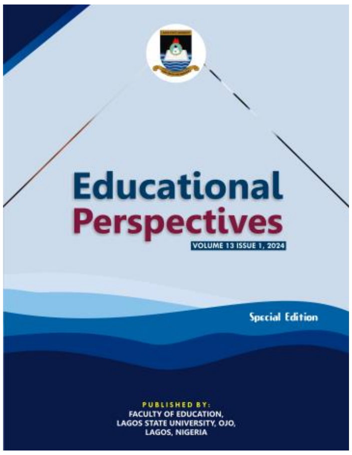

Quality of Teacher-Talk in Team-Pair-Solo and Reciprocal Strategies in Mathematics Classrooms

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KEYWORDS:

Quality, students' contributions, team-pair-solo teaching strategy (TPSTS), teacher-talk, reciprocal teaching strategy (RTS), performance, Mathematics educators.

WORD COUNT:
219

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ABSTRACT

A teacher may have good knowledge of Mathematics but may not be impactful to students. Many authors have associated this with different factors around pedagogy. However, one area of pedagogy that has not been given the deserved attention is the quality of teacher-talk in the classroom. This study as part of larger one, adopted qualitative (case study) research design to explore three teaching strategies on circle geometry and quality of teacher-talk via the use of transcribed videotaped lessons. The study sample comprised 187 Senior Secondary School II students (G-11) and three mathematics teachers from three purposively sampled schools in Lagos State. Descriptive statistics; frequency counts and percentage, trend and content analysis were used in analysing the data. Data on teacher-talk was collected through video recordings of observed classrooms. Data obtained from these videos were coded and transcribed before being interpreted using Brodie (2004) analytical framework The findings of the study showed differences in the quality of teacher-talk in the treatment and conventional classrooms that are capable to bring out students' active participation and smooth classroom interaction. It is concluded that the students' active participation and interaction in mathematics classrooms are prominently dependent on the quality of teacher-talk. It is recommended that the Mathematics educators should acknowledge the importance of teacher-talk which should be taken into cognisance in Mathematics classrooms.

HOW TO CITE

Sojinu O.S, Sanni R, Alabi I.A, Akudo K.O, Orulebaja Y & Olude B. (2025). Quality of Teacher-Talk in Team-Pair-Solo and Reciprocal Strategies in Mathematics Classrooms. *Educational Perspectives, 13*(2), 360-373.

Introduction

As mathematics education becomes more focused on developing deeper conceptual understanding and problem-solving skills, the nature of teacher-student and student-student interactions plays a crucial role in shaping learning outcomes. Effective classroom interaction is influenced not only by the way mathematical content is delivered but also by the strategies used to engage students in meaningful discourse and collaborative learning. Recent educational research has shown that the strategic use of interactive teaching methods can significantly improve student comprehension, engagement, and performance in mathematics (Hattie, 2020). The quality of mathematics classroom interaction has been found to be significantly improved by a number of instructional strategies, such as inquiry-based learning, cooperative learning, and problem-solving approaches. For instance, cooperative learning promotes peer-to-peer interaction, which can assist students in sharing different viewpoints, building knowledge collectively, and helping one another solve mathematical issues (Johnson et al., 2020). Zakaria et al. (2013) asserted that cooperative learning strategies in the classroom allows an increase in the quality of the students' participation in the classroom discussions, add values to the knowledge of the students, and increases their self confidence in answering questions.Students are encouraged to ask questions and investigate mathematical ideas on their own through inquiry-based methodologies, which foster critical thinking and active engagement (Cohen & Larkin, 2020).

These strategies can change the usual teacher-centered discourse in mathematics classes to one that is more interactive, encouraging peer-supported learning and deeper cognitive engagement (Hattie, 2020). However, depending on a number of variables, including the teacher's questioning style, feedback systems, and the language employed to scaffold student learning, the effect of teacher speaking in these strategies can differ. Improving the efficacy of collaborative learning strategies in mathematics education requires an understanding of these processes. Yet, a key component of these strategies' efficacy is the teacher's involvement in facilitating classroom engagement. Teachers are better equipped to create fruitful classroom interactions that encourage mathematical reasoning and understanding when they take on a more facilitative role, leading conversations, giving focused comments, and promoting reflective thinking (Wiliam, 2021). The effectiveness of these strategies, however, depends on the teacher's capacity to modify them in light of the unique requirements of each student and dynamics of the classroom..

