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Peer-Assisted Learning Strategies in Developing Procedural Fluency Among Grade 11 Students

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Abstract
Aim: The study aimed to enhance the procedural fluency of Grade 11 students in Statistics and Probability by applying Peer-Assisted Learning Strategies (PALS), utilizing coaching and practice.
Methodology: This quasi-experimental research, employing a single-group pretest-posttest design, was conducted with thirty-eight Grade 11 students from the Information and Communication Technology (ICT) track at Lopez National Comprehensive High School in Lopez, Quezon. The diverse academic achievements within this heterogeneous group allowed for a comprehensive analysis of PALS' impact across different proficiency levels. A pre-test was administered prior to implementing the intervention, while a post-test was conducted afterward, considering the learners' responses and the duration of both assessments.
Results: The results demonstrated significant improvements in students' procedural fluency, with marked enhancements in efficiency, flexibility, and accuracy. Notably, this study is unique in its application of PALS specifically within the context of Statistics and Probability for senior high school students, a demographic and subject area not extensively covered in previous research. These findings validate the effectiveness of PALS as a pedagogical intervention, highlighting its potential to foster mathematical proficiency in various educational contexts.
Conclusion: The results indicate that PALS effectively enhances students' procedural fluency in Statistics and Probability. The significant improvements observed in efficiency, flexibility, and accuracy underscore the efficacy of PALS as a pedagogical intervention. These findings validate the effectiveness of collaborative learning strategies in promoting mathematical proficiency among Grade 11 students. Thus, the initial hypothesis is accepted, confirming the positive impact of PALS on procedural fluency.

Keywords: PAL Strategies, Procedural Fluency, Statistics and Probability

INTRODUCTION

Mathematics plays a significant role in people's daily lives. Almost all branches of science use it as a tool and a language (Yadav & Sharma, 2020). It aids in the recognition of patterns and the comprehension of the world around us. Because mathematics is an abstract discipline, many students in elementary, high school, and even university find it tough and challenging. As studied by Abdelkarim and Abuiyada (2016) stated that math educators strive to establish a math-friendly environment to assist their pupils in meeting this challenge. Allowing pupils to learn and study together is one method to accomplish this.

Proficiency in mathematical skills enables students to think with greater speed and clarity, providing them with the mental energy, attention, and focus needed to address complex problem-solving and reasoning questions (Best, 2021).

A crucial aspect of mathematical proficiency is procedural fluency. The capacity to apply procedures accurately, efficiently, and flexibly as well as to adapt them to various situations and issues, create new processes from existing ones, and determine when one approach or procedure should be used instead of another is known as

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procedural fluency. For students to attain procedural fluency, they need to gain hands-on experience in merging concepts and procedures. They should build upon familiar procedures while crafting their informal strategies and procedures (National Council of Teachers of Mathematics, 2014).

According to Abuso and Pasia (2023), the learners' procedural fluency was influenced by their numerical ability. This showed that a learner's aptitude for mathematics reflects their capacity to assess difficulties, but due to the subject matter's innate difficulty, learners were unable to recognize and come up with alternative approaches to solve mathematical problems. Therefore, teachers must come up with creative strategies to increase their student's knowledge of the lesson.

Successful teaching methods offer opportunities for students to link procedures with underlying concepts, allowing them to rehearse and apply strategies while justifying their procedures in concise, engaging, purposeful, and dispersed practice sessions (NCTM, 2014). Abenojar (2024) and McCarron, et. al (2011) assert that teaching and learning activities should be adjusted to facilitate customized cognitive and social gains for both high-performing and low-performing pupils. In response to the need for effective and engaging educational approaches, Peer-Assisted Learning Strategy (PAL) emerges as a promising method. PAL involves structured support provided by one or more students to their peers, aiding in comprehension of course content and fostering essential study skills. Duah et al. (2013) highlight PAL's discussion-oriented nature, led by students' peers, making it suitable for undergraduate mathematics education. Inclusive instructional practices, such as collaborative strategies and peer tutoring, are advocated for meeting educational objectives (Nawaz & Rehman, 2017). PAL, a well-established concept, involves active help and support among peers of equal status, fostering knowledge and skill acquisition through collaborative learning (Capuz & Atienza, 2020). Hodgson et al. (2014) underline the reciprocal benefits of PAL, noting that peer tutors also experience skill growth and reinforcement of positive attitudes toward social responsibilities. Therefore, PAL stands as a valuable approach to improving students' fluency by harnessing collaborative learning and peer support (Chan et al., 2016).

