

Learners' Scaffolding Techniques: Their Advantages in Learning Mathematics

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Abstract. This study aimed to examine the extent of advantages of the scaffolding techniques and how they relate to the academic performance of learners in Mathematics. The respondents of the study were the 312 randomly selected Grade 7 learners from a public secondary school in the Division of Negros Oriental during the academic year 2023- 2024. The study employed the descriptive-correlational research design and utilized a validated questionnaire. Statistical methods employed in this study encompassed percentage, mean, weighted mean, and Multiple Regression Analysis. The findings revealed that learners have "very high" perceptions on the advantages of scaffolding techniques in learning Mathematics in terms of one-on-one peer tutorial, group study, teacher demonstration, video tutorial, and self-directed learning. Moreover, the overall academic performance rating of the learners in Mathematics is at the "satisfactory" level. Furthermore, the learners' perceived effectiveness of the following scaffolding techniques significantly predicts their academic performance in Mathematics: one-on-one peer tutorial, group study, teacher demonstration, and video tutorial. By embracing and enhancing scaffolding techniques, educators can not only elevate the learning experiences of students in Mathematics but also potentially extend these positive outcomes to other academic disciplines.

Keywords: Group study, Peer tutorial, Scaffolding techniques, Video tutorial.

1.0 Introduction

The educational system of a country has a significant impact on its development. Learning is a labor-intensive process in which learners actively construct their meaning based on prior experiences (Francis et al., 2023). At all academic levels, Mathematics is a topic that calls for logical thought, organization, and demonstration. Using the motivating impact of learning through the different scaffolding techniques, promoting global consciousness and global competences of young learners, is a great strategy to integrate a global citizenship perspective in secondary education. The development of teachers has become an essential component of guaranteeing quality education and achieving Sustainable Development Goal 4 (Park et al., 2023).

Cabral (2023), on the other hand, stipulates that the educational system must adapt to the rapid changes and complexities of society. Recognizing the need for curriculum revisions to minimize future learning losses, the Department of Education (DepEd) released the MATATAG K to 10 Curriculum, a redesigned curriculum for Kindergarten through Grade 10. Philippine Vice President and DepEd Secretary, Sara Duterte-Carpio, presented priority points for the intervention of DepEd in support of its MATATAG Agenda. Areas mentioned were curriculum and teaching, literacy and numeracy enhancement, inclusive education programs, and instructional methods. Meanwhile, Cao (2024) asserted that, as an important subject in the fundamental education stage, mathematics is crucial in developing collaborative consciousness and problem-solving abilities of the students. Teachers can then integrate the use of scaffolding techniques to remedy the learning gap between the learners. As

Thompson (2023) stipulated, learners will have a better understanding of how the techniques affected their ability to progress through solving challenging issues.

Scaffolding techniques are designed to support the learning of the students (Chen, 2023). A teacher/parent, peer, a computer-based or paper-based tool, or the learners themselves can support their learning. After the pandemic, the community emphasized the role of teachers and enhanced internet access for interaction (Park, Liu, & Li, 2023). Teachers and learners integrate and innovate differentiated instructions and techniques to spot learning gaps that may have resulted from learning loss. Although there have been several types of research on scaffolding, there is a present shortage of literature concentrating on the different scaffolding techniques that can improve student performance in mathematics. Other studies usually explored the students' attitude towards peer tutoring and their academic achievement, but not a lot specifically focused on the scaffolding techniques through video tutorials and self-directed learning.

With the above premise, the researchers sought to identify the scaffolding techniques that aid learners achieve academic success in mathematics. Thus, this study attempts to provide a more thorough knowledge of the delicate connection between the different scaffolding techniques and academic performance of the students by taking into account various techniques, such as one-on-one peer tutorial, group study, teacher demonstration, video tutorial, and self-directed learning.

2.0 Methodology

2.1 Research Design

A descriptive-correlational survey was used for this research. It is descriptive in the sense that it described the nature of the scenario on the scaffolding strategies and their influence on the academic achievement of the students. Additionally, the fact that this study ascertained the connection between the extent of using scaffolding strategies and the students' performance in school made it correlational.

