Al-Ishlah: Jurnal Pendidikan
Vol.17, 1 (March, 2025), pp. 1684-1695
ISSN: 2087-9490 EISSN: 2597-940X, DOI: 10.35445/alishlah.v17i1.6199

Evaluating One-to-One Scaffolding and Peer–Scaffolding in Mathematics Learning: Which is Effective?

Imam Kusmaryono[1*], Dyana Wijayanti[2]

[1] Universitas Islam Sultan Agung, Semarang, Indonesia; kusmaryono@unissula.ac.id
[2] Universitas Islam Sultan Agung, Semarang, Indonesia; dyana.wijayanti@unissula.ac.id

ARTICLE INFO

Keywords:

Evaluation;
Mathematics Learning;
Scaffolding

Article history:

Received 2024-10-21
Revised 2025-01-12
Accepted 2025-03-28

ABSTRACT

Effective mathematics learning is shaped by teacher-student interactions and a supportive learning environment. Scaffolding, as a pedagogical strategy, plays a vital role in addressing learning difficulties and enhancing student achievement. This mixed-method study employed a sequential explanatory design, combining quantitative and qualitative approaches. Eighty Grade X students participated as research subjects. Data were collected through mathematics achievement tests, classroom observations, and interviews. Quantitative data assessed the impact of scaffolding on learning outcomes, while qualitative data explored interaction patterns within the scaffolding process. The findings indicate that both one-to-one and peer scaffolding significantly improve students' mathematics achievement. One-to-one scaffolding provides direct teacher guidance but tends to foster student dependency due to its unidirectional nature. In contrast, peer scaffolding promotes mutual interaction, collaboration, and knowledge construction among students, fostering greater engagement and autonomy in learning. While both scaffolding methods are beneficial, peer scaffolding offers a more dynamic and cooperative learning experience. It encourages open communication, peer support, and cognitive development through shared understanding. As a result, peer scaffolding is recommended as a more effective approach for enhancing mathematics learning and fostering a collaborative classroom culture.

Corresponding Author:
Imam Kusmaryono
Universitas Islam Sultan Agung, Semarang, Indonesia; kusmaryono@unissula.ac.id

1. INTRODUCTION

Mathematics is a scientific discipline that aims to improve critical thinking so that students are able to contribute to solving problems in everyday life, including in the world of work and the development of science. The dynamics of successful mathematics learning are largely determined by the interaction process of teachers and students and by a conducive learning environment. For this reason, teachers require to pay attention to the learning interaction process, which accommodates the skills needed by students in the current destructive era.

In learning activities, interactions transpire between students and students, teachers and students, and between students and learning resources. However, the interaction process in mathematics learning often does not run smoothly because of the learning difficulties experienced by students. Difficulties in learning mathematics experienced by students include: difficulties in reading and understanding the meaning of questions, difficulties in understanding and constructing mathematical concepts, difficulties in using formulas and symbol notation, and difficulties in the calculation process. Learning difficulties will hinder the improvement of student learning achievement (Lodge et al., 2018; Zhang et al., 2021).

One solution to overcome difficulties in learning mathematics is for teachers or peers, to provide assistance in learning mathematics to other students. The assistance provided is in the form of scaffolding to small groups and individuals (van de Pol & Volman, 2019). The purpose of providing this assistance is for students to solve the mathematical problems given. The term scaffolding is used as an illustration where teachers provide temporary assistance to students to help them complete tasks or develop new understanding, so that in the future students are expected to be able to work on new tasks independently, developing a higher level of understanding and thinking skills (Alrawili et al., 2020).

Scaffolding is a concept of learning with temporary assistance, where teachers provide assistance to students during the preliminary stages of learning. Then, teachers gradually reduce this assistance and provide students the opportunity to take over increasingly large responsibilities as soon as they are able to do it independently (Brower et al., 2018; Brownfield & Wilkinson, 2018).

In the context of mathematics learning, scaffolding assistance is very important for students. Scaffolding can help students to: (a) improve their understanding of the material and critical thinking skills better, (b) students feel less pressured by more capable students, (c) students are more confident in asking questions and showing their abilities, and (d) students can reach their maximum potential and be more independent in the learning process.

Vygotsky, in his theory, linked *scaffolding* to students' maximum stages in constructing learning material, which is known as the zone of proximal development (ZPD) (Eun, 2019). According to Vygotsky, students have two stages in actual and potential development (Kusmaryono et al., 2021). The implication of Vygostky's theory in education is a cooperative learning setting, so that students can interact around tasks and mutually generate affective problem solving strategies in the zone of proximal development.

The literature that adopts Jerome Bruner's suggestion about scaffolding is divided into two, namely vertical scaffolding (hereinafter called one-to-one scaffolding) and sequential scaffolding (hereinafter called peer-scaffolding) (Abune, 2019). One-to-one scaffolding is assistance from teachers who work one-on-one with one student to provide the right amount of support so that students can complete certain tasks (Kim & Belland, 2018). Meanwhile in constructivism, peer-scaffolding is when the teacher provides opportunities for more prominent students to help the teacher as a tutor for small groups. The challenge for teachers is apart from handing over some of their authority to students and teachers must be able to motivate designated students to play their role optimally (van de Pol & Volman, 2019).

