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Think-pair-share plus (TPS+): activities on unit conversion and finding the volume of solids for grade 7 learners

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Abstract. The primary objective of this action research was to assess the efficacy of the Think-Pair-Share Plus (TPS+) strategy in enhancing Grade 7 mathematics engagement and achievement, particularly regarding unit conversion and volume calculations. Utilizing a one-group pretest-posttest design, the study involved 20 learners from Sapa Anding Agricultural Vocational Technical School. Quantitative analysis demonstrated a substantial and statistically significant increase in both academic performance and learner engagement levels following the intervention. Thematic analysis of student feedback highlighted that while the collaborative framework fostered conceptual clarity and enjoyment, some participants experienced difficulty with verbal articulation during the sharing phase. These findings suggest that integrating structured peer feedback into cooperative learning significantly bolsters mathematical competence. Ultimately, the study advocates for the broader implementation of TPS+, accompanied by targeted scaffolding, to effectively bridge gaps in student communication and conceptual mastery.

INTRODUCTION

In the Philippine curriculum, Grade 7 mathematics is a crucial pivot point, introducing learners to essential concepts such as unit conversion and the volume of solids. Proficiency in these areas is vital not only for advanced mathematical pursuits but also for practical applications in engineering and the sciences. Despite this importance, students frequently struggle to conceptualize these abstract topics, often leading to diminished motivation and suboptimal performance, a trend reflected in international benchmarks like the Programme for International Student Assessment (PISA), where Filipino learners consistently rank below the OECD average in mathematical literacy (DepEd, 2023; OECD, 2023). Traditional, teacher-centered pedagogies—often characterized by rote memorization and passive listening—frequently fail to elicit the requisite cognitive engagement in these subjects, resulting in pervasive academic underachievement (Talidong & Toquero, 2020).

To mitigate these issues, educators must adopt instructional frameworks that promote active learning and systematic reasoning. Extensive literature supports the use of cooperative learning models, such as Think-Pair-Share (TPS), for their ability to enhance student engagement through peer discourse (Lyman, 1981; Trisnadewi et al., 2025). However, a specific iteration of this model—Think-Pair-Share Plus (TPS+), which integrates structured peer feedback—remains underutilized in specific contexts. While TPS is widely researched, there is a notable scarcity of empirical studies on the efficacy of TPS+ tailored to Grade 7 geometry and measurement. This study aims to bridge that gap by evaluating the impact of TPS+ on learner engagement and academic achievement in unit conversion and volume of solids. By addressing these specific pedagogical challenges, this research provides a necessary foundation for the subsequent theoretical analysis of social interaction in learning.

THEORETICAL REVIEW

This study posits that implementing TPS+ will significantly influence learner outcomes. Specifically, it tests the null hypothesis that there is no significant difference in learners' engagement and academic achievement before and after the intervention. The theoretical framework is grounded in Constructivist Learning Theory and Engagement Theory, which collectively suggest that social interaction and active involvement are prerequisites for deep mathematical understanding (Vygotsky, 1980; Fredricks et al., 2004).

Constructivist Learning Theory

Constructivist Learning Theory posits that learners construct knowledge through social interaction and shared experience (Vygotsky, 1980; Bruner, 1961). In the context of this study, this theory supports the use of collaborative strategies like TPS+. When students discuss unit conversions and volume calculations in pairs, they clarify their thought processes and validate their understanding against their peers' perspectives. This social validation allows students to reconstruct their understanding of complex geometric formulas and conversion factors, leading to deeper comprehension than individual study alone (Slavin, 2014; Cobb, 1994).

Engagement Theory

The study also draws upon Engagement Theory, which emphasizes active participation as a driver for academic success. According to this theory, students who are actively engaged in collaborative environments—sharing ideas and receiving immediate feedback—are more likely to achieve higher academic outcomes (Kearsley & Shneiderman, 1998). Engagement encompasses behavioral, emotional, and cognitive dimensions, all of which are critical for mastering tedious or abstract mathematical tasks (Fredricks, Blumenfeld, & Paris, 2004). The TPS+ framework activates these dimensions by structuring opportunities for interaction, thereby encouraging students to invest more time and effort in their learning (Trowler, 2010).