2.2 Research Participants

The respondents of the study were the three hundred twelve (312) randomly selected grade 7 students from public secondary schools of Sta. Catalina District, Division of Negros Oriental. These students are enrolled for the school year 2023–2024. They were chosen using a systematic sampling design in which every second student in the list became part of the study.

2.3 Research Instrument

The study utilized a custom-made questionnaire created by the researchers, combining modified standardized questionnaires and insights from related studies and literature. The entire questionnaire underwent content validation and cross-checking by three Mathematics experts to ensure alignment with the specific problems of the study. A dry run was conducted to check item reliability using Cronbach's alpha coefficient test with the following results: 0.776 for one-on-one tutorial; 0.806 for group study; 0.701 for teacher demonstration; 0.863 for video tutorial; and 0.860 for self-directed learning.

2.4 Data Gathering Procedure

A formal request letter seeking permission to conduct the study was forwarded to the Schools Division Superintendent of Negros Oriental and the District Supervisor (PSDS), with endorsement from the Dean of the Graduate School at Foundation University. Following that, the signed and approved request was forwarded to the principal of the school, the respective advisers, and the subject teachers of the grade seven students of the targeted school. During the actual data gathering, the researchers ensured that the disclosure statement was attached directly to the questionnaires right before the respondents began answering them. This was done to ensure the confidentiality of the data and to keep the respondents aware of their roles before the conduct of the study. The disclosure statement also served as proof of their consent to participate in the study. Before the conduct of the experiment and the distribution of the test questionnaires, the researchers explained to the students the significance of the research as well as the objective of the study during distribution. Students were also advised that the information they provided in response to the questions of the study would be kept confidential and kept in a safe place. After the students responded to the questions, the questionnaires were collected. Afterwards, the results were tallied, analyzed and interpreted.

2.5 Ethical Considerations

All relevant ethical considerations were observed by the researchers throughout the course of the study. Confidentiality was maintained to protect the data acquired from the respondents, ensuring their privacy and dignity. The researchers also made sure to minimize potential risks for the respondents. Adherence to ethical norms set by Foundation University's Ethics Committee was a priority and their ethical approval was provided.

3.0 Results and Discussion

3.1 Extent of Students' Perception on the Advantages of One-on-One Peer Tutorial

The extent of students' perception on the advantages of one-on-one peer tutorial is presented in Table 1. As depicted by the data, the overall extent of students' perception of the advantages of one-on-one peer tutorial is "very high," as reflected in the composite mean of 4.37.

Table 1. Extent of students' perception on the advantages of one-on-one peer tutorial (n = 312)

Through the one-on-one peer tutorial, I experience the following advantages:	$w\bar{x}$	VD	EoP
1. I feel a sense of joy and satisfaction whenever my peers assist me with our lessons.	4.57	SA	VH
2. I listen to my peer tutor when they share ideas and experiences.	4.57	SA	VH
3. I have managed to form good friendships with my peer tutors.	4.56	SA	VH
4. I appreciate the teaching strategies employed by my peer tutor, which contribute to my learning.	4.54	SA	VH
5. I ask my peer tutor questions and clarifications on various concepts.	4.49	SA	VH
6. I evaluate my current knowledge and realize my weaknesses in mathematics.	4.40	SA	VH
7. I have improved my understanding and mastery of the subject matter.	4.22	SA	VH
8. I have gained valuable knowledge from my peer tutor, which has positively impacted my studies.	4.21	SA	VH
9. I find peer tutoring more reliable and accessible compared to self-studying and traditional teaching.	4.15	A	H
10. I can exchange ideas which deepen my understanding of the subject matter.	3.98	A	H
Composite	4.37	SA	VH

Specifically, the students "very highly" perceive the advantages of one-on-one peer tutorials in learning mathematics because they feel a sense of joy and satisfaction whenever their peers assist them with their lessons. They also listen to their peer tutor when sharing ideas and experiences. These statements both rank first among other indicators ($w\bar{x} = 4.57$), which implies that the students feel satisfied and happy when their peer helps them with their lessons. This finding is likewise evident in the study of Lai and Hwang (2022), where they found that one-on-one tutoring can foster positive social and emotional benefits, including improved self-confidence, reduced anxiety, and development of communication and collaboration skills.

