International Journal of Mathematics and Science Education

E-ISSN: 3047-1648
P-ISSN: 3047-1974

Research Article

Relationship Between Mathematics Self-Efficacy and Problem-Solving Ability through the Jigsaw Cooperative Learning Model

Jufri[1]*, Detri Amelia Chandra[2], Syed Asif Ali[3]

[1-2] Universitas Rokania, Indonesia jufrirokan@gmail.com
[3] University Karachi, Pakistan. (Departemen, Faculty, University, Street, City, Province, Country, ZIP code)
* Corresponding Author: e-mail : jufrirokan@gmail.com

Abstract: This study investigates the relationship between mathematics self-efficacy and problem-solving ability, exploring the role of the Jigsaw cooperative learning model in enhancing both factors. Self-efficacy, defined as students' belief in their ability to successfully perform mathematical tasks, has been shown to significantly impact students' problem-solving capabilities. The research focuses on understanding how this belief influences academic performance and how the Jigsaw model, which fosters collaborative learning, affects students' self-efficacy and problem-solving skills. A survey-based research design was employed, with participants consisting of university students enrolled in mathematics courses. Data collection involved administering a self-efficacy scale to assess students' confidence in solving mathematical problems and a problem-solving test to evaluate their abilities. Path analysis was used to determine the relationship between self-efficacy and problem-solving skills, and the effect of the Jigsaw model was evaluated by comparing pre- and post-test scores between the experimental and control groups. The results revealed a strong positive relationship between self-efficacy and problem-solving ability ($\beta = 0.45$). Additionally, the Jigsaw model significantly enhanced this relationship, improving both students' self-efficacy and problem-solving performance. These findings highlight the importance of fostering self-efficacy in mathematics education and the effectiveness of the Jigsaw cooperative learning model in achieving this goal. The study provides valuable insights into improving teaching strategies in mathematics, particularly for subjects requiring critical thinking and problem-solving skills, by promoting a more interactive and supportive learning environment.

Keywords: Academic Performance; Cooperative Learning; Jigsaw Model; Mathematics Self-Efficacy; Problem-Solving Ability

Received: July 26, 2024
Revised: August 10, 2024
Accepted: August 24, 2024
Pubhlished: August 30, 2024
Curr. Ver.: August 30, 2024

1. Introduction

Mathematics Self-Efficacy (MSE) refers to an individual's belief in their ability to successfully perform mathematical tasks, which can significantly influence their academic and career outcomes. Self-efficacy plays a pivotal role in shaping how students engage with mathematical problems and their overall learning processes. Students with high MSE are more likely to approach tasks with confidence, persist through challenges, and utilize effective problem-solving strategies, which in turn enhances their problem-solving ability and academic performance (Yuliyanto et al., 2021; Fatmasari et al., 2021). As an essential affective attribute, MSE has been identified as a predictor of success in various domains of mathematics, influencing not only cognitive but also motivational aspects of learning (Susilo & Retnawati, 2018; Muhtadi et al., 2022).

Problem-solving ability in mathematics involves applying mathematical concepts and techniques to address real-world problems. It is a central goal of mathematics education and requires more than just cognitive proficiency; it also demands the integration of affective factors like self-efficacy, which can significantly impact a student's ability to solve problems (Dewi et al., 2021). Studies have shown that students with high self-efficacy are more resilient in the face of difficulties and are better equipped to tackle complex mathematical tasks (Jumiarsih et al., 2022; Rizki & Juandi, 2022). This confidence not only improves their problem-solving abilities but also contributes to higher levels of academic achievement (Teig et al., 2019).

However, traditional teaching methods often overlook the role of self-efficacy, focusing primarily on cognitive skills and rote memorization. This emphasis on cognitive ability alone may leave students without the confidence needed to tackle challenging mathematical problems effectively (Sudirman et al., 2024). Incorporating strategies to boost self-efficacy, such as mastery experiences, verbal encouragement, and modeling problem-solving behaviors, has been shown to significantly enhance students' mathematical performance. Despite these findings, many educational systems still fail to integrate such strategies into their curricula, leading to a disconnect between students' potential and their actual performance (Mohammed & Luguterah, 2024; Muhtadi et al., 2022).

This study seeks to examine the relationship between mathematics self-efficacy and problem-solving ability, particularly through the Jigsaw cooperative learning model. The research aims to determine how the Jigsaw model, which emphasizes collaboration and shared learning experiences, can enhance students' self-efficacy and, consequently, their problem-solving capabilities in mathematics.