Over the past decade (2015–2024), an increasing number of studies have investigated various dimensions of scaffolding in educational contexts. This body of research has addressed: (a) the role of scaffolding strategies in enhancing student motivation (Acosta-Gonzaga & Ramirez-Arellano, 2022; Yu et al., 2024); (b) the impact of scaffolding on the development of higher-order thinking skills (Alrawili et al., 2020); (c) its influence on mathematics achievement (Brower et al., 2018; Brownfield & Wilkinson, 2018); (d) the practical implementation of scaffolding techniques in classroom settings (Dominguez & Svihla, 2023; Garderen et al., 2021; van de Pol et al., 2015; van de Pol & Volman, 2019); (e) the integration of computational thinking within scaffolding-based instructional frameworks (Bereiter, 1999; Ihechukwu, 2020); and (f) the importance of aligning teacher-delivered scaffolding with the specific demands of instructional content (Martin et al., 2019).

Despite this growing body of work, our review of the recent literature reveals several notable gaps. First, much of the existing research continues to focus on general outcomes such as motivation and academic achievement, with limited exploration of more nuanced cognitive or behavioral effects. Second, the scaffolding strategies employed across studies tend to be broadly defined and lack clarity or consistency in their operationalization. Third, there remains a significant lack of comparative analysis regarding the effectiveness of different scaffolding approaches—particularly between one-to-one teacher scaffolding and peer-scaffolding methods—within subject-specific contexts such as mathematics instruction.

This study seeks to address these gaps by investigating the effectiveness of scaffolding in supporting students who struggle with mathematics and examining how different scaffolding models—one-to-one and peer—affect learning interactions and outcomes. The research is guided by the following questions: (a) Is scaffolding effective in helping students overcome learning difficulties in mathematics? If so, (b) which approach—one-to-one or peer scaffolding—is more effective? (c) What are the characteristics of the learning interactions that occur under each method?

Given that unresolved difficulties in learning mathematics can hinder students from achieving conceptual understanding—despite being in their Zone of Proximal Development (ZPD)—it is critical to tailor support strategies to their individual needs. We argue that learners with different ability levels require differentiated scaffolding methods. This study aims to provide evidence on the effectiveness of one-to-one and peer scaffolding approaches in mathematics education, offering practical insights for teachers seeking to support students with diverse learning needs.

2. METHODS

The research applies a combination of quantitative and qualitative research with sequential explanatory research designs. The sequential explanatory design research steps begin with quantitative research, namely determining the problem/potential, formulating the problem, then developing a theoretical basis and hypothesis, collecting quantitative data analysis and hypothesis testing results. Quantitative research will end after testing the hypothesis (proven or not proven). Then, proceed by using qualitative methods to strengthen, expand, and the results may even conflict with the quantitative data obtained at the preliminary stage. The next qualitative research activity is determining the data source, collecting and analyzing qualitative data, and then combining quantitative and qualitative data analysis. For more details, research steps with a sequential explanatory design (Dawadi et al., 2021; Gogo & Musonda, 2022; Lall, 2021; Toyon, 2021) can be seen in Figure 1 below.

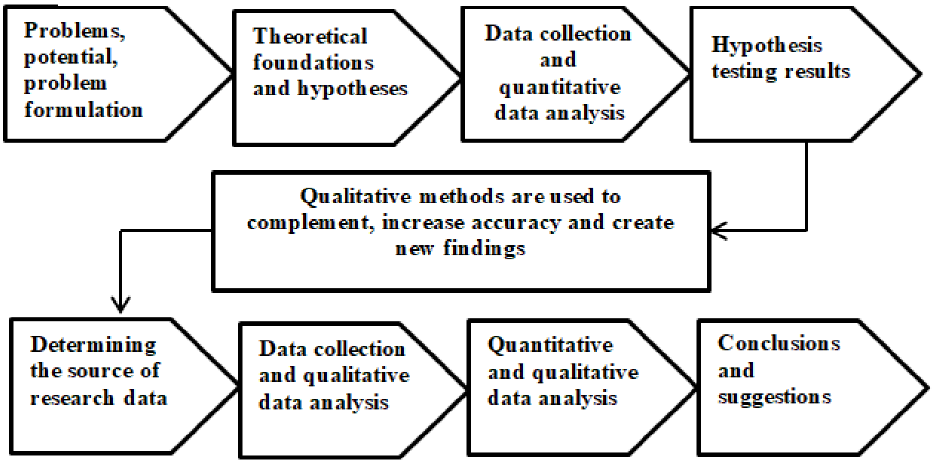

Figure 1. Research steps with sequential explanatory design

The participants in this research consisted of 80 students from classes X-A and X-B, 2 mathematics teachers, and 2 observers. The student criteria are early-grade students at the high school level. They are in the process of adjusting to learning in a new class. They are between 15-16 years old. The selected mathematics teachers are teachers who have more than 5 years of teaching experience. Teachers master the material and understand problem-based mathematics learning. Teachers are able to implement learning using the scaffolding method. The observers have been trained to fill in the observation format and are able to be independent in conducting learning observations. Determining the subjects interviewed was carried out using a purposive snowball sampling technique (Kirchherr & Charles, 2018; Zickar & Keith, 2023).