Furthermore, the students "very highly" perceive the advantages of one-on-one peer tutorial because they have managed to form good friendships with their peer tutors ($w\bar{x} = 4.56$) and appreciate the teaching strategies employed by their peer tutor, which contribute to their learning ($w\bar{x} = 4.54$). They also ask their peer tutor questions and clarifications on various concepts ($w\bar{x} = 4.49$); evaluate their current knowledge and realize their weaknesses in mathematics ($w\bar{x} = 4.40$); have improved their understanding and mastery of the subject matter ($w\bar{x} = 4.22$); and have gained valuable knowledge from their peer tutor, which has positively impacted their studies ($w\bar{x} = 4.21$). These data connote that the students receive a dynamic and interesting learning experience through one-on-one peer tutorial, which improves their academic performance, self-concept, attitude, social skills, and behavioral outcomes.

These findings are all indicated in a growing body of studies (Barahona, Padrón, & Waxman, 2023). One-on-One tutoring also promotes self-directed learning skills by encouraging students to ask questions, explain their understanding, and take ownership of their learning process (De Backer et al., 2020). It fosters student engagement by fostering a more personalized learning experience (Arco-Tirado et al., 2020) and addressing individual learning styles and needs (Thurston et al., 2020).

Other factors include the students finding one-on-one peer tutoring more reliable and accessible compared to self-studying and traditional teaching ($w\bar{x} = 4.15$) and students being able to exchange ideas, which deepen their understanding of the subject matter ($w\bar{x} = 3.98$). These enumerated factors are "highly" perceived by the grade 7 students as the advantages of one-on-one peer tutorial. The data suggest that peer tutoring can be employed as an alternate relevant and successful learning strategy during the learning process (Anditiasari et al. 2023).

One-on-one peer tutorial serves as a significant scaffolding technique for learners, playing a crucial role in learning mathematics. This educational intervention involves students of similar ages or academic levels collaborating to enhance their comprehension of a particular subject. It has a positive impact on academic achievement across several areas, including mathematics, biology (Khan et al., 2021), and financial accounting. Moreover, it enables learners to articulate their ideas, fostering the development of essential skills such as cooperation, self-control, and self-worth (Arthur et al., 2022). Furthermore, one-on-one peer tutoring has been a well-established educational practice for decades and recent research continues to explore its effectiveness and benefits in diverse educational contexts.

3.2 Extent of Students' Perception on the Advantages of Group Study

The extent of students' perception of the advantages of group study is presented in Table 2. The data show that the overall extent of students' perception of the advantages of group study is "very high," as reflected in the composite mean of 4.32.

Table 2. Extent of students' perception on the advantages of group study (n = 312)

Through the group study, I experience the following advantages:	$w\bar{x}$	VD	EoP
1. I enjoy working with other students on assignments and projects.	4.57	SA	VH
2. I am more responsible in accomplishing my tasks when I am with my groupmates.	4.47	SA	VH
3. I enjoy learning when I am with my classmates/groupmates.	4.43	SA	VH
4. Tasks become easier to accomplish when working with my classmates or groupmates.	4.43	SA	VH
5. I am more confident in expressing my ideas when working with groups.	4.30	SA	VH
6. I look forward to daily interactions with my classmates/groupmates.	4.30	SA	VH
7. I am comfortable learning when I'm alongside my classmates.	4.24	SA	VH
8. I feel confident when sharing my insights with my groupmates.	4.21	SA	VH
9. I get high scores in the test exams when studying with classmates/groupmates.	4.13	A	H
10. I easily comprehend ideas or concepts when they are explained by my classmates or groupmates.	4.13	A	H
Composite	4.32	SA	VH

It is also reflected in the table that the students "very highly" perceive the advantages of group study because they enjoy working with other students on assignments and projects, which rank first among other indicators ($w\bar{x} = 4.57$). This finding indicates that group study can help students enjoy working and have a better knowledge of the concepts, increase their critical thinking abilities, and solve problems more effectively. A similar finding was also manifested in the study of Ahn (2020), where collaborative learning environments fostered by group study can enhance motivation and engagement.