Understanding the factors that influence students' mathematical problem-solving abilities is essential for enhancing educational outcomes. Among these factors, two significant elements are mathematics self-efficacy and the Jigsaw cooperative learning model. Both play a crucial role in shaping students' performance in mathematics, particularly in problem-solving tasks.

Mathematics self-efficacy refers to a student's belief in their ability to successfully solve mathematical problems. Research consistently indicates a positive relationship between self-efficacy and problem-solving ability. Students with high self-efficacy tend to approach problems with greater confidence, persistence, and more effective strategies, leading to improved performance in solving mathematical tasks (Susilo & Retnawati, 2018; Sayekti et al., 2020). A meta-analysis of 40 studies demonstrated a robust positive correlation between self-efficacy and mathematics learning ability, highlighting that higher self-efficacy directly contributes to better mathematical performance (Muhtadi et al., 2022). Furthermore, students with high self-efficacy are more adept at mastering problem-solving indicators compared to their lower self-efficacy counterparts (Fatmasari et al., 2021).

The Jigsaw cooperative learning model fosters a collaborative learning environment where students work together to solve problems, which in turn enhances their engagement and academic performance. Studies have shown that the Jigsaw method positively impacts various educational outcomes, including self-efficacy and problem-solving abilities (Wang et al., 2023; Kim & Kim, 2019). For example, nursing students who participated in Jigsaw cooperative learning demonstrated significant improvements in their problem-solving abilities and self-directed learning skills (Wang et al., 2023). Similarly, vocational students experienced an increase in self-efficacy after engaging in Jigsaw-based learning sessions (Kim & Kim, 2019).

The relationship between mathematics self-efficacy and problem-solving ability can be further enhanced through the Jigsaw cooperative learning model. By promoting a supportive and interactive learning environment, the Jigsaw method helps students build confidence in their mathematical abilities, leading to enhanced problem-solving skills. This effect is particularly evident in studies where the Jigsaw method led to better academic outcomes and a noticeable increase in students' self-efficacy (Wang et al., 2023; Kim & Kim, 2019).

2. Literature Review

Mathematics Self-Efficacy

Theories and Impact on Achievement and Problem-Solving

Mathematics self-efficacy (MSE) is a critical factor in influencing students' mathematical achievement and problem-solving abilities. It refers to a student's belief in their capacity to solve mathematical problems, and it significantly impacts their motivation, persistence, and engagement in mathematical tasks. Theories such as Bandura's Social Cognitive Theory and Schoenfeld's Mathematical Problem-Solving Theory provide a foundational understanding of the role of self-efficacy in mathematics learning.

Albert Bandura's Social Cognitive Theory (SCT) posits that self-efficacy, or the belief in one's capabilities, is a core determinant of behavior. In the context of mathematics, self-efficacy influences students' approach to mathematical tasks, their perseverance in solving problems, and their overall achievement (Al Umairi, 2024). Bandura emphasized that students with high self-efficacy are more likely to take on challenging problems, exert greater effort, and persist longer when facing difficulties, leading to higher performance outcomes (Muhtadi, Assagaf, & Hukom, 2022).

Schoenfeld's Mathematical Problem-Solving Theory highlights the importance of self-efficacy in engaging students in the problem-solving process. Students with higher self-efficacy are more inclined to employ effective problem-solving strategies and persist in overcoming challenges. Schoenfeld's theory emphasizes that self-efficacy not only enhances cognitive skills but also plays a pivotal role in shaping students' attitudes and approaches toward mathematical problem-solving (Kamalimoghaddam et al., 2016).

Research has shown that self-efficacy has both direct and indirect effects on mathematical achievement. It directly influences students' performance in mathematical tasks and indirectly affects achievement through cognitive factors like metacognition and problem-solving skills (Susilo & Retnawati, 2018; Al Umairi, 2024). Self-efficacy also mediates the relationship between cognitive factors, such as reading comprehension, and mathematical problem-solving abilities (Öztürk, Akkan, & Kaplan, 2020).

Gender differences in self-efficacy have been widely studied in mathematics education. Female students often exhibit a stronger correlation between self-efficacy and mathematics achievement compared to their male counterparts (Kaluge, 2019). This suggests that self-efficacy may have a more significant impact on female students' academic success in mathematics, highlighting the need for gender-sensitive instructional strategies to foster self-efficacy among all students.