Think-Pair-Share Plus (TPS+) Strategy

The conceptual model of this study follows an Input-Process-Output (IPO) framework, in which TPS+ serves as the primary intervention process. Unlike standard TPS (Lyman, 1981), the "Plus" component integrates structured peer feedback, requiring students to evaluate their peers' work critically for clarity and accuracy. This added layer of scrutiny aims to refine students' metacognitive skills, helping them identify errors in real-time and fostering a sense of competence and autonomy in solving mathematical problems.

METHODS

Research Design

To evaluate the intervention's efficacy, the study employed a pre-experimental one-group pretest-posttest design (Campbell & Stanley, 1963; Creswell & Creswell, 2018). This design was selected to quantify changes in student engagement and academic achievement within the target group following implementation of the TPS+ pedagogical model. Although this structure facilitates a direct comparison of baseline and post-intervention data, it is crucial to recognize the potential internal validity challenges inherent in designs lacking a control group—namely, history, maturation, and testing biases (Shadish et al., 2002). To counteract these confounding variables, the study adhered to a condensed implementation timeline of three weeks, thereby reducing the likelihood that significant external factors would skew the results (Cohen et al., 2018).

Participants

The study cohort comprised 20 Grade 7 learners from Sapa Anding Agricultural Vocational Technical School in the District of Ramon Magsaysay, Zamboanga del Sur, Philippines. Participants were chosen through purposive sampling based on specific inclusion criteria: (1) official enrollment in the Grade 7 mathematics curriculum, and (2) identified difficulties in foundational measurement concepts as evidenced by formative assessment records. This selection process ensured that the intervention targeted learners who stood to benefit most from the remedial nature of the collaborative strategy.

Instruments

Data gathering relied on three validated tools: the Mathematics Achievement Test, A 30-item researcher-developed assessment targeting competencies in unit conversion and solid mensuration. The tool underwent content validation by subject matter experts and pilot testing to establish internal consistency. Engagement Survey: An engagement scale adapted from Fredricks et al. (2004) was used to assess the behavioral, emotional, and cognitive dimensions of student participation. Feedback Questionnaire: A qualitative instrument designed to harvest open-ended learner reflections regarding their experience with the TPS+ framework.

Procedure and Intervention (TPS+ Implementation)

The study was executed in three distinct phases: baseline assessment, intervention, and summative evaluation. The TPS+ intervention spanned three weeks and focused on converting metric units and calculating the volumes of prisms and pyramids. The strategy followed a structured four-step cycle:

1. Think: Students were given 3–5 minutes to solve a problem individually (e.g., "Convert 5.6 kilometers to meters") to foster independent processing.
2. Pair: Learners formed dyads to discuss their initial answers and reasoning.
3. Plus (Peer Feedback): This critical phase distinguished the strategy from standard TPS. Partners exchanged papers and used a structured checklist to evaluate the clarity of the solution and the accuracy of the units employed.
4. Share: Selected pairs presented their validated solutions to the class for plenary discussion.