The data collection instruments in this study consisted of (1) a test instrument in the form of a mathematics test question sheet, (2) an observation instrument in the form of a learning observation sheet, and (3) an interview instrument in the form of a list of interview questions. The test is the instrument to obtain quantitative data about test results, scores (mathematics learning achievement). The observation is to obtain qualitative data about teacher interactions with students in mathematics learning classes with scaffolding. The interview contains semi-structured interview questions that the researcher can develop according to the research objectives (Aung et al., 2021; Elhami & Khoshnevisan, 2022). The purpose of the interview is to obtain more in-depth information (qualitative data) in the form of students' opinions or responses, and students' learning experiences when learning mathematics using the scaffolding method.

Research data analysis with sequential explanatory design was carried out to answer different but complementary problem formulations (Hardiansyah et al., 2024; Noyes et al., 2019). Quantitative data analysis includes analysis of preliminary data and final data. Preliminary data analysis used statistical tests, namely classic assumption tests consisting of normality tests and variance homogeneity tests (Flatt & Jacobs, 2019). Final data analysis uses a comparative test, namely the independent samples t-test.

Activities in qualitative data analysis include data reduction, data display, and conclusion or verification (Miles et al., 2019). The results of qualitative data analysis are useful to support and/or explain the general picture of the quantitative data (Gogo & Musonda, 2022; Istimuryani et al., 2023). To enhance the reliability of these findings, we evaluated the accuracy of the data through triangulation, credibility, and confirmability (Alita et al., 2021). The researchers conducted credibility tests through discussion forums with teachers, observers, and educational psychology experts in groups.

The researchers conducted this study by using sequential explanatory designs through 3 stages, namely: First stage, (1) the researcher takes quantitative data from the results of preliminary tests in classes X-A and X-B; (2) researchers analyzed data from preliminary test results in classes X-A and X-B through descriptive statistics: normality and homogeneity of variance tests; (3) the researcher determines the classes that receive one-to-one scaffolding and peer-scaffolding treatment based on zone of proximal development (ZPD) as seen from previous learning results (prior learning). The second stage, (1) the teacher carries out mathematics learning in classes X-A and X-B. Class X-A where students with low abilities receive one-to-one scaffolding treatment. X-B class where high-ability students receive peer-scaffolding treatment; (2) two observers recorded the activities and interactions between teachers and students in mathematics learning; (3) at the end of the lesson, the teacher gives a final test to all students; (4) researchers analyze the final test result data. The third stage, the researcher conducted qualitative research, namely (1) the researcher prepared a list of questions for the interview; (2) the researchers conducted interviews with selected subjects; (3) researchers collect data from interviews and conducted qualitative data analysis; (4) researchers collaborate on findings to generalize qualitative research results using quantitative research findings.

3. FINDINGS AND DISCUSSION

Explanatory research data is presented using various methods, such as tables, graphs or diagrams, and narratives. This data presentation makes the data more organized and easy to understand. It is also accompanied by a good analysis process so that conclusions can be drawn.

3.1 Students' Mathematics Learning Achievement Before and After Receiving Scaffolding

In this research, the preliminary data was obtained in the form of test results data for class X-A and X-B students after participating in mathematics learning without scaffolding treatment. The preliminary data in Table 1 is used as a basis for researchers to manage research actions by implementing mathematics learning based on the scaffolding method.

Table 1. Student preliminary test results in mathematics learning without scaffolding

Statistics	Class X-A	Class X-B
Number of Samples	40	40
Percentage of Correct Answers	65%	60%
Percentage of Incorrect Answers	35%	40%
The highest score	80	78
Low Value	65	68
Average	65.7	68.9
Standard deviation	9.82	10.24

Preliminary test result data (Table 1) shows that students' mathematics learning achievements are less than satisfactory. Table 1 indicated that the average score of class X-A and X-B students does not meet the minimum completion standard of 75.0 and the achievement level is still below 80%. Based on these results, researchers suggest teachers to implement mathematics learning using the scaffolding method (one-to-one scaffolding and peer-scaffolding).

The results of the preliminary data normality test suggested the value of Asiymp.Sig. of .432 and .991 > .05, it can be concluded that the two samples have a normal distribution. Meanwhile, the results of the homogeneity test of the Komogorov-Smirnov variant obtained the Asiymp.Sig value. (2-tailed) .721 > .05, it can be concluded that the two samples have homogeneous variances. Thus, the classical assumption test has been fulfilled in terms of normality of data and homogeneity of variance, so that both samples can be treated for further research (Alita et al., 2021; Flatt & Jacobs, 2019) . In the next stage, the researcher prepares a lesson plan, observation sheet and test questions, while the teacher conducts the mathematics learning process. At the end of the lesson, the teacher provides a final test to the students. Data on the results of the final test for learning mathematics using the scaffolding method are presented in Table 2 below.

Table 2. Final test results for learning mathematics with scaffolding

Statistics (n = 40)	Class X-A	Class X-B
Highest score	100	100
Lowest score	75	81
Average	84.5	80.7
Standard deviation	11.07	9.43

In Class X-A, the teacher performed his role as a facilitator by providing one-to-one scaffolding according to student needs. The average final test score has increased from the preliminary test. Classical learning completeness reaches more than 80%. In class X-B, the ten students appointed as mentors in peer-scaffolding carried out their roles well. The average final test score has increased from the preliminary test. Classical learning completeness reaches 80%.