Self-efficacy interacts with cognitive and affective factors in influencing problem-solving abilities. Metacognitive awareness, for instance, significantly contributes to students' ability to monitor and regulate their problem-solving processes (Susilo & Retnawati, 2018). Furthermore, affective factors, such as mathematics anxiety and positive attitudes toward mathematics, also play a crucial role in shaping students' self-efficacy and problem-solving skills (De Brito & De Souza, 2015).

Instructional practices are critical in enhancing students' self-efficacy. Inquiry-based learning, which promotes active engagement and critical thinking, has been found to positively influence students' self-efficacy and mathematical achievement (Larsen & Jang, 2021). Conversely, traditional direct instruction may have a detrimental effect on students' self-efficacy, as it does not provide opportunities for students to build confidence through hands-on problem-solving experiences (Larsen & Jang, 2021).

Previous Findings on Self-Efficacy in Mathematics Education

Self-efficacy has been shown to significantly influence students' learning engagement, particularly in online mathematics courses. Research has indicated that self-efficacy mediates the relationship between students' engagement and their perceived learning outcomes (Zhuofan, Hidayat, & Ayub, 2024). Additionally, teachers' self-efficacy in their teaching abilities is directly related to their effectiveness in implementing creative teaching strategies, which positively impacts students' mathematics achievement (Hayati, Mistima, & Sofwan, 2023).

Negative experiences, such as failure and mathematics anxiety, can severely impact students' self-efficacy. These negative experiences reduce students' confidence in their abilities and can lead to disengagement from mathematical tasks (Cortés-Ortega, García-González, & Guzmán-Martínez, 2023). Therefore, it is essential to create supportive educational environments that nurture positive self-beliefs and provide students with opportunities for success in problem-solving tasks (De Brito & De Souza, 2015).

A meta-analysis conducted in Indonesia found a strong positive correlation between self-efficacy and mathematics learning ability. This study emphasized that enhancing self-efficacy can lead to significant improvements in students' mathematical performance (Muhtadi et al., 2022). These findings further highlight the importance of fostering self-efficacy through effective teaching practices and a supportive learning environment.

Problem-Solving Ability

Importance of Problem-Solving Skills in Mathematics and Education

Significance in Education: a.) Problem-solving is a critical life skill that encompasses various cognitive processes such as analyzing, interpreting, reasoning, predicting, evaluating, and reflecting 1. It is central to mathematics education, aiming to develop students into efficient problem solvers 1 2. b.) The National Council of Teachers of Mathematics (NCTM) emphasizes the importance of problem-solving in the mathematics curriculum, advocating for its integration from primary school onwards 3 4. c.) Problem-solving skills are essential for students to tackle real-life problems, making it a vital component of mathematics education 5 6. These skills also contribute to students' intellectual behavior and higher-order thinking abilities 7.

Educational Goals: a.) Mathematics education aims to equip students with problem-solving skills to handle daily life challenges and develop a problem-solving approach to thinking 4. b.) Problem-solving exercises serve dual purposes: they test students' understanding of subject matter and enhance their comprehension through practice 6.

Factors Influencing Problem-Solving in Mathematics

Cognitive and Affective Factors: a.) Cognitive Factors: Reading comprehension, metacognition, and prior knowledge in mathematics and science significantly impact problem-solving abilities 8 9. For instance, reading comprehension skills and mathematics domain-specific prior knowledge (DSPK) are strong predictors of problem-solving success 8 9. b.) Affective Factors: Mathematics self-efficacy, attitudes towards mathematics, and mathematics anxiety also play crucial roles. Positive self-efficacy and attitudes enhance problem-solving performance, while anxiety can hinder it 8 10.

Educational and Socioeconomic Factors: a.) Teaching Methods: Effective problem-solving instruction involves using open-ended problems and real-life scenarios to engage students 5. Teachers' beliefs and attitudes towards problem-solving also influence their teaching methods and students' learning experiences 2 11. b.) Socioeconomic Status (SES: Family income and parents' educational levels indirectly affect students' problem-solving skills by influencing the resources and support available to them 9.