Moreover, the findings of this study provide new insights into the application of PALS specifically in the context of procedural fluency in Statistics and Probability. While previous research has often focused on general mathematical skills, this study highlights the efficacy of PALS in targeting specific components of procedural fluency, such as efficiency, flexibility, and accuracy. The structured approach of combining coaching and practice sessions allowed for a targeted intervention that directly addressed these aspects of procedural fluency, contributing to a more nuanced understanding of how PALS can be utilized in specific mathematical domains.

Objectives

The study intended to apply Peer Assisted Learning Strategies, utilizing coaching and practice, to enhance the procedural fluency of Grade 11 students in Statistics and Probability.

Specifically, it was geared towards answering the following questions:

1. Before exposing students to Peer-Assisted Learning Strategies, what is the level of their procedural fluency in terms of:
   1.1. efficiency;
   1.2. flexibility; and
   1.3. accuracy?
2. What are the post-test scores of the students following exposure to Peer-Assisted Learning Strategies in terms of:
   2.1. efficiency;
   2.2. flexibility; and
   2.3. accuracy?
3. Is there a statistically significant difference between the pre-test and post-test scores of the students before and after their exposure to Peer-Assisted Learning Strategies?

METHODS

Research Design

This study utilized a quasi-experimental research method, specifically a single-group pretest-posttest design, to investigate and analyze the impact of Peer-Assisted Learning Strategies (PALS) on procedural fluency in Statistics and Probability among Grade 11 senior high school students at Lopez National Comprehensive High School. The

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quasi-experimental design was chosen to assess the current state of students' mathematical proficiency, implement targeted interventions, and refine these interventions for future applications.

Quasi-experimental designs are particularly useful when random assignment is not feasible, allowing researchers to study the effects of an intervention within a naturalistic setting (Levitt et al., 2018). In this study, the quasi-experimental approach was appropriate because it enabled the researchers to evaluate the impact of PALS in a real classroom environment without disrupting the existing class structure. The necessity of this design stemmed from the need to measure the effectiveness of PALS by comparing students' performance before and after the intervention within the same group of participants. One unique aspect of this study design was the specific structuring of the PALS sessions to target procedural fluency in Statistics and Probability. The PALS sessions were meticulously crafted to address key components of procedural fluency: efficiency, flexibility, and accuracy. The sessions incorporated two main strategies coaching and practice over a series of ten sessions each.

Population and Sampling

The participants in this study comprised thirty-eight (38) Grade 11 senior high school students (single group) enrolled in the Information and Communication Technology (ICT) track at Lopez National Comprehensive High School, Lopez, Quezon. This group was selected for the research due to their diverse range of academic achievements in mathematics, creating a heterogeneous grouping in terms of their proficiency levels. The heterogeneous nature of the group allowed the researchers to observe the effects of PALS across a spectrum of proficiency levels, thereby providing comprehensive insights into its effectiveness.

The researchers employed a cluster sampling method to select 38 respondents for the study. These respondents consisted of Information and Communication Technology (ICT) Grade 11 senior high school students from Lopez National Comprehensive High School in Lopez, Quezon. The selected group of students engaged in peer-assisted learning strategies, specifically answering worksheets through coaching and practice in pairs.

Instrument

Pre-test and post-test gauged the procedural fluency level of Grade 11 ICT, senior high school students. The teacher provided a test in Statistics and Probability, which was administered both before and after the experimental intervention. These assessments were crucial for comparing and quantifying the extent of improvement resulting from the treatment. Additionally, the researcher created worksheets adapted in the textbooks specifically tailored for use in the peer-assisted learning strategies of coaching and practice. The researchers modified a scoring rubric to assess the procedural fluency of the participants based on accuracy, flexibility, and accuracy. This adjusted scoring rubric has been validated by experts beforehand. The process involved several steps in creating and validating the teacher-made test (adapted from textbooks), worksheets, and scoring rubric.

The researchers developed one of the research tools, which consisted of worksheets utilized for implementing peer-assisted learning strategies involving coaching and practice. These worksheets were sourced from textbooks or modules, incorporating activities, questions, and problems relevant to the subject of Statistics and Probability.