Based on data on students' preliminary test scores and final test scores (Tables 1 and 2), researchers have conducted comparative tests using independent samples t-test statistics. The results of statistical tests for class X-A data show that the value of Asiymp.Sig. (2-tailed) .004 < .05, it can be concluded that there is a difference in the average score of the preliminary test and the final test. Statistical independent samples t-test was also carried out on class X-B data. The statistical test results show that the value of Asiymp.Sig. (2-tailed) .002 < .05, so it can be concluded that there is a difference in the average score of the preliminary test and the final test. A comparison of the results of the preliminary test – final test and scaffolding requirements is presented in Figure 2.

The researchers conducted an independent samples t-test on the final scores between class X-A and class X-B after both classes received learning treatment using the scaffolding method. The independent samples t-test statistical test shows that the Asiymp.Sig. (2-tailed) .000 < .05, it can be concluded that there is a difference in the average final test score between students who received mathematics learning using the one-to-one scaffolding method (class X-A) and the peer-scaffolding method (class X-B).

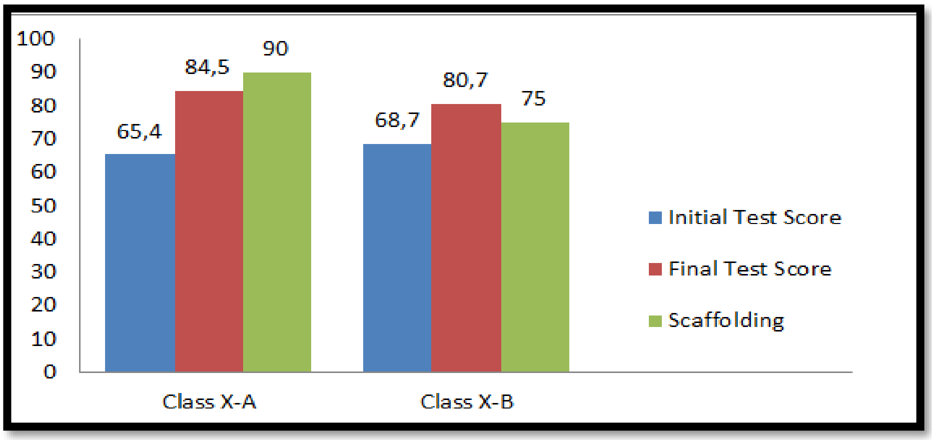

Figure 2. Comparison of preliminary test results – final test, and scaffolding requirements

3.2 The observation of mathematics learning activities and interactions

In this research, two observers manage to observe and record during the learning process. The things observed include the activities and interactions of students with students, and teachers with students when learning mathematics using the scaffolding method. Class X-A received mathematics learning treatment with one-to-one scaffolding, and class X-B with peer-scaffolding. The results of learning observations are presented in Table 3 below.

Table 3. Display data on observations of mathematics learning interactions

Stages of the *scaffolding method*	Description of observation results	
	Student groups with one-to-one scaffolding (Class X-A)	Student groups with peer-scaffolding (Class X-B)
Explaining: The teacher provides a detailed explanation of the concepts to be studied, so that students clearly understand the purpose and objectives of learning	The teacher detects the student's ZPD level; The teacher explains the learning objectives. Students understand the learning objectives to be achieved.	Students (tutors) provide preliminary explanations to small groups The tutor explains the learning objectives. Students understand the learning objectives to be achieved.
Reviewing: The teacher attempts to invite students to connect the material they will study with the basic concepts of the supporting material	Teachers determine appropriate forms of assistance for students with different abilities; Students reveal concepts that have been mastered previously.	Students (tutors) guide small groups with great effort; Associative learning interactions occur in the form of cooperation, assimilation and acculturation.
Developing conceptual thinking: Teachers develop students' thinking concepts starting from non-routine problems given to understand new concepts, students try to develop concepts to find solutions to these problems	Teachers and students interact progressively; Students communicate their ideas. Teachers give and answer all students' questions with enthusiasm; All student difficulties are resolved.	Students (tutors) and peers have open interaction; Guidance given to colleagues can improve critical thinking but is not yet optimal;
Limitation: The teacher controls activities during the student's thinking process so that they remain in	The teacher gives idea-provoking questions; The teacher asks further questions to check students'	The tutor provides idea-provoking questions; Students ask each other questions and answers in small groups;

line with learning objectives.	understanding; Students convey the results of their thinking processes in discussions.	The tutor asks follow-up questions to check students' understanding; Students ask questions and convey the results of their thinking processes in discussions.

Data from observations of mathematics learning in Table 3 have gone through a strict reduction process. Next, the researcher conducted interviews with respondents who had been selected using a purposive snowball sampling technique. The summary of the interview results has been reduced and is presented in Table 4 below.