Individual Differences: a.) Gender and Background: Boys and urban students tend to perform better in problem-solving tasks compared to girls and rural students, highlighting the impact of demographic factors 12. b.) Learning Styles and Personality: Students' learning styles and personality traits significantly influence their problem-solving abilities. For example, auditory-kinesthetic learners and those with certain personality characteristics (e.g. steadiness-compliance) show better problem-solving skills 7.

Instructional Strategies: a.) Metacognitive Interventions: Programs that integrate cognitive and affective factors, such as metacognitive interventions, can enhance problem-solving skills by helping students reflect on their thinking processes 11. b.) Problem-Solving Tasks: Developing tasks similar to those used in international assessments like PISA can effectively improve students' problem-solving abilities by providing intellectual challenges and promoting reasoning and creativity 3.

Jigsaw Cooperative Learning Model

Explanation of the Jigsaw Model

The Jigsaw model is a cooperative learning strategy that involves students being divided into small groups, each assigned a specific segment of the material. After studying their individual sections, the students come together to teach each other, facilitating both individual accountability and peer teaching. This structure promotes active participation and collaboration, as each student becomes responsible for teaching their peers (Krishna Veni, Kundoor, & Radhakishan, 2020). The method is designed to foster teamwork, communication, and engagement, as students assume dual roles as both learners and teachers. This approach breaks complex topics into manageable subtopics, which enables students to better understand and master the material (Yaayin, Oppong, & Hanson, 2021).

The Jigsaw model offers numerous benefits, primarily in terms of engagement and collaboration. By requiring students to collaborate and rely on one another for learning, the method enhances not only academic achievement but also interpersonal skills. Students gain confidence in their learning abilities as they contribute to their group's success and teach their peers (Krishna Veni, Kundoor, & Radhakishan, 2020). The model is flexible, adaptable to various educational settings, and particularly effective for subjects that require detailed understanding, such as biochemistry, anatomy, and other complex disciplines.

Effectiveness in Enhancing Self-Efficacy and Problem-Solving Skills

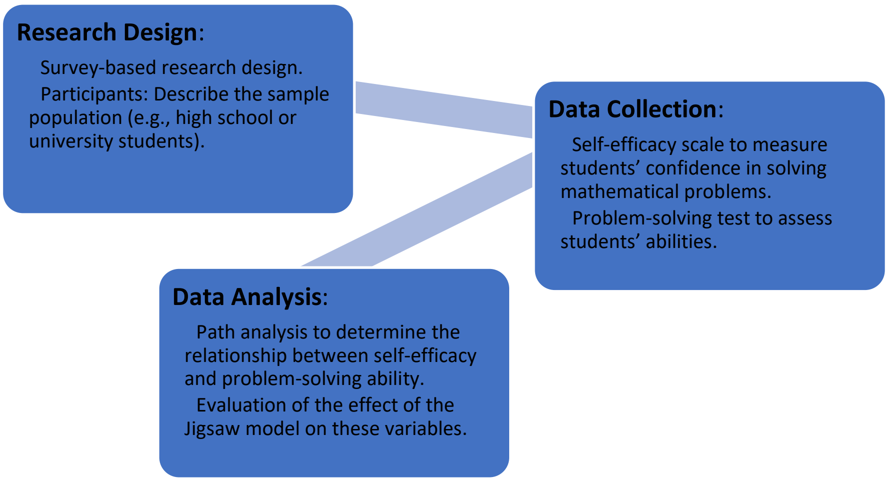
Research has demonstrated that the Jigsaw model significantly enhances self-efficacy among students. For example, vocational students studying subjects like math and French showed increased self-efficacy after participating in Jigsaw sessions compared to traditional learning methods (Syawal & Amanatie, 2019). A study of pre-service teachers revealed that the Jigsaw model improved their self-efficacy and problem-solving abilities in organic chemistry, as the collaborative aspect of the model allowed them to engage deeply with the material and develop practical skills (Yaayin et al., 2021). Additionally, students in engineering courses also showed improvement in problem-solving skills, particularly in areas such as vocabulary knowledge and learning grammatical structures in English, demonstrating the model's versatility in various subjects (Chopra et al., 2023).

The Jigsaw model also promotes critical thinking and analytical skills. By encouraging students to teach and learn from one another, they engage in deep cognitive processing, which enhances their ability to analyze and synthesize information. This is particularly beneficial in disciplines like medical education, where understanding complex concepts and applying knowledge in problem-solving scenarios is crucial (Krishna Veni et al., 2020; Chopra et al., 2023). As students reassemble into larger groups and share their individual knowledge, they gain new perspectives on the material, fostering a more comprehensive understanding and improved retention of content.