The data further reveal that: a) the students "very highly" perceive the advantages of group study because they are more responsible in accomplishing their tasks when they are with their groupmates ($w\bar{x} = 4.47$); b) they enjoy learning when they are with their classmates/groupmates and tasks become easier to accomplish when working with their classmates or groupmates which both indicator ($w\bar{x} = 4.43$); and c) they are more confident in expressing their ideas when working with groups and they look forward to daily interactions with their classmates/groupmates which both indicator ($w\bar{x} = 4.30$). In addition, the students are comfortable learning when they are alongside with their classmates ($w\bar{x} = 4.24$); and feel confident when sharing their insights with their groupmates ($w\bar{x} = 4.21$). These results suggest that working in a group encourages effective communication, teamwork, and resolution of conflicts and allows students to share various perspectives and expertise, resulting in a deeper understanding of the subject matter. These findings affirm the statement of Zohrevandi et al. (2024) that exchanging knowledge and information helps learners become more aware of their learning needs. Likewise, Yang et al. (2024) posited that learning with others in a group allows students to become aware of their own strengths and weaknesses in sharing knowledge and learning, and then take action to manage their efforts.

Other factors "highly" perceived by the students include getting high scores in the test exams when studying with classmates/groupmates ($w\bar{x} = 4.13$) and easily comprehending ideas or concepts when they are explained by their classmates or groupmate ($w\bar{x} = 4.13$). This finding means that collaborative learning help students to comprehend ideas and concepts easily, resulting in getting high scores in their test examinations. Similarly, the study of Cheng et al. (2021) and He and Zhu (2020) found that participating in group conversations and activities can help students get a better understanding, retain more knowledge, and convey ideas to others. Additionally, Byiringiro (2024)

found that students work in cooperative groups, learn how to provide and receive information, gain fresh insights and views, and express themselves in a socially acceptable manner.

In general, group study serves as a valuable tool for students to enhance academic achievement, develop collaborative skills, and deepen their understanding of course material. It is labeled as one of the significant scaffolding techniques of the students, playing an important role in learning mathematics. Beyond academic achievement, group studies help strengthen communication and collaborative skills, promote critical thinking and problem-solving (Liu et al., 2020), improves motivation and engagement (Shen et al., 2020), and gives social support while lowering anxiety.

3.3 Extent of Students' Perception on the Advantages of Teacher Demonstration

The extent of students' perception of the advantages of teacher demonstration is presented in Table 3. Based on the data, the overall extent of students' perception is "very high," as reflected in the composite mean of 4.52.

Table 3. Extent of students' perception on the advantages of teacher demonstration (n = 312)

Through the teacher demonstration, I experience the following advantages:	$w\bar{x}$	VD	EoP
1. I feel excited to learn when I see and observe our teacher demonstrating exercises first.	4.70	SA	VH
2. I find it easier to understand concepts when my teacher provides examples in his/her discussion.	4.67	SA	VH
3. I enjoy watching our teacher demonstrate the processes involved in our lesson.	4.61	SA	VH
4. I love learning when the teacher allows us to explore new ideas within the given time.	4.58	SA	VH
5. I feel the eagerness to learn when the teacher involves us in the class activities.	4.56	SA	VH
6. I grasp the concepts well when my teacher relates them to real-life examples.	4.46	SA	VH
7. I can develop my skills effectively when my teacher adds hands-on activities in the class.	4.46	SA	VH
8. I feel motivated when the teacher incorporates varied instructional materials into lessons.	4.41	SA	VH
9. I find it engaging when the teacher uses different activities in our class.	4.38	SA	VH
10. I gain confidence when my teacher encourages my participation during discussions.	4.34	SA	VH
Composite	4.52	SA	VH

The data further show that the students "very highly" perceive the advantages of teacher demonstration because students feel excited to learn when they see and observe their teacher demonstrating exercises first ($w\bar{x} = 4.70$), which ranks number 1 among other indicators. This signifies that teacher demonstrations can engage students and encourage active engagement in the learning process and positively impact student learning outcomes. Correspondingly, Boyle et al. (2023) maintained that observing demonstrations encourages students to witness effective problem-solving ways, which improves their ability to apply taught tactics independently. Also, Klassen et al. (2020) highlighted the potential for demonstrations to spark curiosity and increase active participation of the students.