Table 4. Data from interviews with respondents

Interview Questions	Description of interview results	
	Student groups with one-to-one scaffolding (Class X-A)	Student groups with peer-scaffolding (Class X-B)
What obstacles prevent you from understanding the material when studying mathematics?	Students lack the confidence to openly communicate their problems to the teacher.	Students experience high level of mathematics anxiety. Students lack confidence when learning mathematics
Do you need discussion sessions while studying mathematics?	Students demand discussion sessions when experiencing difficulties learning mathematics.	Students demand discussion sessions with peers when experiencing difficulties learning mathematics.
In discussions, do you prefer (often) asking questions or answering questions?	Students ask more questions and follow the teacher's instructions. Students respond to questions only when asked by the teacher.	Students ask each other and have two-way interaction in a number of mathematical tasks.
How does scaffolding affect your critical thinking skills?	Students said their understanding of mathematics had increased. Students become more critical, careful and thorough in understanding problems.	Students said their understanding of mathematics had increased. Students have systematic critical thinking control.
Will you always expect scaffolding help in learning mathematics?	Students require concentration and focus in learning mathematics. Students who experience learning difficulties always require help (scaffolding).	The students aspire to change roles as a tutor. Students become more confident if they are in the position of a tutor who shares knowledge.

Finally, the researcher has succeeded in presenting findings in the form of quantitative and qualitative data. Next, researchers provide synthesis to increase the generality and applicability of these findings and develop new knowledge through the integration process.

3.3 Educational interaction in mathematics learning using the scaffolding Method

Learning is a process of interaction between students, educators and learning resources in a learning environment. In the learning process, the teacher's most important task is to be able to condition the learning environment and provide guidance or scaffolding assistance to support changes in student behavior.

Based on interview data (Table 5), in general students' demand for scaffolding in mathematics learning is relatively high. Scaffolding requirements can be interpreted as the score required to reach the maximum value. The observation results, supported by data in Figure 2, suggested that students of class X-A x demand more one-to-one scaffolding by 90%, and the demand for peer-scaffolding for class X-B students is by 75%.

The observation results (Table 4) indicated that in learning using the one-to-one scaffolding method, unidirectional interaction tends to occur. Students still have lack of confidence to communicate ideas to teachers. Teachers are more active in asking questions and encouraging students to come up with ideas. The assistance provided by teachers can be in the form of instructions, warnings, encouragement, breaking down problems into other forms that enable students to be independent. The only interaction that occurs is in the form of assimilation. Assimilation interactions occur where ideas that emerge from students are merged into a solution to solve the problem. Thus, to provide good scaffolding, especially for students with low abilities, really depends on the teacher's knowledge and abilities.

The results of learning observations using the peer-scaffolding method (Table 4) suggested that there was educational interaction between tutors and small group students. Interactions that occur in the form of: (a) cooperation between individuals or groups to obtain solutions to mathematical problems, (b) assimilation of ideas that arise from students are merged into a solution to solve the problem, and (c) combining two or more different but complementary ideas become solutions to solving mathematical problems.

Educational interactions are an important point in learning activities. This educational interaction describes an active two-way interaction with a certain amount of knowledge as the medium, so that this interaction is a creative and meaningful interaction. In educational interaction, knowledge construction occurs through critical examination (Wilkinson, 2019), in which teachers receive feedback from students, and students benefit in the form of new knowledge from teachers or peer tutors. This is related to constructivist learning theory which states that students can construct their own concepts of teaching material with the assistance of tools (*scaffolding*) (Lee et al., 2023).

3.4 The effectiveness of one-to-one scaffolding and peer-scaffolding in mathematics learning

The research data in Table 2, after being analyzed using statistical tests, interpreted that the average score of the final test results in all classes (class X-A and class X-B) had increased from the preliminary test results (Table 1). Class learning completeness reached 80% or even more. This suggested that providing scaffolding is effective in improving student learning achievement (Zuo et al., 2023). The increase in learning achievement from the preliminary test score (Table 1) to the final test score (Table 2) indicated a change in students' thinking structure after receiving scaffolding. This means that scaffolding has helped students move across different zones of proximal development (ZPD) (Navaneedhan & Kamalanabhan, 2017).

The success of increasing learning achievement cannot be separated from the teacher who conduct his role as a facilitator (Mahan, 2022) by conducting one-to-one scaffolding according to the student demand in class X-A. Meanwhile in class X-B, students appointed as mentors in peer-scaffolding carry out their roles well. Through the help of scaffolding, learning difficulties experienced by students can be overcome well, so that students' understanding of mathematical concepts becomes stronger and learning achievement increases as well.

The results of the statistical test analysis (data from Table 2 compared with Table 3) and data interpretation that were carried out show that the one-to-one scaffolding and peer-scaffolding methods are both effective in increasing student learning achievement. Thus, providing scaffolding assistance can overcome students' learning difficulties. Judging from the increase from the preliminary score to the final score, the one-to-one scaffolding method has a higher and more effective learning achievement score (Alrawili et al., 2020; Awadelkarim, 2021; Huang, 2019; Kusmaryono, Gufron, et al., 2020). The researchers were not surprised when the research results indicating that learning mathematics with one-to-one scaffolding was more effective than peer-scaffolding. Bearing in mind that the preliminary test results (Table 1) of class X-A students are lower than class X-B students.

Furthermore, to improve their understanding of mathematics, children (students) demand to interact with teachers who are considered smarter than them. The high level of scaffolding required by students is a sign that students have low knowledge or critical thinking. Thus, the students require high levels of scaffolding methods.