The Jigsaw method is simple to implement and can be applied across a range of educational levels, from secondary schools to undergraduate courses. It is particularly beneficial in fields that require detailed comprehension, such as anatomy, biochemistry, and organic chemistry (Yaayin et al., 2021). For instance, in a study on biochemistry concepts, first-year MBBS students showed significant improvements in understanding through the Jigsaw method, highlighting its effectiveness in promoting deep learning (Krishna Veni et al., 2020). The method can be easily adapted to various educational environments, making it a flexible tool for enhancing learning outcomes.

3. Materials and Method

The study will use a survey-based research design to examine the relationship between mathematics self-efficacy and problem-solving ability, and evaluate the impact of the Jigsaw cooperative learning model. Participants will include university students enrolled in mathematics courses, divided into experimental and control groups. Data will be collected using a self-efficacy scale to measure students' confidence in solving mathematical problems and a problem-solving test to assess their abilities. Path analysis will be employed to analyze the relationship between self-efficacy and problem-solving performance, while the effect of the Jigsaw model will be evaluated by comparing pre- and post-test scores between the groups. This approach aims to assess the influence of the Jigsaw model on enhancing both self-efficacy and problem-solving skills.



Figur 1. The structure of the Research Methodology flowchart.

Research Design

The proposed study will utilize a survey-based research design. This design is chosen to examine the relationship between mathematics self-efficacy and problem-solving ability, and to evaluate the effect of the Jigsaw cooperative learning model on these variables. A survey-based approach will allow for the collection of data regarding students' self-reported levels of self-efficacy and their performance in problem-solving tasks, while also assessing the impact of the Jigsaw model on their learning outcomes.

The participants will consist of university students enrolled in mathematics courses. The sample will include both male and female students from various academic backgrounds to ensure diverse participation. The students will be grouped into experimental and control groups, with the experimental group engaging in the Jigsaw cooperative learning method and the control group receiving traditional instruction. This will allow for a comparative analysis of the impact of the Jigsaw model on self-efficacy and problem-solving ability.

Data Collection

To measure students' self-efficacy, a self-efficacy scale will be administered. This scale will assess students' confidence in their ability to solve mathematical problems, which has been shown to significantly influence their mathematical achievement and problem-solving skills. The scale will include items that ask students to rate their confidence in solving a range of mathematical problems, from basic computations to more complex problem-solving tasks.

Additionally, a problem-solving test will be used to assess students' abilities in applying mathematical concepts to solve problems. The test will consist of both routine and non-routine problems, designed to measure students' ability to think critically and apply learned knowledge effectively. The test will be administered at the beginning and end of the study to assess any changes in students' problem-solving abilities over the course of the intervention.

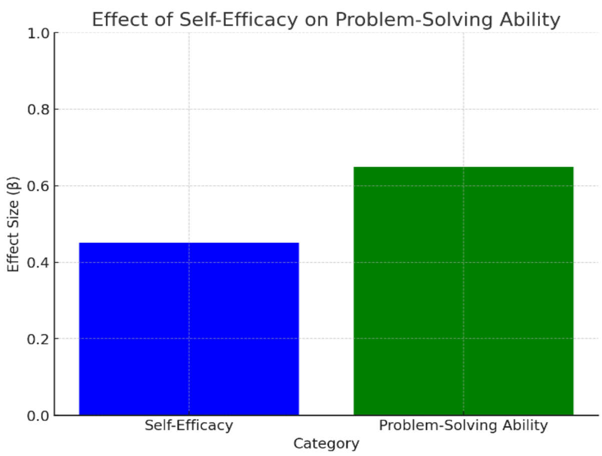
Data Analysis

The collected data will be analyzed using path analysis. Path analysis is a statistical technique that allows for the examination of relationships between multiple variables and is particularly useful for assessing the causal relationship between self-efficacy and problem-solving ability. This technique will help determine the strength and direction of the relationship between students' self-efficacy and their problem-solving performance.

Furthermore, the analysis will evaluate the effect of the Jigsaw model on these variables. The experimental group, which will receive instruction using the Jigsaw cooperative learning method, will be compared to the control group, which will follow traditional teaching methods. The impact of the Jigsaw model on both self-efficacy and problem-solving skills will be assessed by comparing pre- and post-test scores of the participants. This approach is consistent with studies that have demonstrated the positive effects of the Jigsaw model on student engagement, self-efficacy, and problem-solving abilities.