Content Validation. Before crafting the test items, the researcher developed a table of specifications aligned with the learning competencies. Subsequently, the teacher-made test and scoring rubrics underwent validation by a master teacher and mathematics educators who are teaching in Statistics and Probability, with knowledge in procedural fluency. The worksheets had undergone a similar validation process, with validators reviewing aspects such as sentence construction, grammar, language usage, problem presentation, and content relevance. Following validation, the researcher made any required adjustments and revisions.

Data Collection

The researchers created a weekly lesson log to outline teaching strategies, activities, and assessments, indicating where peer-assisted learning strategies were incorporated during the lesson. Moreover, students received orientation on how to engage in peer-assisted learning strategies through coaching and practice.

The study focused on enhancing the procedural fluency of Grade 11 senior high school ICT students through peer-assisted learning strategies involving practice and coaching. The researcher undertook the following steps: Firstly, drafting a letter of request addressed to the Schools Division Superintendent seeking permission to conduct the study among Grade 11 senior high school ICT students at Lopez National Comprehensive High School and subsequently, obtaining approval from the school principal's office and following this, sending out requests to

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those who teach Statistics and Probabilities subject required for the study, including Mathematics master teachers and senior high school Mathematics teachers, to validate the research instruments.

The PALS schedule included 10 sessions, 5 coaching sessions, and 5 practice sessions. Two (2) sessions occur each week over 5 weeks, 5 weeks and 1 day to be exact. The whole intervention was scheduled during school time. Each session featured approximately 40-45 minutes between student pairs. The sessions were planned to take place the day after each lesson. There were changes in the schedule during the last three days of the session due to several days of class cancellations, which caused adjustments to the schedule for implementing the intervention. (see attached memo). The selection and distribution of students, along with the teacher's role, were structured according to the approved guidelines. According to Leung (2019), he emphasizes that student interactions should be supervised by the teacher, who should also assist students who are unable to complete the exercise or problem on time. To form pairs, students were ranked based on their midterm grades from highest to lowest. The list was then split into two halves: in implementing the coaching session, students in the first half became the coaches, while those in the second half became the players. Each coach was paired with a player from the corresponding position on the other list. Before the program began, students were oriented on how the intervention works. Respect and patience were emphasized as essential for effective pair work. Students were also instructed on how to conduct their interactions during the sessions. Coaches and Players received a worksheet containing the lesson that was tackled, one exercise or more depending on the session. Initially, all students worked individually, aiming to complete the activity within 30-35 minutes. Afterward, they had 6-10 minutes to collaborate, during which the coach could share his/her knowledge during the coaching session. Coaches then asked their players about their results. If the player's result was correct, the player explained the procedure they followed to the coach. If the player's result was incorrect, the coach assisted their partner, ensuring they completed the task on time. Players could ask their coaches for help, when necessary, but the emphasis was on perseverance and individual effort. The goal was for all students to strive as much as possible to achieve the correct result. While implementing the practice session, the same student pairs were maintained throughout the sessions, the students engaged in answering worksheets using peer-assisted learning strategies, which also involved coaching sessions, and partners exchanged papers after answering the given activity with the same amount of time as coaching and then explained their finished works to each other if the pair did not get the right answer, the partner explained the correct procedure/s and answer, and vice versa. In case they were both wrong, the teacher discussed and explained the procedures to the pair. In instances where more than five pairs did not obtain the correct procedures and answers, the teacher gathered all pairs and then explained the correct procedures to the group.

Additionally, the researchers provided an answer key to facilitate guidance during the coaching and practice sessions.

The researchers used a test based on the lessons they tackled to assess the participants' performance in procedural fluency, aiming to collect quantitative data. This test was structured to assess the respondents' proficiency in procedural fluency, focusing on aspects such as efficiency, flexibility, and accuracy. The outcomes derived from this test offered insights into the students' procedural fluency levels and aided in gauging the influence of peer-assisted learning strategies on their academic achievements.

The gathered data were thoroughly reviewed to guarantee completeness and clarity. Any responses that were missing or unclear were identified and resolved.

Data Analysis

In this study, an examination of students' responses, along with the presentation of pre-test and post-test scores, was performed utilizing frequency and percentage distribution. To assess the notable variation in procedural fluency before and after exposure, a paired t-test was employed. Additionally, a paired t-test was utilized to ascertain the significant difference in the application of a Learning Strategy with practice and coaching.