Why is the one-to-one scaffolding method more effective? Because one-to-one scaffolding has advantages, including: (a) teachers have a lot of knowledge and experience in overcoming student learning difficulties (Awadelkarim, 2021); (b) students can communicate directly with the teacher from heart to heart (one-to-one), (c) students can develop critical thinking through teacher guidance (Gunawardena & Wilson, 2021), (Yu et al., 2024), and (d) students receive appropriate support services according to the task at hand. The one-to-one scaffolding method is more suitable (effective) for increasing conceptual understanding and motivation of students who have low-enhancing understanding abilities (Acosta-Gonzaga & Ramirez-Arellano, 2022; Yu et al., 2024). The weaknesses of implementing the one-to-one scaffolding method are (a) learning interactions tend to be one-way interactions from teacher to student, (b) potentially causing students to become dependent and always expect help from the teacher. And (c) student learning independence develops more slowly.

On the other hand, the application of the peer-scaffolding method is also effective in improving learning achievement (van de Pol & Volman, 2019). The advantages of peer-scaffolding include (a) learning interactions in peer-scaffolding are more open sharing between students as peers, (b) students can learn from their peers and of course they will be free to express their opinions, and (c) students are not afraid to ask questions if there is something they do not understand. In this way, students' knowledge can be constructed in their cognitive structures quickly (Haataja et al., 2019; Kusmaryono, Ubaidah, et al., 2020). They are not afraid to ask questions if there is something they don't understand (Tammeleht et al., 2021). They learn without becoming frustrated by things that are currently too difficult for them to achieve and they learn without math anxiety (Kusmaryono et al., 2022).

Basically, the implementation of one-to-one scaffolding and peer-scaffolding has several challenges that teachers need to face and prepare for. The challenges in implementing one-to-one scaffolding are (1) teachers must break down learning materials into several units according to individual (student) needs and (2) teachers need to present models and final products of an assignment then students make them for the next assignment project. While the challenges in implementing peer-scaffolding are that teachers need to map students' abilities based on groups, namely expert and impact groups) then teachers plan appropriate learning strategies according to the characteristics of the mathematics material.

4. CONCLUSION

The implementation of one-to-one scaffolding and peer-scaffolding methods are both effective in improving students' mathematics learning achievement. Thus, it can be said that providing scaffolding assistance can overcome students' learning difficulties. The educational interaction that occurs in one-to-one scaffolding is a one-way interaction and is assimilation in nature. Peer-scaffolding interactions are more open sharing between students as peers, allowing critical thinking to emerge when interactions occur that are cooperative, assimilation, and acculturation. The implications of the results of this study can be considered in the context of direct learning (one-to-one scaffolding) and small group learning (peer-scaffolding) in the future. This study only involved respondents in a small sample of less than 100. In future studies, researchers can consider new research on the effectiveness of technology-based scaffolding in online classes.

In the use of digital technology-based scaffolding, teachers can utilize digital platforms with Web 2.0 Applications such as E-Scaffolding Enhance Learning (e-SEL). According to the results of Sarah's research (2022), it was concluded that learning with a website simulation-based scaffolding approach, namely E-Scaffolding Enhance Learning (e-SEL), has high category effectiveness. Research involving respondents or the number of samples can be increased to a wider area so that it can increase credibility in its generalization.

REFERENCES

Abune, A. A. (2019). Effects of peer scaffolding on students’ grammar proficiency development. *Journal of Literature, Languages and Linguistics*, *7*, 105–120. https://doi.org/10.7176/jlll/58-02

Acosta-Gonzaga, E., & Ramirez-Arellano, A. (2022). Scaffolding matters? Investigating its role in motivation, engagement and learning achievements in higher education. *Sustainability*, *14*(20), 1–17. https://doi.org/10.3390/su142013419

Alita, D., Putra, A. D., & Darwis, D. (2021). Analysis of classic assumption test and multiple linear regression coefficient test for employee structural office recommendation. *Ndonesian Journal of Computing and Cybernetics Systems*, *15*(3), 295–306. https://doi.org/10.22146/ijccs.65586

Alrawili, K. S., Osman, K., & Almuntasheri, S. S. (2020). Effect of scaffolding strategies on higher-order thinking skills in science classroom. *Journal of Baltic Science Education, 19*(5), 718–729. https://doi.org/10.33225/jbse/20.19.718

Aung, K. T., Razak, R. A., & Nazry, N. N. M. (2021). Establishing validity and reliability of semi-structured interview questionnaire in developing risk communication module: A pilot study. *Edunesia : Jurnal Ilmiah Pendidikan*, *2*(3), 600–606. https://doi.org/10.51276/edu.v2i3.177

Awadelkarim, A. A. (2021). An analysis and insight into the effectiveness of scaffolding: EFL instructors'/teachers' perceptions and attitudes. *Journal of Language and Linguistic Studies*, *17*(2), 828–841. https://doi.org/10.52462/jlls.58

Bereiter, C. (1999). Referent-centred and problem-centred knowledge: Elements of an educational epistemology. *Interchange*, *23*(12), 337–361. https://doi.org/10.1007/BF01447280

Brower, R. L., Woods, C. S., Jones, T. B., Park, T. J., Hu, S., Tandberg, D. A., Nix, A. N., Rahming, S. G., & Martindale, S. K. (2018). Scaffolding mathematics remediation for academically at-risk students following developmental eeducation reform in Florida. *Community College Journal of Research and Practice*, *42*(2), 112–128. https://doi.org/10.1080/10668926.2017.1279089