Furthermore, the students "very highly" perceive the advantages of teacher demonstration in learning mathematics because they find it easier to understand concepts when their teacher provides examples in their discussion ($w\bar{x} = 4.67$). They also enjoy watching their teacher demonstrate the processes involved in the lesson ($w\bar{x} = 4.61$); they love learning when the teacher allows them to explore new ideals within the given time ($w\bar{x} = 4.58$); they feel the eagerness to learn when the teacher involves them in the class activities ($w\bar{x} = 4.56$). In addition, students grasp the concepts well when their teacher relates them to real-life examples and they can develop their skills effectively when their teacher adds hands-on activities in the class, which both have a mean rating of 4.46. Moreover, students feel motivated when the teacher incorporates varied instructional materials into lessons, find it engaging when the teacher uses different activities in the class, and gain confidence when the teacher encourages their participation during discussions, garnering the following weighted mean values of 4.41, 4.38, and 4.34, respectively, all denoting a "very high" extent of perception. Also, teacher demonstrations, varied instructional materials, hands-on activities, and student involvement contribute to positive outcomes, including increased engagement, improved understanding, positive attitudes, motivation, and effective skill development among students. Similarly, Alghamdy (2024) affirmed that to assist students in achieving complete development, teachers must provide appropriate learning opportunities and assistance. Thus, teacher demonstrations and discussions are an effective tool to engage students in the learning process (Wang, 2024) and effective demonstrations should be personalized to the student's specific learning style, prior knowledge, and degree of understanding (Lee & Kim, 2022).

Teacher demonstration serves as one of the learners' significant scaffolding techniques, playing an important role in learning mathematics. It has been a cornerstone of effective teaching across various disciplines and educational levels. Teacher demonstrations facilitate student learning by increasing comprehension, lowering cognitive load (Dowdy & Dean, 2021) and enhancing engagement (Klassen et al., 2020). However, it is critical to tailor demonstrations to individual needs (Lee & Kim, 2022), maintain clarity and conciseness (Cho & Cho, 2021), and include interactive aspects. Furthermore, stressing student agency (Chin & Lin, 2020) and implementing alternate tactics such as different scaffolding techniques (Van de Walle et al., 2021) might improve the effectiveness of teacher demonstrations.

3.4 Extent of Students' Perception on the Advantages of Video Tutorial

The overall extent of students' perception of the advantages of video tutorials is "very high" as reflected in the composite mean of 4.35.

Table 4. Extent of students' perception on the advantages of video tutorial (n = 312)

Through the video tutorial, I experience the following advantages:	$w\bar{x}$	VD	EoP
1. Video tutorials enable me to learn and understand effectively since I can view them at my own pace, rewind, and review portions I did not understand the first time.	4.50	SA	VH
2. I find video tutorials enjoyable and effective in increasing my interest in learning.	4.46	SA	VH
3. I become motivated to learn when watching video tutorials.	4.43	SA	VH
4. I consider video tutorials as valuable sources of information.	4.42	SA	VH
5. Video tutorials have helped me improve my performance in mathematics.	4.42	SA	VH
6. I am satisfied with the learning I acquired from video tutorials.	4.30	SA	VH
7. I spend more time studying while watching video tutorials to acquire mathematical skills.	4.28	SA	VH
8. I conveniently access information anywhere and at any time.	4.27	SA	VH
9. My mathematical skills are enhanced and improved with the use of video tutorials.	4.23	SA	VH
10. I easily comprehend the material and find explanations for my questions after watching video tutorials.	4.19	A	H
Composite	4.35	SA	VH

Based on the data presented, the students "very highly" perceive the advantages of video tutorials because these enable them to learn and understand the lessons effectively since they can view the tutorial at their own pace, rewind, and review portions they did not understand the first time ($w\bar{x} = 4.50$). This statement ranks first among other indicators, signifying that learners can access video tutorials from any location at any time and that video tutorials provide a simple and accessible learning option, allowing students to learn at their own pace and revisit certain areas as needed. In a way, video tutorials promote inclusiveness and democratize access to knowledge. Similarly, Attard and Holmes (2022) claimed that outside of the scheduled sessions at school, alternative teaching techniques are made available.

