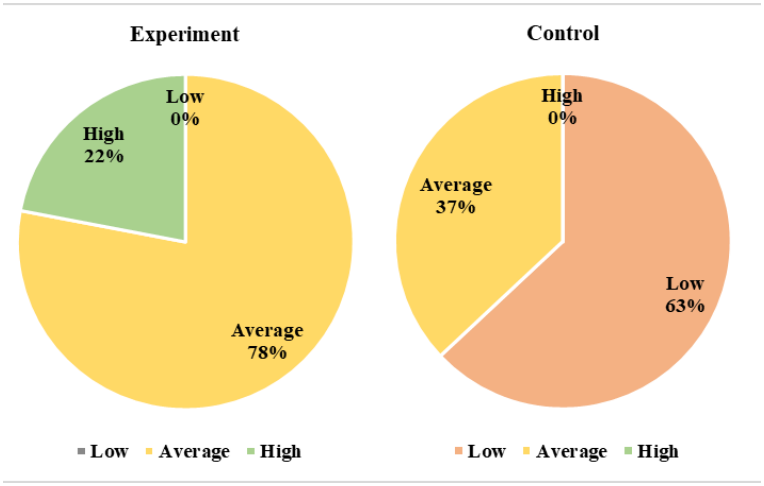

Figure 3. N Gain score

Table 1. Result of MANCOVA Analysis for Problem Solving Skill

Source	*Dependent Variable*	*Df*	*Sig.*
STEM	Problem-Solving	1	0,01

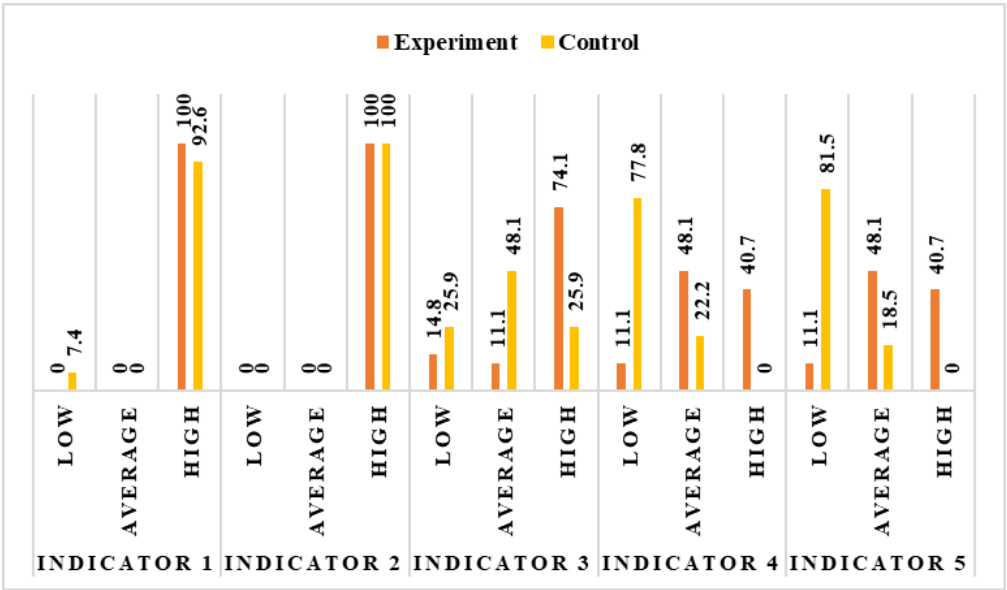

Figure 4 N Gain Score Problem-Solving Indicator

Research question 2: How Did STEM Learning Impact Student Decision-Making?

Students' decision-making abilities were assessed using the N-Gain score. Figure 5 illustrates the differences in decision-making abilities between the control and experimental classes. The experimental class exhibited a medium average in decision-making skills, whereas the control class showed a low average. The STEM learning

treatment in the experimental class resulted in better decision-making abilities compared to the 5E treatment applied in the control class.