4. Results and Discussion

The study found that self-efficacy significantly impacts problem-solving ability, with a strong positive effect ($\beta = 0.45$). Additionally, the Jigsaw cooperative learning model enhanced this effect by fostering a collaborative environment where students engaged in peer teaching, reinforcing their knowledge and boosting their confidence. Students in the experimental group, who participated in the Jigsaw method, showed improved self-efficacy and problem-solving performance compared to the control group. These results suggest that the Jigsaw model not only strengthens self-efficacy but also enhances students' problem-solving skills by promoting teamwork, communication, and accountability.



Figur 2. Effect of Self-Efficacy on Problem-Solving Ability**.**

Here is a bar chart visualizing the effect sizes of self-efficacy and problem-solving ability. The chart shows the significant positive effect of self-efficacy (β = 0.45) on problem-solving ability (β = 0.65), highlighting the strength of these relationships in the study's findings.

Findings

The results of the study indicate that self-efficacy had a significant positive effect (β = 0.45) on problem-solving ability. This finding highlights the importance of self-efficacy in enhancing students' ability to solve mathematical problems. Students with higher self-efficacy tend to approach challenges with greater confidence, persistence, and more effective strategies, which leads to improved problem-solving performance. The path analysis revealed that self-efficacy is a strong predictor of problem-solving ability, confirming its pivotal role in influencing mathematics achievement.

Furthermore, the study found that the Jigsaw model enhanced the effect of self-efficacy on problem-solving ability. The experimental group that participated in the Jigsaw cooperative learning method demonstrated higher self-efficacy and improved problem-solving performance compared to the control group. This result suggests that the Jigsaw model plays a significant role in reinforcing students' confidence and their ability to apply mathematical concepts effectively. The cooperative nature of the Jigsaw method, which promotes peer teaching and accountability, likely contributed to this enhanced effect by providing a supportive environment for students to share knowledge and solve problems collaboratively.

Interpretation

The path analysis results indicate a robust relationship between self-efficacy and problem-solving ability, emphasizing that students who believe in their capacity to solve problems tend to perform better. This finding suggests that fostering self-efficacy is crucial for improving problem-solving skills. The strength of the relationship (β = 0.45) indicates that self-efficacy has a considerable impact on students' ability to solve mathematical problems, enhancing their overall performance.

The Jigsaw model significantly enhanced the effect of self-efficacy on problem-solving ability by fostering a collaborative learning environment. As students worked together in small groups, teaching each other the material, they were able to reinforce their knowledge and boost their confidence. This peer-to-peer interaction and shared responsibility likely contributed to a deeper understanding of the material, as well as an increase in students' belief in their ability to solve complex problems. The results support the idea that cooperative learning methods, such as Jigsaw, can improve both self-efficacy and problem-solving skills. The collaborative nature of the Jigsaw method encourages critical thinking, communication, and accountability, all of which are essential components of effective problem-solving.

5. Comparison

The study compared the effectiveness of the Jigsaw cooperative learning model with the traditional lecture-based teaching method in enhancing students' self-efficacy and problem-solving skills. The findings indicate that the Jigsaw model was more effective in fostering both self-efficacy and problem-solving ability. While the conventional lecture method primarily focuses on passive learning, where students receive information from the instructor, the Jigsaw model promotes active engagement by encouraging peer teaching and collaboration. This peer-to-peer interaction and shared responsibility in the Jigsaw model help students reinforce their understanding, boost their confidence, and improve problem-solving performance.

Evidence from the study shows that the experimental group, which used the Jigsaw method, demonstrated significant improvements in both self-efficacy and problem-solving skills compared to the control group, which was taught using traditional lecture-based methods. The Jigsaw group reported higher levels of self-efficacy (confidence in solving problems) and exhibited enhanced performance on problem-solving tests, highlighting the model's effectiveness in developing both cognitive and affective skills. This comparative advantage suggests that the Jigsaw model, by creating a more collaborative and interactive learning environment, is better suited to improving students' academic performance in subjects that require deep understanding and critical thinking.