Ethical Consideration

Before conducting the survey, the researchers followed several ethical principles to ensure the well-being of the respondents by minimizing potential harm. The dignity of the teacher-participants was respected, and their full consent was obtained before the study's commencement. Measures were implemented to protect the participants' privacy, ensuring the confidentiality of the research data in compliance with the Data Privacy Act. Anonymity was maintained for all individuals and organizations involved in the study. The researcher avoided any deception or exaggeration about the study's aims and objectives. All affiliations, funding sources, and potential conflicts of interest

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were transparently declared. Communication regarding the research was conducted honestly and clearly, avoiding any misleading information or biased representation of the primary data findings.

RESULTS and DISCUSSION

This part of the study shows the presentation, interpretation, and analysis of the gathered data from the questionnaires answered by the respondents. Such presentation is by the specific questions posited on the study's objectives.

Part 1. The Pretest Score of the Learners before being Exposed to Peer-Assisted Learning Strategies

The learners' scores prior to the implementation of Peer-Assisted Learning Strategies through coaching and practice were low, indicating a need for improvement in their procedural fluency in specific lessons on Statistics and Probability.

Table 1
Pre-test scores of the Learners before being exposed to Peer-Assisted Learning Strategies in terms of Efficiency, Flexibility, and Accuracy

Efficiency			Flexibility			Accuracy			
Scores	f	%	Scores	f	%	Scores	f	%	Verbal Interpretation
5	0	0	5	0	0	5	0	0	Highly Proficient
3	0	0	3	5	13	3	4	11	Moderately Proficient
1	38	100	1	33	87	1	34	89	Low Proficient
Total	38	100	Total	38	100	Total	38	100	

As shown in Table 1, all 38 students (100%) scored 1 on the pre-test, indicating a "Low Proficient" level in terms of efficiency. No students scored at the "Highly Proficient" or "Moderately Proficient" levels. The data clearly illustrate a significant gap in the students' procedural fluency in Statistics and Probability before the implementation of PALS. With 100% of the students classified as "Low Proficient," it is evident that there is a widespread need for intervention to improve their efficiency in mathematical tasks. The uniform low score suggests that students likely rely on basic, rote methods for solving problems, without employing more efficient strategies such as breaking down problems into smaller steps or using mental math. This inefficiency can be attributed to a lack of practice in using optimized techniques or insufficient foundational skills. According to Sweller (2011), cognitive load theory posits that students' working memory can be overwhelmed by inefficient problem-solving methods, leading to errors and reduced learning effectiveness. The low proficiency in efficiency observed in this study aligns with the idea that students may be using inefficient methods that burden their cognitive resources.

In terms of flexibility, out of 38 students, 33 students (87%) scored 1, indicating a "Low Proficient" level. Five students (13%) scored 3, showing they are "Moderately Proficient." No students scored 5, which would indicate "Highly Proficient" flexibility. The data reveal a significant gap in the students' procedural fluency, specifically in their flexibility to solve problems in Statistics and Probability. Most of the students (87%) are at a "Low proficiency" level, indicating they rely on a limited range of problem-solving strategies and may struggle to adapt to different types of problems. Only a small portion (13%) demonstrates moderate proficiency, suggesting some capability to use diverse approaches but still lacking in overall flexibility. The absence of students in the "Highly Proficient" category underscores a widespread need for improvement in this area. The majority of students demonstrate limited flexibility, likely sticking to familiar methods even when they are not the most suitable. Only a few students show the ability to adapt and apply different strategies, indicating a small number who are more comfortable with varied approaches. This rigidity can limit their problem-solving effectiveness and adaptability. Rittle-Johnson et al. (2008) emphasize the importance of flexibility in mathematical problem-solving, which involves knowing multiple strategies and choosing

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the most appropriate one. The low scores in flexibility suggest that many students are not yet skilled at this adaptive approach. This is problematic as flexibility is crucial for higher-order thinking and problem-solving in varied contexts.