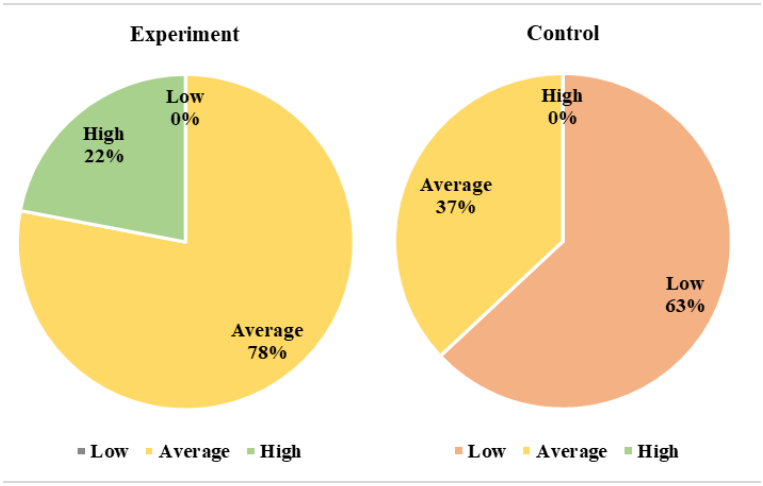

Figure 5 N Gain Score

Table 2. Result of MANCOVA Analysis Decision Making Skill

Source	*Dependent Variable*	*Df*	*Sig.*
STEM	Decision Making	1	0,00

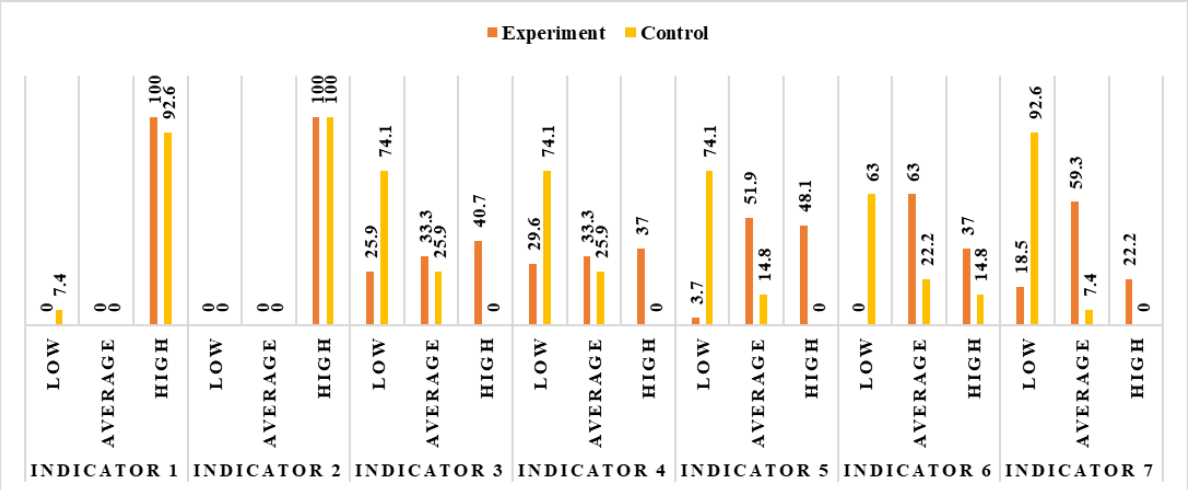

Figure 6 N Gain Score Decision-Making Indicator

Research question 3: Is Problem Solving and Decision-Making Related?

The Pearson correlation analysis presented in Tables 3 and 4 illustrates the relationship between problem-solving ability and decision-making skills in both the control and experimental classes. The correlation analysis results for the control class indicated a strong correlation, with a value of 0.893 between problem-solving ability and decision-making skills. In the experimental class, the correlation analysis yielded a result of 0.797, also indicating a strong correlation between these two variables.

Table 3. Result of Pearson Correlation Analysis for Control Class

Correlations			
		Problem Solving	**Decision Making**
Problem Solving	Pearson Correlation	1	.893
	Sig. (2-tailed)		.000
	N	27	27
Decision Making	Pearson Correlation	.893	1
	Sig. (2-tailed)	.000	
	N	27	27

Table 4. Result of Pearson Correlation Analysis for Experimental Class

Correlations			
		Problem Solving	**Decision Making**
Problem Solving	Pearson Correlation	1	.797
	Sig. (2-tailed)		.000
	N	27	27
Decision Making	Pearson Correlation	.797	1
	Sig. (2-tailed)	.000	
	N	27	27

Discussion

The MANCOVA analysis, detailed in Table 1, was conducted to assess the effect of the STEM treatment on problem-solving ability. The analysis yielded a p-value of 0.01, indicating that the STEM learning treatment has a significant impact on students' problem-solving abilities. This finding suggests that STEM education effectively enhances students' problem-solving skills in the context of water pollution. This study confirms that the STEM learning approach effectively improves students' problem-solving skills related to water pollution. The syntax of STEM learning is a significant stimulus for enhancing these skills. Integrated STEM learning has been shown to foster students' problem-solving abilities (Hebebci & Usta, 2022).