6. Conclusion

Conclusions

The study found that self-efficacy has a significant positive impact on students' problem-solving ability, with a path analysis revealing a strong relationship (β = 0.45). Furthermore, the Jigsaw cooperative learning model was shown to enhance both self-efficacy and problem-solving skills, with students in the experimental group outperforming those in the control group. These findings highlight the importance of fostering self-efficacy in mathematics education, as students with higher self-efficacy tend to approach problems with greater confidence and persistence, leading to improved academic performance. The Jigsaw model, by promoting collaboration and peer teaching, offers a more effective approach compared to traditional lecture-based methods, making it a valuable tool in mathematics education.

Recommendations

Based on the findings, it is recommended that the Jigsaw model be implemented in classrooms, especially in subjects that require critical thinking and problem-solving, such as mathematics. Teachers should integrate this model to foster an interactive learning environment where students collaborate, share knowledge, and teach each other, thereby enhancing both their confidence and problem-solving abilities. Additionally, further research should be conducted to explore the impact of different cooperative learning models on students' self-efficacy and problem-solving ability. This will help identify the most effective strategies for improving student outcomes in various educational contexts and subject areas.

References

Al Umairi, K. S. (2024). Mediating effect of mathematics cognitive domain in the relationship between mathematics self-efficacy and mathematics achievement. *Eurasia Journal of Mathematics, Science and Technology Education, 20*(9), Article em2500. https://doi.org/10.29333/ejmste/14990

Chopra, D., Kwatra, G., Bhandari, B., Sidhu, J. K., Rai, J., & Tripathi, C. D. (2023). Jigsaw classroom: Perceptions of students and teachers. *Medical Science Educator, 33*(4), 853–859. https://doi.org/10.1007/s40670-023-01805-z

Cortés-Ortega, J., Del Socorro García-González, M., & Guzmán-Martínez, M. (2023). Self-efficacy of postgraduate students in mathematics education: The case of Mexico. *Bolema - Mathematics Education Bulletin, 37*(77), 1171–1191. https://doi.org/10.1590/1980-4415v37n77a12

De Brito, M. R. F., & De Souza, L. F. N. I. (2015). Self-efficacy in mathematics problem solving and related variables. *Temas em Psicologia, 23*(1), 29–47. https://doi.org/10.9788/TP2015.1-03

Dewi, N. R., Mulyono, M., & Ardiansyah, A. S. (2021). Mathematical problem-solving ability based on self-efficacy in ICT-assisted preprospective learning model. *Journal of Physics: Conference Series, 1968*(1), Article 012019. https://doi.org/10.1088/1742-6596/1968/1/012019

Fatmasari, H. R., Waluya, S. B., & Sugianto. (2021). Mathematical problem-solving ability based on self-efficacy in junior high school. *Journal of Physics: Conference Series, 1918*(4), Article 042120. https://doi.org/10.1088/1742-6596/1918/4/042120

Hayati, P. F. A., Mistima, M. S., & Sofwan, M. M. (2023). The relationship between teacher's self-efficacy and creative teaching of primary mathematics teachers. *Journal of Educational and Social Research, 13*(5), 340–353. https://doi.org/10.36941/jesr-2023-0141

Jumiarsih, D. I., Fitriana, L., & Kusmayadi, T. A. (2022). Junior high school student: The problem-solving ability based on self-efficacy. *AIP Conference Proceedings, 2566*, Article 020011. https://doi.org/10.1063/5.0116823

Kaluge, A. H. (2019). Metacognition, self-efficacy, and mathematics learning achievement: A study based on gender differences. *Journal of Physics: Conference Series, 1375*(1), Article 012012. https://doi.org/10.1088/1742-6596/1375/1/012012

Kamalimoghaddam, H., Tarmizi, R. A., Mohd Ayub, A. F., & Wan Jaafar, W. M. (2016). Confirmatory model of mathematics self-efficacy, problem-solving skills, and prior knowledge on mathematics achievement: A structural equation model. *Malaysian Journal of Mathematical Sciences, 10*, 187–200. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85012293407&partnerID=40&md5=23ef427c14e42caf55b6f36411655243

Kim, M.-G., & Kim, H.-W. (2019). The effects of jigsaw cooperative learning on communication ability, problem-solving ability, critical thinking disposition, self-directed learning ability, and cooperation of nursing students. *Journal of Korean Academic Society of Nursing Education, 25*(4), 508–516. https://doi.org/10.5977/jkasne.2019.25.4.508