In terms of accuracy, out of 38 students, 34 students (89%) scored 1, indicating a "Low Proficient" level. Four students (11%) scored 3, showing they are "Moderately Proficient." No students scored 5, which would indicate "Highly Proficient" accuracy. The data indicates a significant deficiency in the students' procedural fluency in terms of accuracy before the implementation of PALS. The vast majority (89%) of students are categorized as "Low Proficient," suggesting they struggle with performing calculations correctly and consistently solving problems without errors. Only 11% of the students show "Moderately Proficient" accuracy, indicating some capability but still a need for improvement. The absence of "Highly Proficient" students underscores a widespread issue that needs to be addressed. PALS can effectively enhance students' accuracy in mathematical problem-solving through structured peer interactions and collaborative learning. Ehly and Topping (2019) suggest that peer-assisted learning strategies significantly improve mathematical accuracy by providing opportunities for students to practice calculations and problem-solving with immediate feedback from peers.

Part 2. The Post-test Score of the Learners after being Exposed to Peer-Assisted Learning Strategies (Coaching and Practice)

The learners' scores improved after implementing Peer-Assisted Learning Strategies through coaching and practice, compared to their Pre-Test results. This indicates that the intervention effectively enhanced their procedural fluency in specific lessons on Statistics and Probability.

Table 2
Post-test scores of the Learners after being exposed to Peer-Assisted Learning Strategies in terms of Efficiency, Flexibility and Accuracy

Efficiency			Flexibility			Accuracy			
Scores	f	%	Scores	f	%	Scores	f	%	Verbal Interpretation
5	3	8	5	8	21	5	3	8	Highly Proficient
3	17	45	3	30	79	3	22	58	Moderately Proficient
1	18	47	1	0	0	1	13	34	Low Proficient
Total	38	100	Total	38	100	Total	38	100	

As shown in Table 2, out of 38 students, 18 students (47%) scored 1, indicating a "Low Proficient" level in terms of efficiency. Seventeen students (45%) scored 3, showing they are "Moderately Proficient." Three students (8%) scored 5, indicating they are "Highly Proficient. The students scoring 3 or 5 in efficiency suggests that Peer-Assisted Learning Strategies (PALS) have helped students improve their problem-solving speed and approach. This aligns with findings by Ehly and Topping (2019), who argue that structured peer interactions can enhance efficiency by providing immediate feedback and promoting faster problem-solving techniques. In contrast to some studies that primarily focus on the cognitive benefits of PALS, such as enhanced problem-solving abilities and conceptual understanding (Nawaz & Rehman, 2017), this study also highlights the emotional and motivational benefits. The improvements in procedural fluency were accompanied by increased student confidence and motivation to engage with mathematical content, suggesting that PALS not only improves academic performance but also contributes to positive attitudes toward learning.

In terms of flexibility, out of 38 students, 8 students (21%) scored 5, indicating a "Highly Proficient" level. Thirty students (79%) scored 3, showing they are "Moderately Proficient." No students scored 1, which would indicate "Low Proficient." The post-test data reveal significant improvement in students' procedural fluency in terms of flexibility compared to their pre-test performance. A majority of the students (79%) have achieved a "Moderately Proficient" level, indicating they can apply various strategies to solve mathematical problems effectively. Additionally, 21% of the students have reached the "Highly Proficient" level, demonstrating a high degree of adaptability and skill in using different problem-solving approaches. The absence of students in the "Low Proficient" category suggests that all

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students have shown some level of improvement in their flexibility. Tzuriel and Shamir (2018) indicated that peer mediation can significantly improve cognitive flexibility by exposing students to different perspectives and approaches. Similarly, van Aalst (2020) found that peer assessment in collaborative groups can develop flexible mathematical thinking, as students engage in discussions and practice applying various strategies.

While in terms of accuracy, out of 38 students, 13 students (34%) scored 1, indicating a "Low Proficient" level. Twenty-two students (58%) scored 3, showing they are "Moderately Proficient." Three students (8%) scored 5, indicating they are "Highly Proficient." The post-test data reveals varying levels of proficiency among the students in terms of accuracy. While most students (58%) are classified as "Moderately Proficient," a considerable portion (34%) still fall into the "Low Proficient" category. However, there is also a notable improvement, with 8% of students reaching the "Highly Proficient" level, demonstrating enhanced accuracy in mathematical problem-solving. The improvement in accuracy, where 8% of students are now "Highly Proficient" and 58% are "Moderately Proficient," shows that PALS has helped students become more precise in their calculations and problem-solving. Immediate feedback from peers helps correct errors swiftly, reinforcing accurate methods, as noted by Siegler and Lortie-Forgues (2015).