Furthermore, STEM-integrated project-based learning includes specific stages that contribute to improving problem-solving skills (Fiteriani et al., 2021). Through STEM learning, students' problem-solving skills can be deepened and developed (Rosiningtias et al., 2023). The observed increase in students' problem-solving abilities can be attributed to the active involvement of students in the learning process, which promotes their problem-solving capabilities (Maspul, 2023). Innovative learning was more effective than conventional learning in enhancing problem-solving abilities among junior high school students. (Ridwan et al., 2021)

STEM learning is an effective educational approach because it incorporates teaching strategies that challenge students to innovate and create, promoting active engagement in learning activities (Kennedy et al., 2014).

Furthermore, STEM learning encompasses an understanding of model design based on theoretical frameworks (Hallström et al., 2019). It is specifically structured to address real-world problems and is grounded in existing situations (Chen et al., 2020; English, 2023). To improve the relatively low problem-solving skills, students' abilities to express their opinions should be enhanced, and they should be encouraged to re-explore their creativity in generating solutions (Puccio et al., 2020).

Table 2 presents the results of the MANCOVA calculation for the experimental class, yielding a p-value of 0.00. This indicates that STEM learning significantly affects students' decision-making skills. The STEM learning model is particularly effective in enhancing students' decision-making abilities due to its instructional strategies (Wahono et al., 2021). STEM education fosters decision-making skills in both scientific and social contexts, addressing real-world problems encountered in everyday life (Zarestky et al., 2023). The observed improvement in decision-making skills can be attributed to the opportunities that STEM provides for students to engage in structured problem-solving processes (Gönbatar et al., 2022).

The experimental class achieved the highest scores on the indicators of describing the problem and analyzing causes, whereas the control class had the highest N-Gain on the indicators of describing the problem. These decision-making indicators align with the syntax of STEM learning, which supports students' decision-making abilities. STEM education allows students to select solutions and evaluate alternatives, enabling them to compile effective and appropriate decisions (Alderman et al., 2022).

Moreover, STEM fosters students' confidence in making decisions based on investigations they have conducted (Çakir & Altun, 2021).This finding aligns with previous research that suggests a close relationship between problem-solving and decision-making skills, as the processes for achieving both typically involve similar stages (Yurtseven et al., 2021). While students' problem-solving and decision-making abilities are closely related, it is important to note that an individual with strong problem-solving skills does not necessarily possess equally strong decision-making abilities (Bedel et al., 2021). Decision-making is considered a problem-solving component; however, individuals often overlook the various stages involved in the decision-making process, leading to less effective outcomes (Veysel, 2017). The results of the correlation analysis support existing literature that indicates enhancing one ability can positively influence the other (Atici et al., 2024).

Conclusion

This study concludes that STEM learning significantly influences both problem-solving and decision-making skills. The post-test results indicated a marked improvement in students' abilities following the implementation of the STEM learning treatment. Furthermore, this research identified a relationship between problem-solving and decision-making skills, suggesting that these two abilities influence each other and can develop concurrently. However, a limitation of this study is that the products created were constructed using basic and inexpensive materials. Future research on this topic is encouraged to utilize more complex products made from higher-quality materials to enhance the depth of investigation and outcomes.

Acknowledgements

The authors would like to express their gratitude to all participants from the school for their cooperation and support in facilitating this study.

References

Abazov, R. (2016). How to improve your problem-solving skills. *QS Top Universities*, 1–4. https://www.researchgate.net/publication/305062877

Adair, J. (2010). *Decision making and problem solving*. Kogan Page.

Alderman, J., Forsyth, J., Griffy-Brown, C., & Walton. Richard C. (2022). The benefits of hiring a STEM CEO: Decision making under innovation and real options. *Technology in Society*, *71*.