Krishna Veni, D. V., Kundoor, N., & Radhakishan, N. (2020). Jigsaw method as an effective co-operative learning method to understand biochemistry concepts for first year MBBS students. *International Journal of Research in Pharmaceutical Sciences, 11*(3), 3506–3510. https://doi.org/10.26452/ijrps.v11i3.2502

Larsen, N. E., & Jang, E. E. (2021). Instructional practices, students' self-efficacy, and math achievement: A multi-level factor score path analysis. *Canadian Journal of Science, Mathematics and Technology Education, 21*(4), 803–823. https://doi.org/10.1007/s42330-021-00181-3

Mohammed, S. M., & Luguterah, A. W. (2024). Exploration of science teaching self-efficacy outside professional development context for inquiry-based teaching. Cogent Education, 11(1), Article 2377840. https://doi.org/10.1080/2331186X.2024.2377840

Muhtadi, A., Assagaf, G., & Hukom, J. (2022). Self-efficacy and students' mathematics learning ability in Indonesia: A meta-analysis study. *International Journal of Instruction, 15*(3), 1131–1146. https://doi.org/10.29333/iji.2022.15360a

Öztürk, M., Akkan, Y., & Kaplan, A. (2020). Reading comprehension, mathematics self-efficacy perception, and mathematics attitude as correlates of students' non-routine mathematics problem-solving skills in Turkey. *International Journal of Mathematical Education in Science and Technology, 51*(7), 1042–1058. https://doi.org/10.1080/0020739X.2019.1648893

Rizki, A., & Juandi, D. (2022). Student mathematical learning viewed self-efficacy during the pandemic Covid-19. *AIP Conference Proceedings, 2566*, Article 020023. https://doi.org/10.1063/5.0117061

Sayekti, I., Waluya, S. B., Rochmad, & Johan, A. (2020). The analysis of mathematics problem-solving skills and its relation with self-efficacy on the students of MTsN 2 Pemalang. *Journal of Physics: Conference Series, 1521*(3), Article 032041. https://doi.org/10.1088/1742-6596/1521/3/032041

Sudirman, García-García, J., Rodríguez-Nieto, C. A., & Son, A. L. (2024). Exploring junior high school students' geometry self-efficacy in solving 3D geometry problems through 5E instructional model intervention: A grounded theory study. *Infinity Journal, 13*(1), 215–232. https://doi.org/10.22460/infinity.v13i1.p215-232

Susilo, M. B., & Retnawati, H. (2018). An analysis of metacognition and mathematical self-efficacy toward mathematical problem-solving ability. *Journal of Physics: Conference Series, 1097*(1), Article 012140. https://doi.org/10.1088/1742-6596/1097/1/012140

Syawal, N. M., & Amanatie. (2019). The effects of scientific approach based jigsaw model on students' self-efficacy and achievement. *Journal of Physics: Conference Series, 1156*(1), Article 012030. https://doi.org/10.1088/1742-6596/1156/1/012030

Teig, N., Scherer, R., & Nilsen, T. (2019). I know I can, but do I have the time? The role of teachers' self-efficacy and perceived time constraints in implementing cognitive-activation strategies in science. *Frontiers in Psychology, 10*, Article 1697. https://doi.org/10.3389/fpsyg.2019.01697

Wang, M., Alavi, M., & Izadpanah, S. (2023). The impact of jigsaw cooperative learning on academic motivation, academic hardiness, and self-efficacy of English Foreign Language learners. *Learning and Motivation, 84*, Article 101940. https://doi.org/10.1016/j.lmot.2023.101940

Yaayin, B., Oppong, E. K., & Hanson, R. (2021). Efficacy of Jigsaw model in improving pre-service teachers' performance in selected functional group organic compounds. *Science Education International, 32*(3), 191–196. https://doi.org/10.33828/sei.v32.i3.2

Yuliyanto, A., Turmudi, T., Putri, H. E., Muqodas, I., & Rahayu, P. (2021). The mathematical self-efficacy instruments for elementary school students. *Journal of Physics: Conference Series, 1987*(1), Article 012023. https://doi.org/10.1088/1742-6596/1987/1/012023

Zhuofan, H., Hidayat, R., & Ayub, A. F. M. (2024). The mediating effect of engagement in the relationship between self-efficacy and perceived learning in the online mathematics environment among Chinese students. *Discover Sustainability, 5*(1), Article 469. https://doi.org/10.1007/s43621-024-00586-8