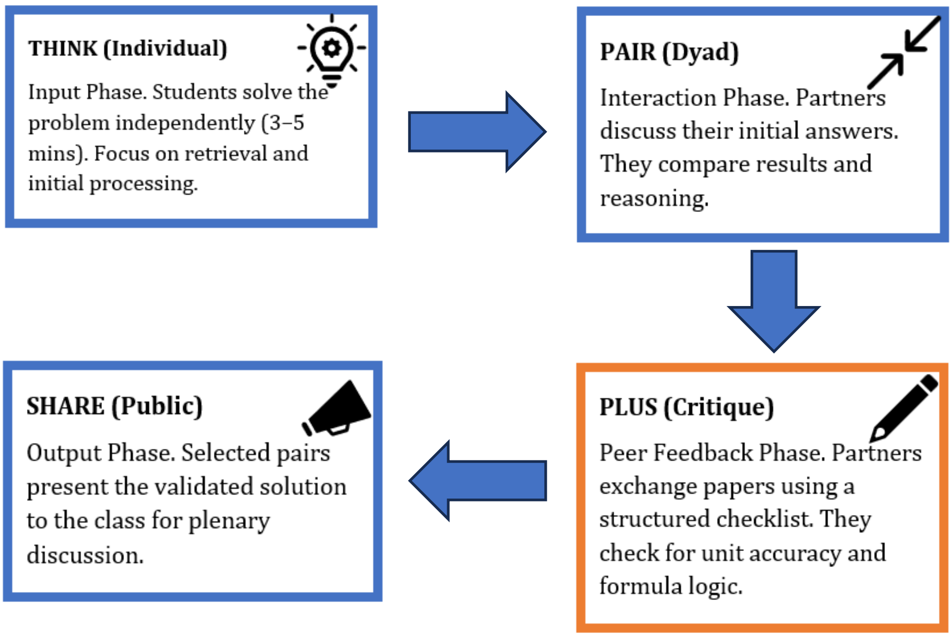

Figure 1. The Procedural Framework of the Think-Pair-Share Plus (TPS+) Strategy

Note. The diagram illustrates the four-step intervention cycle used in the study, highlighting the "Plus" phase, during which structured peer feedback occurs prior to public sharing.

Data Analysis

Quantitative data were analyzed using descriptive statistics (Mean and Standard Deviation) and the Wilcoxon Signed-Rank Test to assess significant differences between pre- and post-test data, given the non-normal distribution of the small sample. Qualitative feedback was subjected to a rigorous thematic analysis using the six-phase framework proposed by Braun and Clarke (2006). This process involved: (1) data familiarization through repeated reading; (2) generating initial codes from student responses; (3) collating codes into potential themes; (4) reviewing themes against the dataset; (5) defining and naming themes (e.g., "Peer Validation," "Public Speaking Anxiety"); and (6) producing the final analysis.

RESULTS AND DISCUSSION

Result

Academic Achievement

The primary objective of the study was to quantify improvements in learners' performance regarding unit conversion and volume calculations. Table 1 details the comparative analysis of pre-test and post-test scores.

Table 1. Comparison of Pre-test and Post-test Achievement Scores

Variable	Pre-test Mean (SD)	Post-test Mean (SD)	Z-value	p-value	Effect Size (r)	Interpretation
Mathematics Achievement	8.45 (2.72)	18.80 (2.80)	-3.924	< .001*	0.62	Large Effect

Note. N=20. Maximum score = 30.
**Significant at p < 0.05.*

Quantitative analysis demonstrated a marked enhancement in academic performance. The mean score rose substantially from 8.45 (*SD=2.72*) to 18.80 (*SD=2.80*). The Wilcoxon Signed-Rank Test confirmed this difference is statistically significant ($Z = -3.924, p < .001$). Furthermore, the effect size was calculated as r = 0.62, indicating a large effect size according to Cohen’s criteria. This suggests that although the learners did not fully meet the "Meeting Expectations" threshold (typically 75% mastery), the TPS+ intervention was highly effective in moving them beyond the baseline of zero knowledge.

Learner Engagement

The study also sought to determine the impact of TPS+ on learner engagement. Table 2 illustrates the changes in engagement levels.

Table 2. Comparison of Pre-test and Post-test Learner Engagement Levels

Variable	Pre-test Mdn	Post-test Mdn	Z	p	Effect Size (r)
Engagement	44.50	54.50	-3.925	< .001	0.62

Note. N = 20. Mdn = Median. Statistical significance determined via the Wilcoxon Signed-Rank Test.

As evidenced in Table 2, the median engagement score increased significantly from 44.50 to 54.50. The statistical analysis ($Z = -3.925, p < .001$), combined with a large effect size (r = 0.62), supports the conclusion that the interactive nature of the "Pair" and "Plus" phases effectively stimulated behavioral and cognitive engagement.

Qualitative Findings

Thematic analysis of learner feedback identified two dominant themes in the implementation of TPS+: *Collaborative Visualization* and *Performance Anxiety*. Collaborative Visualization and Enjoyment. A majority of participants reported that the "Pair" and "Plus" phases significantly aided their conceptual grasp of the material. Students noted that discussing problems with a peer helped them "visualize the shape" and understand the derivation of formulas, rather than relying on rote memorization. The interactive nature of the intervention also shifted their perception of the topic, with several learners describing the volume activities as "fun" compared to traditional lectures.