Aminah, S., Ngabekti, S., Kariada Tri Martuti, N., & Raya Sekaran Gunungpati Semarang, J. (2018). The effectiveness of problem based learning model in environmental changes material toward learning achievement of senior high school students. *Journal of Biology Education*, *7*(3), 257–264. http://journal.unnes.ac.id/sju/index.php/ujbe

Andreis, F. de. (2020). A theoretical approach to the effective decision-making process. *Open Journal of Applied Sciences*, *10*(06), 287–304. https://doi.org/10.4236/ojapps.2020.106022

Aranda, L., Mena-Rodríguez, E., & Rubio, L. (2022). Basic Skills in Higher Education: An Analysis of Attributed Importance. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.752248

Artika, W., Amalya, C. P., Safrida, S., Maulida, M., Afandi, A., & Ratna, L. (2023). Applying environmental-STEM approach on pollution issue material to enhance students' problem-solving skills. *Jurnal Penelitian Pendidikan IPA*, *9*(5), 4036–4042. https://doi.org/10.29303/jppipa.v9i5.3846

Atici, E. K., & Turhan, M. (2024). The impact of simulation applications on the problem-solving and decision-making skills of school administrators and prospective administrators: An experimental study. *Education and Information Technologies*. https://doi.org/10.1007/s10639-024-12866-x

Bashir, I., Lone, F. A., Bhat, R. A., Mir, S. A., Dar, Z. A., & Dar, S. A. (2020). Concerns and threats of contamination on aquatic ecosystems. In *Bioremediation and Biotechnology: Sustainable Approaches to Pollution Degradation* (pp. 1–26). Springer International Publishing. https://doi.org/10.1007/978-3-030-35691-0_1

Bedel, A., & Özdermir, B. (2021). The role of automatic thought and decision-making styles in middle school students' problem-solving skills. *Eğitim Bilimleri Dergisi*. https://doi.org/10.15285/maruaebd.732700

Bybee, R. W. (2010). What is STEM education? *Science*, *329*(5995), 996.

Bybee, R. W. (2013). *Challenges and opportunities the case for education*. NTSA. www.nsta.org/permissions.

Bybee, R. W., Taylor, J. A., Gardner, A., Carlson, J., Westbrook, A. L., & Landes, N. (2006). *The BSCS 5E instructional model: Origins and effectiveness*. https://www.researchgate.net/publication/281412517

Çakir, Z., & Altun, S. (2021). The investigation of the effect of montessori approach-based STEM activities on the problem-solving skills of pre-service preschool teachers. *Kuramsal Eğitimbilim*, *14*(2), 93–119. https://doi.org/10.30831/akukeg.824773

Carr, A. (2024). Strategy as problem-solving. *Parameters*, *54*(1), 123–137. https://doi.org/10.55540/0031-

1723.3276

Çevik, M., Bakioglu, B., & Temiz, Z. (2024). The Effects of Out-of-School Learning Environments on STEM Education: Teachers' STEM Awareness and 21st-Century Skills. *Kuramsal Eğitimbilim*, *17*(1), 57–79. https://doi.org/10.30831/akukeg.1309078

Chen, L., Taniguchi, Y., Shimada, A., & Yamada, M. (2020). How to design collaborative problem solving-based STEM lessons based on the perspective of learning behaviors? *Proceedings of 2020 IEEE International Conference on Teaching, Assessment, and Learning for Engineering, TALE 2020*, 197–204. https://doi.org/10.1109/TALE48869.2020.9368346

English, L. D. (2023). Ways of thinking in STEM-based problem solving. *ZDM - Mathematics Education*, *55*(7), 1219–1230. https://doi.org/10.1007/s11858-023-01474-7

Eshrati Fard, A., Bahador, A., Nazemi Moghadam, M., Rajabi, H., & Moradi, A. N. (2014). The possible impact of problem-solving method of instruction on exceptional students' creativity. *Journal of Education and Training Studies*, *2*(3), 60–68. https://doi.org/10.11114/jets.v2i3.342

Fiteriani, I., Diani, R., Hamidah, A., & Anwar, C. (2021). Project-based learning through STEM approach: Is it effective to improve students' creative problem-solving ability and metacognitive skills in physics learning? *Journal of Physics*, *1796*(1). https://doi.org/10.1088/1742-6596/1796/1/012058