Furthermore, the students "very highly" perceive the advantages of video tutorials in learning mathematics because they find video tutorials enjoyable and effective in increasing their interest in learning ($w\bar{x} = 4.46$) and they become motivated to learn when watching video tutorials ($w\bar{x} = 4.43$). Also, the students consider video tutorials as valuable sources of information that help them improve their performance in mathematics ($w\bar{x} = 4.42$). The data further reveal that students are satisfied with the learning they acquire from video tutorials ($w\bar{x} = 4.30$); spend more time studying while watching video tutorials ($w\bar{x} = 4.28$); conveniently access information anywhere and at any time ($w\bar{x} = 4.27$), and the mathematical skills of the students are enhanced and improved with the use of video tutorials ($w\bar{x} = 4.23$). These findings imply that video tutorials have emerged as a popular learning resource in a variety of sectors due to their accessibility, entertaining style, and effectiveness in transmitting information.

Video tutorials are seen as a valuable content-delivery tool that may be used in a variety of learning modes. Thus, the process and results of learning can be enhanced by the incorporation of instructional videos (Prastiti et al., 2023), which is an excellent supplemental instructional tool that can help improve learning (Delos Santos et al., 2022). In addition, the students "highly" perceive the advantages of video tutorials in learning mathematics because they easily comprehend the material and find explanations for their questions after watching video tutorials ($w\bar{x} = 4.19$). This shows that video tutorials enable learners to discover, study, practice, and evaluate their

progress (Basitere et al., 2023) and encourage them to think and understand arithmetic more effectively, quickly, and deeply (Sudiarta & Widana, 2019). This also affirms the statement of Delos Santos et al. (2022) that video tutorials help students enhance their capacity to understand.

Overall, video tutorials have grown in popularity and effectiveness, providing a combination of visual and auditory information to accommodate a wide range of learning styles. It has become an increasingly popular learning tool in a variety of educational and professional settings, serving as one of the significant learners' scaffolding techniques in learning mathematics.

3.5 Extent of Students' Perception on the Advantages of Self-directed Learning

Table 5 presents the extent of students' perception of the advantages of self-directed learning. As depicted on the table, the overall extent of students' perception is "very high," as signified by the composite mean of 4.27.

Table 5. Extent of students' perception on the advantages of self – directed learning (n = 312)

Through self-directed learning, I experience the following advantages:	$w\bar{x}$	VD	EoP
1. I am able to follow my own learning plan.	4.42	SA	VH
2. I have the opportunity to evaluate my progress as the lesson progresses.	4.37	SA	VH
3. I can organize and improve my own learning.	4.34	SA	VH
4. I make choices depending on my strengths and weaknesses.	4.32	SA	VH
5. I develop a sense of responsibility and feel in control with my own learning.	4.29	SA	VH
6. I can choose my own learning styles and strategies to achieve learning goals.	4.29	SA	VH
7. I express my views and activities that address my needs.	4.21	SA	VH
8. I enjoy learning and work well at my own pace in various activities.	4.19	A	H
9. I have developed problem-solving skills by dealing with the different areas of difficulty on my own.	4.18	A	H
10. I learn better and more effectively through setting my own learning priorities.	4.12	A	H
Composite	4.27	SA	VH

The data reflect that the students "very highly" perceive the advantages of self-directed learning because they are able to follow their own learning plan ($w\bar{x} = 4.42$), ranking number 1 among other indicators. In addition, the data reveal that the students can organize and improve their own learning ($w\bar{x} = 4.34$), which implies that self-directed learning provides students with a sense of autonomy and the ability to personalize their educational experiences. This finding is parallel with the result obtained by Abidah et al. (cited in Harini et al., 2023) that SDL involves individuals taking control of their own learning process by determining and managing their own study materials, schedule, learning environment, and utilizing various educational resources.