Confidence versus Communication Apprehension. The feedback revealed a dichotomy in student confidence. On one hand, the peer-support mechanism fostered a sense of safety; as one student remarked, "It was less scary to share in front of everyone" after vetting their answer with a partner. Conversely, the "Share" phase introduced a layer of social pressure. A subset of students expressed challenges with oral articulation, noting that they felt "rushed" or nervous when asked to present their solutions to the entire class. This finding underscores the need for additional scaffolding during the public reporting phase of the strategy.

Discussion

The findings strongly support the hypothesis that TPS+ catalyzes both academic gain and increased engagement. The significant improvement in test scores aligns with findings by Vásquez-Colina et al. (2016), who emphasized that peer feedback aids in correcting errors and deepening conceptual understanding. The qualitative data further validates Engagement Theory, as students reported that the social aspect of the "Pair" and "Plus" phases made the learning process more enjoyable and less isolating. However, the reported anxiety during the "Share" phase suggests that while the strategy is effective, additional scaffolding is required to support students in articulating their mathematical reasoning confidently.

Interpretation of Achievement Levels

Despite the statistically significant gains, it is crucial to address why the post-test mean (*18.80*) remained within the "Did Not Meet Expectations" descriptor. This ceiling effect can be attributed to several factors. First, the intervention duration was limited to three weeks; while sufficient to introduce concepts, it may have been insufficient to fully remediate multi-year deficiencies in foundational numeracy, which many Grade 7 learners exhibit. Second, the topics—unit conversion and volume—are inherently abstract. The "Plus" phase helped students verify processes, but deep conceptual mastery likely requires a more extended period of maturation than this study permitted.

Confounding Variables and Limitations

It is also necessary to acknowledge potential confounding variables inherent in the one-group design. The improvement in scores could be partially attributable to the "novelty effect," in which students engage more simply because the teaching method is new, rather than to the method's specific mechanics. Additionally, the classroom environment during the "Share" phase occasionally introduced noise, which qualitative data suggests caused anxiety for introverted learners. Finally, the absence of a control group means that factors such as simultaneous learning in other subjects cannot be entirely ruled out as contributors to the observed growth.

CONCLUSION

The empirical evidence presented herein confirms that the Think-Pair-Share Plus (TPS+) framework is an effective intervention for improving both academic proficiency and learner engagement in Grade 7 mathematics. The integration of structured peer validation—the "Plus" component—successfully transitioned learners from a baseline of minimal understanding to a significantly higher level of conceptual awareness regarding unit conversion and solid geometry. While the strategy aligns effectively with Constructivist principles by leveraging social interaction to correct misconceptions, it is not a standalone panacea. The data indicate that while collaboration reduces isolation, the public "Share" phase can inadvertently trigger communication apprehension for some learners. Therefore, TPS+ should be viewed as a high-potential strategy that requires deliberate pedagogical refinement to maximize its efficacy for all student archetypes.

Recommendations

Based on these findings, the following actionable guidelines are proposed for educators and future researchers:

1. Classroom Implementation and Scaffolding. To mitigate the reported anxiety during the "Share" phase and support articulation, mathematics teachers should implement the following specific scaffolding techniques:

- **Sentence Stems:** Provide learners with cue cards containing sentence starters to structure their verbal reasoning (e.g., *"I determined the volume by first measuring..."* or *"My partner and I agreed that the conversion factor is..."*).
- **Role Assignment:** Assign specific roles within the pairs, such as "Scribe" and "Presenter," which rotate weekly. This reduces cognitive load by allowing students to focus on one aspect of the task at a time.
- **Graphic Organizers:** Utilize structured worksheets during the "Plus" phase that guide students on exactly what to check in their peers' work (e.g., specific checkboxes for "Correct Unit," "Correct Formula," and "Clear Diagram").

2. Implications for Future Research. To address the limitations of the current one-group design, future scholarship should prioritize:

- **Quasi-Experimental Designs:** Replicating this study with a control group is essential to isolate the specific effects of TPS+ from external factors such as maturation or history effects.
- **Longitudinal Analysis:** Conducting studies over an entire academic quarter or year would help determine if the gains in engagement and achievement are sustained over time or if they diminish once the novelty of the method fades.
- **Component Analysis:** Investigating whether the "Plus" (structured feedback) component significantly outperforms standard Think-Pair-Share would provide deeper insights into the value of peer critique in mathematics education.

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