Gavari-Starkie, E., Espinosa-Gutiérrez, P. T., Lucini-Baquero, C., & Pastrana-Huguet, J. (2024). Importance of STEM and STEAM education for improvement of the land in the RURAL environment: examples in Latin America. *Land*, *13*(3). https://doi.org/10.3390/land13030274

Gönbatar, S. A., & Sardag, M. (2022). Discourse analysis of in-service teachers' interdisciplinary collaboration for decision-making through design-based integrated STEM activities. *Egitim ve Bilim*, *47*(212), 17–54. https://doi.org/10.15390/EB.2022.11216

Hallström, J., & Schönborn, K. J. (2019). Models and modelling for authentic STEM education: reinforcing the argument. *International Journal of STEM Education*, *6*(1). https://doi.org/10.1186/s40594-019-0178-z

Hebebci, M. T., & Usta, E. (2022). The Effects of Integrated STEM Education Practices on Problem Solving Skills, Scientific Creativity, and Critical Thinking Dispositions. *Participatory Educational Research*, *9*(6), 358–379. https://doi.org/10.17275/per.22.143.9.6

Hidayani, A., & Meilinda, M. (2023). *STEM-based learning on water cycle material on the topic of flood phenomenon for junior high school students' system thinking ability*. Sriwijaya University.

Kanaki, K., & Kalogiannakis, M. (2022). Assessing Algorithmic Thinking Skills in Relation to Age in Early Childhood STEM Education. *Education Sciences*, *12*(6), 380. https://doi.org/10.3390/educsci12060380

Kennedy, T. J., & Odell, M. R. L. (2014). Engaging Students In STEM Education. In *Science Education International* (Vol. 25).

Koculu, A., Topcu, M. S., & Ciftci, A. (2022). The Effect of STEM Education on Pre-Service Science Teachers' Perceptions of 21st Century Skills and Competences and Problem Solving Skills. *Open Journal for Educational Research*, *6*(2), 165–172. https://doi.org/10.32591/coas.ojer.0602.05165k

Liu, P. (2023). Decision-making and utility theory. *Advances in Economics, Management and Political Sciences*, *26*(1), 313–321. https://doi.org/10.54254/2754-1169/26/20230590

Loedige, K. M., & Al-Youzbaki, M. U. (2024). From learning to choosing: How decision-making evolves with experience in rats. In *eNeuro* (Vol. 11, Issue 7). Society for Neuroscience.

Maspul, K. A. (2023). Elementary school flipped learning STEM education as a medium for engaging and innovative learning. *Jurnal Pendidikan LLDIKTI Wilayah 1 (JUDIK)*, *3*(2), 44–51. https://www.researchgate.net/publication/377414654

McCormick, N. J., Clark, L. M., & Raines, J. M. (2015). Engaging students in critical thinking and problem solving: a brief review of the literature. *Journal of Studies in Education*, *5*(4), 100–113. https://doi.org/10.5296/jse.v5i4.8249

Mutileni, N., Mudau, M., & Edokpayi, J. N. (2023). Water quality, geochemistry and human health risk of groundwater in the Vyeboom region, Limpopo province, South Africa. *Scientific Reports*, *13*(1). https://doi.org/10.1038/s41598-023-46386-4

National Research Council. (2012). A framework for K-12 science education: Practices, crosscutting concepts, and core ideas. In *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. National Academies Press. https://doi.org/10.17226/13165

Puccio, G. J., Burnett, C., Acar, S., Yudess, J. A., Holinger, M., & Cabra, J. F. (2020). Creative problem solving in small groups: the effects of creativity training on idea generation, solution creativity, and leadership effectiveness. *Journal of Creative Behavior*, *54*(2), 453–471. https://doi.org/10.1002/jocb.381

Putri, A. (2019). *Pengembangan web modul IPA menggunakan problem-based learning bermuatan potensi lokal batik untuk meningkatkan thinking skill dan communication skill* [Tesis]. Universitas Negeri Yogyakarta.