Brownfield, K., & Wilkinson, I. A. G. (2018). Examining the impact of scaffolding on literacy learning: A critical examination of the research and guidelines for advancing inquiry. *International Journal of Educational Research*, *90*, 177–190. https://doi.org/10.1016/j.ijer.2018.01.004

Dawadi, S., Shrestha, S., & Giri, R. A. (2021). Mixed-methods research: A discussion on its types, challenges, and criticisms. *Journal of Practical Studies in Education*, *2*(2), 25–36. https://doi.org/10.46809/jpse.v2i2.20

Dominguez, S., & Svihla, V. (2023). A review of teacher implemented scaffolding in K-12. *Social Sciences and Humanities Open*, *8*(1), 100613. https://doi.org/10.1016/j.ssaho.2023.100613

Elhami, A., & Khoshnevisan, B. (2022). Conducting an Interview in Qualitative Research: The Modus Operandi. *Mextesol Journal*, *46*(1), 1–7.

Eun, B. (2019). The zone of proximal development as an overarching concept: A framework for synthesizing Vygotsky's theories. *Educational Philosophy and Theory*, *51*(1), 18–30. https://doi.org/10.1080/00131857.2017.1421941

Flatt, C., & Jacobs, R. L. (2019). Principle assumptions of regression analysis: Testing, techniques, and statistical reporting of imperfect data sets. *Advances in Developing Human Resources*, *21*(4), 484–502. https://doi.org/10.1177/1523422319869915

Garderen, D. van, Juergensen, R., Smith, C., Abdelnaby, H., Lannin, A., & Folk, W. (2021). Instructional scaffolding to engage all learners in complex science text. *Science Scope, 44*(3), 37–43. https://doi.org/10.1080/08872376.2021.12291386

Gogo, S., & Musonda, I. (2022). The use of the exploratory sequential approach in mixed-method research: A case of contextual top leadership interventions in construction H&S. *International Journal of Environmental Research and Public Health*, *19*(7276), 1–20. https://doi.org/10.3390/ijerph19127276

Gunawardena, M., & Wilson, K. (2021). Scaffolding students' critical thinking: A process not an end game. *Thinking Skills and Creativity*, *41*(100848), 1–12. https://doi.org/10.1016/j.tsc.2021.100848

Haataja, E., Toivanen, M., Laine, A., & Hannula, M. S. (2019). Teacher-student eye contact during scaffolding collaborative mathematical problem-solving. *LUMAT: International Journal on Math, Science and Technology Education*, *7*(2), 9–26. https://doi.org/10.31129/LUMAT.7.2.350

Hardiansyah, F., Armadi, A., Misbahudholam AR, M., & Wardi, M. (2024). Analysis of field dependent and field independent cognitive styles in solving science problems in elementary schools. *Jurnal Penelitian Pendidikan IPA*, *10*(3), 1159–1166. https://doi.org/10.29303/jppipa.v10i3.5661

Huang, K. (2019). Design and investigation of cooperative, scaffolded wiki learning activities in an online graduate-level course. *International Journal of Educational Technology in Higher Education*, *16*(1). https://doi.org/10.1186/s41239-019-0141-6

Ihechukwu, N. B. (2020). Impact of instructional scaffolding approach on secondary school students achievement in mathematics. *Malikussaleh Journal of Mathematics Learning*, *3*(2), 46. https://doi.org/10.29103/mjml.v3i2.3168

Istimuryani, N., Sunardi, S., & Prastiti, T. D. (2023). The analysis of the improvement of student's mathematical communication skills in solving problems of circumference and area of circles under the implementation of inquiry-based learning. *International Journal of Current Science Research and Review*, *06*(03), 2153–2167. https://doi.org/10.47191/ijcsrr/v6-i3-35

Kim, N. J., & Belland, B. R. (2018). Effectiveness of computer-based scaffolding in the context of problem-based learning for STEM education: bayesian meta-analysis. *Educational Psychology Review*, *30*(2), 397–429. https://doi.org/10.1007/s10648-017-9419-1

Kirchherr, J., & Charles, K. (2018). Enhancing the sample diversity of snowball samples: Recommendations from a research project on anti-dam movements in Southeast Asia. *PLoS ONE*, *13*(8), 1–17. https://doi.org/10.1371/journal.pone.0201710

Kusmaryono, I., Gufron, A. M., & Rusdiantoro, A. (2020). Effectiveness of scaffolding strategies in learning against decrease in mathematics anxiety level. *Numerical: Jurnal Matematika Dan Pendidikan Matematika*, *4*(1), 13–22.