Furthermore, the students "very highly" perceive the advantages of self – directed learning because they have the opportunity to evaluate their progress as the lesson progresses ($w\bar{x} = 4.37$). They can make choices depending on their strengths and weaknesses ($w\bar{x} = 4.32$), and express their views and activities that address their needs ($w\bar{x} = 4.21$). Also, students develop a sense of responsibility and feel in control with their own learning; and can choose their own learning styles and strategies to achieve learning goals with both indicators having a weighted mean of 4.29. These results indicate that in self-directed learning, students can evaluate their learning progress, their strengths and weaknesses, and they can express their perspective to address their learning needs. A similar finding was also manifested in the study of Yang et al. (2023) where they found out that education must expose young people to a variety of learning situations, as well as real-world responsibility (Putra et al., 2023).

Moreover, the students "highly" perceive the advantages of self-directed learning because they enjoy learning and work well at their own pace in various activities ($w\bar{x} = 4.19$). They have developed problem-solving skills by dealing with the different areas of difficulty on their own ($w\bar{x} = 4.18$), and learn better and more effectively through setting their own learning priorities ($w\bar{x} = 4.12$). Studies suggest that learners taking ownership of their learning experience are more engaged and motivated, leading to deeper understanding and knowledge retention (Boekaerts, 2020).

Self-directed learning (SDL) is one of the core common values of students (Kieu et al., 2023) and serves as one of the significant scaffolding techniques, playing an important role in learning mathematics. Affirming the study of

Abidah et al. (cited in Harini et al., 2023), SDL involves individuals taking control of their own learning process by determining and managing their own study materials, schedule, learning environment, and utilizing various educational resources.

3.6 Academic Performance of the Students in Mathematics

Table 6 shows the academic performance of the students in Mathematics. The data reflect that only 14.10% of the students obtained an outstanding rating, and 31.73%, which is the highest percentage, have a very satisfactory rating. About 30% of them have satisfactory performance, while around 22% of the students have a fairly satisfactory rating. Approximately 2% of the students did not meet expectations. The students with fairly satisfactory ratings and those who did not meet expectations must be provided remedial activities and minimize gaps in their Mathematics learning in the upper grades. Based on the findings, it could be inferred that the majority of the students are at a very satisfactory level in their Mathematics performance.

Table 6. Academic performance of the students in mathematics (n = 312)

Rating	Frequency	Percent
90% - 100%	44	14.10
85% - 89%	99	31.73
80% - 84%	95	30.45
75% - 79%	69	22.12
< 75%	5	1.60
Total	312	100.00
Mean = 83.57 (Satisfactory)		
SD = 5.32		

The overall performance of the students is 83.57% with a verbal description of satisfactory. This implies that in general, students at this level have developed the essential knowledge, abilities, and core understandings of the principles of mathematics. Based on DepEd Order No. 8, s. of 2015, the Policy Guidelines on Classroom Assessment for the K to 12 Basic Education Program, classroom assessment is an essential component of curriculum implementation, allowing teachers to track and measure the progress of the students and change instruction accordingly. Thus, teachers and students are encouraged to collaborate to improve the academic performance of the students in mathematics using various scaffolding techniques.

3.7 Relationship between the Perceived Extent of Advantages of Scaffolding Techniques and Students' Academic Performance in Mathematics

Table 7 presents the data identifying the relationship between the extent of advantages of the five scaffolding techniques and the academic performance of the students. Using Multiple Linear Regression Analysis, the study found that the overall F-test is significant ($p = <.001$). This means that the sample data provide enough evidence to reject the null hypothesis for the entire population. In other words, some of the explanatory or independent variables (scaffolding techniques) are significant predictors of the students' academic performance in Mathematics.

Table 7. Regression Analysis result

Variables	Coefficients	SE	t Stat	p-value
Intercept	77.083	4.361	17.674	0.000
One-On-One Peer Tutorial	3.280	1.153	2.845	0.005
Group Study	-2.787	1.010	-2.760	0.006
Teacher Demonstration	4.134	1.192	3.470	0.001
Video Tutorial	-3.448	0.988	-3.489	0.001
Self-Directed Learning	0.121	0.832	0.146	0.884
R = 0.316				
R ² = 0.100				
adjusted r ² = 0.0845				
F-ratio = 6.775				
p-value = <.001 (significant)				
Level of significance = 0.05				

The regression output reveals that the one-on-one peer tutorial ($p = 0.005$), group study ($p = 0.006$), teacher demonstration ($p = 0.001$), and video tutorial ($p = 0.001$) are significant predictors of the students' Mathematics performance. The results also indicate that students who experienced the high advantage of one-on-one peer tutorial and teacher demonstration tend to have a better performance in mathematics (the coefficients have positive signs).