Ridwan, M. R., Retnawati, H., Hadi, S., & Jailani, J. (2021). The Effectiveness of Innovative Learning on Mathematical Problem-Solving Ability: A Meta-Analysis. *International Journal of Research in Education and Science*, *7*(3), 910–932. https://doi.org/10.46328/ijres.2287

Rollwagen-Bollens, G., Holmlund, T., & Wait, J. (2022). Actively participating in university-sponsored ecological research increases high school students' knowledge of and attitudes about science. *Frontiers in Environmental Science*, *9*, 1–15. https://doi.org/10.3389/fenvs.2021.797769

Rosiningtias, W., Rosana, D., & Ningseh, E. L. (2023). Junior high school students' problem solving skill: PBL-STEM model implementation. *Jurnal Penelitian Pendidikan IPA*, *9*(9), 7658–7664. https://doi.org/10.29303/jppipa.v9i9.4259

Schroth, S. T. ., & Daniels, Janese. (2021). *Building STEM skills through environmental education*. IGI Global, Information Science Reference.

Siribunnam, S., Bednarova, R., & Nuangchalerm, P. (2019). The effect of SSI overlap STEM Education on Secondary Students' Socio-scientific decision making. *Journal of Physics: Conference Series*, *1340*(1). https://doi.org/10.1088/1742-6596/1340/1/012006

Summak, M. S. (2022). Towards a New Learning Ecology: A Critical Participatory Action Research for a Transformative Mission. *International Journal of Research in Education and Science*, *8*(2), 311–327. https://doi.org/10.46328/ijres.2866

Susilawati, W. O., Widodo, H., & Sumarno, S. (2019). Strategy of teachers in suporting environmentally sustainable development. *Journal of Education and Learning (EduLearn)*, *13*(2), 247–254. https://doi.org/10.11591/edulearn.v13i2.12167

Vega, E. C., Dávila, M. A. M., Castillo, P. Z., & Espinoza, O. C. (2023). Population growth and water consumption: Chachapoyas case, 2011 - 2021. *Journal of Law and Sustainable Development*, *11*(11), e1156. https://doi.org/10.55908/sdgs.v11i11.1156

Veysel, T. (2017). Bedensel engelli sporcularin problem çözme becerilerinin karar verme stillerine olan etkisinin. *Journal of International Social Research*, *10*(49), 800–807. https://doi.org/10.17719/jisr.2017.1630

Wahono, B., Narulita, E., Chang, C. Y., Darmawan, E., & Irwanto, I. (2021). The role of students' worldview on decision-making: an indonesian case study by a socio-scientific issue-based instruction through Integrated STEM education. *Eurasia Journal of Mathematics, Science and Technology Education*, *17*(11), 1–15. https://doi.org/10.29333/ejmste/11246

Wutich, A., Rosinger, A. Y., Stoler, J., Jepson, W., & Brewis, A. (2020). Measuring human water needs. *American Journal of Human Biology*, *32*(1). https://doi.org/10.1002/ajhb.23350

Yahaya, J., Fadzli, S., Deraman, A., Yahaya, N. Z., Halim, L., Rais, I. A. I., & Ibrahim, S. R. A. (2022). PRInK: environmental virtual interactive based education and learning model for STEM motivation. *Education and Information Technologies*, *27*(4), 4771–4791. https://doi.org/10.1007/s10639-021-10794-8

Yurtseven, R., & Ocak, G. (2021). Analysis of the relationship between decision making skills and problem solving skills of primary school students. *International Online Journal of Education and Teaching (IOJET)*, *8*(3), 2117–2130. https://www.researchgate.net/publication/352905046

Zabasta, A., Kazymyr, V., Drozd, O., Verslype, S., Espeel, L., & Bruzgiene, R. (2024). Development of shared modeling and simulation environment for sustainable e-learning in the STEM field. *Sustainability (Switzerland)* , *16*(5). https://doi.org/10.3390/su16052197

Zarestky, J., & Vilen, L. (2023). Adult STEM Education for democratic participation. *Adult Learning*, *34*(3), 157–167. https://doi.org/10.1177/10451595231153133

Zengin, R., Kavak, T., Keçeci, G., & Zengin, F. K. (2022). The impact of STEM applications on problem-solving skills of 4th-grade students. *Journal of Science Learning*, *5*(3), 386–397. https://doi.org/10.17509/jsl.v5i3.48182

Zhang, Y. (2023). Application and effectiveness evaluation of environmental education in preschool education. *Contemporary Education and Teaching Research*, *4*(07), 327–331. https://doi.org/10.61360/bonicetr232013020708

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