Kusmaryono, I., Jupriyanto, J., & Kusumaningsih, W. (2021). Construction of students' mathematical knowledge in the zone of proximal development and zone of potential construction. *European Journal of Educational Research*, *10*(1), 341–351. https://doi.org/10.12973/eu-jer.10.1.341

Kusmaryono, I., Ubaidah, N., & Basir, M. A. (2020). The role of scaffolding in the deconstructing of thinking structure: A case study of pseudo-thinking process. *Infinity Journal*, *9*(2), 247–262. https://doi.org/10.22460/infinity.v9i2.p247-262

Kusmaryono, I., Ubaidah, N., & Basir, M. A. (2022). It doesn't mean that students don't have mathematics anxiety: A case study of mathematics learning with path analysis. *European Journal of Educational Research*, *11*(3), 1683–1697. https://doi.org/10.12973/eu-jer.11.3.1683

Lall, D. (2021). Mixed methods research design: when and how to use. *Indian Journal of Continuing Nursing Education*, *22*(2), 143–147. https://doi.org/10.4103/ijcn.ijcn

Lee, H.-Y., Wu, T.-T., Lin, C.-J., Wang, W.-S., & Huang, Y.-M. (2023). Integrating computational thinking into scaffolding learning: An innovative approach to enhance science, technology, engineering, and mathematics hands-on learning. *Journal of Educational Computing Research*, *62*(2), 1–17. https://doi.org/10.1177/07356331231211916

Lodge, J. M., Kennedy, G., Lockyer, L., Arguel, A., & Pachman, M. (2018). Understanding difficulties and resulting confusion in learning: An integrative review. *Frontiers in Education*, *3*(6), 1–10. https://doi.org/10.3389/feduc.2018.00049

Mahan, K. R. (2022). The comprehending teacher: scaffolding in content and language integrated learning. *Language Learning Journal*, *50*(1), 74–88. https://doi.org/10.1080/09571736.2019.1705879

Martin, N. D., Dornfeld Tissenbaum, C., Gnesdilow, D., & Puntambekar, S. (2019). Fading distributed scaffolds: the importance of complementarity between teacher and material scaffolds. *Instructional Science*, *47*(1), 69–98. https://doi.org/10.1007/s11251-018-9474-0

Miles, M. B., Huberman, A. M., & Saldaña, J. (2019). *Qualitative data analysis: A methods sourcebook* (Fourth Edi). SAGE Publications.

Navaneedhan, C., & Kamalanabhan, T. (2017). What is meant by cognitive structures ? How does it influence teaching – learning of psychology ? *IRA International Journal of Education and Multidisciplinary Studies*, *7*(2), 89–98. https://doi.org/10.21013/jems.v7.n2.p5

Noyes, J., Booth, A., Moore, G., Flemming, K., Tunçalp, Ö., & Shakibazadeh, E. (2019). Synthesising quantitative and qualitative evidence to inform guidelines on complex interventions: Clarifying the purposes, designs and outlining some methods. *BMJ Global Health*, *4*(e000893), 1–14. https://doi.org/10.1136/bmjgh-2018-000893

Sarah, L. L. (2022). The implementation of web Based e-scaffolding enhance learning (e-SEL) on centre of mass concept understanding. *Jurnal Inovasi Pendidikan IPA*, *8*(1), 18–33. https://doi.org/10.21831/jipi.v8i1.46476

Tammeleht, A., Rodríguez-Triana, M. J., Koort, K., & Löfström, E. (2021). Scaffolding collaborative case-based learning during research ethics training. *Journal of Academic Ethics*, *19*, 229–252. https://doi.org/10.1007/s10805-020-09378-x

Toyon, M. A. S. (2021). Explanatory sequential design of mixed methods research: Phases and challenges. *International Journal of Research in Business and Social Science*, *10*(5), 253–260. https://doi.org/10.20525/ijrbs.v10i5.1262

van de Pol, J., & Volman, M. (2019). Scaffolding student understanding in small-group work: Students' uptake of teacher support in subsequent small-group interaction. *Journal of the Learning Sciences*, *28*(2), 206–239. https://doi.org/10.1080/10508406.2018.1522258

van de Pol, J., Volman, M., Oort, F., & Beishuizen, J. (2015). The effects of scaffolding in the classroom: support contingency and student independent working time in relation to student achievement, task effort and appreciation of support. *Instructional Science*, *43*(5), 615–641. https://doi.org/10.1007/s11251-015-9351-z

Wilkinson, L. C. (2019). Learning language and mathematics: A perspective from lin guistics and education. *Linguistics and Education*, *49*, 86–95. https://doi.org/10.1016/j.linged.2018.03.005

Yu, J., Kim, H., Zheng, X., Li, Z., & Xiangxiang, Z. (2024). Effects of scaffolding and inner speech on learning motivation, flexible thinking and academic achievement in the technology-enhanced learning environment. *Learning and Motivation*, *86*(February), 101982. https://doi.org/10.1016/j.lmot.2024.101982

Zhang, Y., Zhao, G., & Zhou, B. (2021). Does learning longer improve student achievement? Evidence from online education of graduating students in a high school during COVID-19 period. *China Economic Review*, *70*(101691). https://doi.org/10.1016/j.chieco.2021.101691

Zickar, M. J., & Keith, M. G. (2023). Annual review of organizational psychology and organizational behavior innovations in sampling: improving the appropriateness and quality of samples in organizational research. *Annu. Rev. Organ. Psychol. Organ. Behav.*, *10*, 315–337. https://doi.org/10.1146/annurev-orgpsych-120920- 052946

Zuo, M., Kong, S., Ma, Y., Hu, Y., & Xiao, M. (2023). The effects of using scaffolding in online learning: A meta-analysis. *Education Sciences*, *13*(705), 1–12. https://doi.org/10.3390/educsci13070705