According to Moliner and Alegre (2020), one-on-one peer tutoring can improve students' Math self- concept, resulting in enhanced confidence and motivation for the subject. Its interactive nature can create a greater mental comprehension of mathematical principles (Nasir et al., 2023) and promote inclusive education ideals and cooperative learning (Alegre et al., 2019). Tutors explain concepts in simple words, encouraging tutees to actively learn as well as allowing students for more focused education while also catering to their individual needs.

In terms of students who experienced the high advantage of teacher demonstration, Klassen et al. (2020) highlighted the potential for demonstrations to spark curiosity and increase the active participation of the students. Teacher demonstrations can be an effective strategy for enhancing academic achievement (Asmawati & Malkan, 2020). Students can observe and imitate effective techniques, improving their own performance tasks. Thus, teacher demonstrations and discussions are an effective tool to engage students in the learning process (Wang, 2024).

In addition, the students who claimed to experience a lower advantage of group study and video tutorials are those who perform well academically in mathematics (the coefficients have negative signs). Students who are confident in their mathematics ability may feel less reliant on external assistance and prefer the control provided by individual studies. Xu and Luo (2021) theorized that high-achieving mathematics students generally choose independent learning techniques. These students may find that group conversations disrupt their concentration and prefer a more personalized approach to learning subjects. Also, Ambrose et al. (2020) discovered that students who have a thorough comprehension of a subject may be slowed down by others who require additional explanation. This can limit the breadth of exploration for high-achieving math students who absorb concepts quickly.

For those students who claim to experience a lower advantage of video tutorials, unlike teachers or tutors, video tutorials are unable to adapt to their individual needs or respond to particular inquiries in real-time. This can be difficult for students seeking a deeper understanding of a concept. According to the study of Winne and Yoon (2019), students who excel at mathematics may find video tutorials redundant if they already understand the concepts. They might find that video tutorials lack the depth and challenge they want (Vandebrouck et al., 2018). Meanwhile, the extent of the students' self-directed learning is not significantly related to the academic performance of students in Mathematics ($p = 0.884 > \alpha = 0.05$). This result negates the findings of Bashir and Amin (2020) and Cremersac et al. (2020) that students who exhibit self-directed learning behaviors tend to achieve higher scores. While a positive correlation has been established between SDL and the academic performance of students, there is still disagreement about the cause and direction of the relationship.

Mathematics educators should be aware that, while the ideas of students about mathematics can be influential, they are not sufficient to predict mathematical achievement, according to Alotaibi and Alanazi (2021). Equipping students with appropriate concepts of mathematics and self-directed learning skills is key to enhancing their performance in mathematics. Nevertheless, further research is needed to investigate these intricacies and identify the specific aspects of SDL that have the greatest impact on mathematics achievement.

4.0 Conclusion

This work advances the field by providing empirical evidence of the effectiveness of various scaffolding techniques in mathematics education and shedding light on the influence of students' demographic profiles on their perceptions. Collaboration, demonstration, offline and online video tutorials, and independent study can help learners become more involved and motivated in their mathematics studies. Students with lower family monthly income have limited access to educational resources outside of the classroom, so they rely more on teacher demonstrations as a valuable source of learning and value collaborative learning environments such as group studies, which allow them to gain access to a pool of resources, share knowledge, and navigate academic

challenges collectively within the classroom setting. Regardless of age, students hold a highly positive view of scaffolding techniques in the context of learning mathematics. There must be longitudinal studies to assess the long-term effects of scaffolding interventions on academic performance and learning trajectories.

5.0 Contributions of Authors

The authors confirm their equal contribution to every part of this research. All authors reviewed and approved the final version of this paper.

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7.0 Conflict of Interests

All authors declared that they have no conflicts of interest as far as this study is concerned.

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