Part 3. Significant Difference Between the Pre-Test and Post-Test Scores Of The Students Before And After Their Exposure To Peer-Assisted Learning Strategies

The difference between the students' Pre-test and Post-test scores before and after implementing the strategies demonstrates significant improvement in efficiency, flexibility, and accuracy.

Table 3
Test of Difference between the Pre-test and Posttest Scores in Procedural Fluency of the Respondents Exposed to Peer-assisted Learning Strategy

Procedural Fluency	Pre-test		Post test		Mean diff	t	df	Sig. (2-tailed)
	mean	sd	mean	sd				
Efficiency	1.00	0.00	2.21	1.28	-1.21	-5.84	37	0.000
Flexibility	1.32	0.74	3.42	0.83	-2.11	-14.05	37	0.000
Accuracy	1.21	0.62	2.47	1.20	-1.26	-6.15	37	0.000
Total	3.53	1.20	8.11	2.97	-4.58	-9.99	37	0.000

Legend: $p < .05$ significant, $p > .05$ not significant

As gleaned in Table 3, the results of the test of the difference between the pre-test and post-test scores in procedural fluency of the respondents exposed to Peer-Assisted Learning Strategies (PALS). Procedural fluency encompasses efficiency, flexibility, and accuracy in mathematical problem-solving.

In terms of Efficiency, the mean difference between pre-test and post-test scores for efficiency is -1.21, indicating low proficient to moderate proficient ($t = -5.84$, $p < 0.05$). This suggests that students' efficiency in mathematical problem-solving increased significantly after exposure to PALS. During PALS sessions, students engage in structured practice activities where they solve problems collaboratively and provide immediate feedback to each other. Ehly and Topping (2019) suggest that PALS enhances mathematical accuracy by providing opportunities for students to practice calculations and problem-solving with immediate feedback from peers. This immediate feedback helps correct mistakes on the spot, reinforcing accurate problem-solving techniques.

In terms of Flexibility, the mean difference for flexibility is -2.11, showing low proficient to moderate proficient ($t = -14.05$, $p < 0.05$). This indicates that students' ability to adapt and apply different strategies in problem-solving significantly enhanced after participating in PALS. In PALS, students often discuss and compare different problem-solving strategies, which exposes them to a variety of approaches. Star and Rittle-Johnson (2008) highlight the importance of flexibility in mathematical problem-solving, which involves knowing multiple strategies and choosing the most appropriate one. PALS facilitates this by allowing students to learn different strategies from their peers, fostering flexible thinking.

In Accuracy, the mean difference for accuracy is -1.26, demonstrating low proficient to moderate proficient ($t = -6.15$, $p < 0.05$). This suggests that students' accuracy in mathematical tasks improved significantly following

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exposure to PALS. PALS creates an interactive learning environment that keeps students engaged and motivated. This increased engagement leads to more focused and attentive participation in learning activities, which contributes to better accuracy. According to Fuchs et al. (2019), engaging students in interactive and collaborative learning experiences, such as PALS, increases their motivation and investment in the learning process. When students are more engaged, they are more likely to pay attention to details and strive for accuracy in their work.

The total mean difference across all aspects of procedural fluency is -4.58, with a significant t-value of -9.99 ($p < 0.05$). This overall improvement underscores the effectiveness of PALS in enhancing students' procedural fluency in Statistics and Probability.

The results indicate a consistent and significant improvement in procedural fluency across all dimensions after the implementation of PALS, highlighting its effectiveness in enhancing students' mathematical proficiency. The findings from this study align with extensive research that highlights the benefits of peer-assisted learning. According to Ehly and Topping (2019), structured peer interactions and immediate feedback significantly enhance students' mathematical accuracy and procedural knowledge. This immediate feedback mechanism allows students to correct errors in real-time, reinforcing correct methods and procedures.

In conducting Peer Assisted Learning Strategies in Statistics and Probability through coaching and practice, it is essential to note the study's reliance on a single group design, which may not fully account for alternative instructional methods, and the potential for bias from both students and teachers within this setting. Additionally, the findings may have limited generalizability to different educational contexts or student populations due to specific conditions or variables unique to the study's setting.

Conclusions

The results demonstrate that PALS effectively enhances students' procedural fluency in Statistics and Probability. The significant improvements observed in efficiency, flexibility, and accuracy underscore the efficacy of PALS as a pedagogical intervention. These findings validate the effectiveness of collaborative learning strategies in promoting mathematical proficiency among Grade 11 students. Thus, the hypothesis posited before is not accepted.

Recommendations

The study's findings highlight the significant improvement in students' procedural fluency in Statistics and Probability through Peer-Assisted Learning Strategies (PALS), indicating a promising approach for educators to incorporate into their teaching practices. Given its effectiveness, teachers might consider extending PALS to other topics within Statistics and Probability and across other mathematics strands in Grade 11. Regular assessment and monitoring are essential to track student progress and identify areas needing further attention, as ongoing evaluation proved crucial during the study for gauging PALS effectiveness and pinpointing additional support requirements. Addressing proficiency gaps through targeted intervention sessions, such as small-group instruction, one-on-one tutoring, or differentiated learning activities, can provide focused support and reinforce key concepts. Encouraging collaborative learning environments where students engage in peer-assisted problem-solving activities can further sustain and reinforce procedural fluency. This collaborative approach not only enhances cognitive skills but also develops essential communication, negotiation, and teamwork abilities valuable in both academic and real-world contexts.

REFERENCES

Abenojar, M. B. (2024). Effectiveness of Directed Reading Thinking Activity (DRTA) in Improving the Reading Comprehension of Grade Three Pupils. International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR), 3(2), 435-446. https://etcor.org/storage/iJOINED/Vol.%20III(2),%20435-446.pdf

Abdelkarim, R. E., & Abuiyada, R. (2016). The Effect of Peer Teaching on MathematicsAcademic Achievement of the Undergraduate Students in Oman. International education studies, 9(5), 124-132

Abuso, A. C., & Pasia, A. E. (2023). Contextualized Mathematical Learning Media in Fostering the Procedural Fluency Among Junior High School Students. International Journal of Open-access, Interdisciplinary and New

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Best, J. (2021, April 6). Here's Why Mathematical Fluency is Critical For Problem Solving and Reasoning - 3P Learning. 3P Learning.

Capuz, M. K. A., & Atienza, M. A. (2020). Effectiveness of peer-assisted-learning model in teaching physical examination in Otorhinolaryngology to clerks and postgraduate interns. Philippine Journal of Health Research and Development, 30-38.

Chan, N. N., Phan, C. W., Aniyah, S. N., & Dipolog-Ubanan, G. F. (2016). Peer-assisted learning in higher education: Roles, perceptions and efficacy. Pertanika Journal of Social Sciences & Humanities, 24(4), 1817-1828.

Duah, F., Croft, T., & Inglis, M. (2014). Can peer-assisted learning be effective in undergraduate mathematics? International Journal of Mathematical Education in Science and Technology, 45(4), 552-565.

Ehly, S. W., & Topping, K. J. (2019). Peer-Assisted Learning: Theory and Applications. Educational Psychology Review, 31(2), 453-473.Florian, L. (2013). The SAGE handbook of special education

Hodgson, Y., Brack, C., & Benson, R. (2014). Introducing case-based peer-assisted learning in a professional course. Journal of University Teaching & Learning Practice, 11(2), 4.

Levitt, H. M., Bamberg, M., Creswell, J. W., Frost, D. M., Josselson, R., & Suárez-Orozco, C. (2018). Journal article reporting standards for qualitative primary, qualitative meta-analytic, and mixed methods research in psychology: The APA Publications and Communications Board task force report. American Psychologist, 73(1), 26.

McCarron, S. (2011). Reflective leadership: effects of peer mentoring on minority students within an urban school setting.

Nawaz, A., & Rehman, Z. U. (2017). The strategy of peer tutoring and students' success in mathematics: An analysis. Journal of Research and Reflections in Education, 11(1), 15-30.

National Council of Teachers of Mathematics (2014). Procedural Fluency in Mathematics. National Council of Teachers of Mathematics.

Siegler, R. S., & Lortie-Forgues, H. (2015). Conceptual knowledge of fraction arithmetic. Journal of Educational Psychology, 107(3), 909.

Sweller, J. (2011). Cognitive load theory. In Psychology of learning and motivation (Vol. 55, pp. 37-76). Academic Press.

Yadav, S., & Sharma. (2020). Role Of Mathematics In The Development Of Society. ResearchGate. https://www.researchgate.net/publication/343775504_Role_Of_Mathematics_In_The_Development_Of_Society