Research on how various educational approaches affect the character of teacher-student interactions has grown in recent years, with a focus on collaborative learning models such as Reciprocal Teaching (RT) and Team-Pair-Solo (TPS). (Peter et al., 2016; Irma & Dwi, 2021).It is imperative to investigate the ways in which student involvement, comprehension, and mathematical performance are impacted by the quality of teacher discourse in these strategies. Team-Pair-Solo promotes, support and peer-supported learning by having students work in groups initially, then in pairs, and ultimately on their own (Kagan, 2020). The nature and quality of interactions between the teacher and students can be greatly influenced by this structure, particularly when it comes to giving feedback, elaborating on ideas, and helping students work through problems. Comparably, it has been demonstrated that Reciprocal Teaching Strategy, which consists of a structured dialogue between the teacher and students that emphasizes prediction, questioning, summarizing, and clarification, enhances comprehension and develops critical thinking abilities (Palincsar & Brown, 2020).

Examining teacher conversation quality in relation to Team-Pair-Solo and Reciprocal Teaching techniques in mathematics classroom is the goal of this work. It will examine how these qualities affect the character of interactions between teachers and students as well as how the quality of teacher discourse can either help or hurt students' learning. This study will advance knowledge of the function of teacher-talk in promoting collaborative learning and enhancing mathematics education outcomes by examining current research and theoretical viewpoints. In teaching the subject effectively, one needs to maintain the mandate of assumptions, properties, and applications. The overall performance in mathematics among secondary students has been poor for several years in African country. This has raised concern on quality and knowledge of teachers and their inputs within the teaching and learning methods. (Sanni & Sojinu, 2021). Teacher-talk encompass what teachers say or do in the classroom, particularly as the present contents and as they react to students' contributions during instruction. These talks are important to student's learning achievements in the classroom. It cannot be repudiated that a teacher while teaching delivers some specific communicative acts, such as asking, initiating, probing, directing, responding to questions, explaining, and giving direction or instruction. These activities and the way they are intentioned and implemented facilitate students to perform the same or similar things in communicating with each other accordingly in diverse classroom interactions.

Moreover, an empirical study by Mercer and Dawes (2020) evaluated how teacher-talk could improve classroom discourse in inclusive mathematics environments. Their research indicated that when teachers utilized inclusive language and encouraged all students to contribute their thinking, regardless of their perceived ability, kids demonstrated higher participation and mathematics interest. The study underscored the significance of teachers' verbal exchanges in fostering a secure and welcoming atmosphere for students to learn, indicating that teacher-talk is essential to advancing equality of opportunity in mathematics classes. Recent study by Tseng et al. (2023) examined how teacher speaking might support mathematical conversations in group learning exercises. According to their findings, students were more likely to acquire higher-order thinking abilities and participate in fruitful mathematical conversations when teachers actively mediated discussions, supported student explanations, and asked students to defend their positions. This study supported the notion that teacher-talk involves more than just giving explanations; it also involves facilitating discussions that result in a deeper comprehension of mathematics.

Different researchers have worked on the outcome of classroom conversation as regards students' contributions and understanding of concepts in the Mathematics classroom (Alabi, 2021; Alabi & Sanni, 2021; Brodie, 2008; Işıksal, & Koç, 2015), little has been done on the teacher-talk. Also, there is growing body of research on how teacher-talk influences students' social competencies and scientific achievements (Brock et., 2019; van der Wilt et.al, 2020).

Teacher-Talk in Classroom

Research on teacher-talk in mathematics classes has been important, especially when it comes to how various teaching philosophies affect students' learning and engagement. The verbal exchanges between educators and students are referred to as "teacher-talk," and they are essential for developing critical thinking, problem-solving abilities, and comprehension. A word altered by the teacher in a classroom setting is referred to as teacher-talk. Teacher- talk is a benchmark in terms of its alignment with some authors' pedagogical recommendation and language learning theories. (Edwards-Groves & Davidson, 2017). Student achievement can be significantly impacted by the quality of teacher-talk, particularly when particular pedagogical techniques are used. Team-Pair-Solo (TPS) and Reciprocal Teaching (RT), two cooperative learning techniques that are frequently used to improve student engagement and collaborative learning in math classes, are the subjects of this study.Teacher-talk becomes more dynamic and participatory when constructivist approaches like TPS and RT are used, allowing students to express their ideas, pose questions, and participate in discussions. Peer learning and active student participation are promoted by the TPS approach.

Figure 1: Image of steps in Team Pair Solo (TPS) Strategy

Three stages are involved in the figure 1: students work alone at first, then in pairs to discuss and compare their solutions, and ultimately in teams to work together to tackle increasingly difficult issues. The quality of teacher-talk is essential during these stages for assisting students in moving through each one, giving feedback, and encouraging dialogue. In RT, students participate in controlled group settings as both teachers and learners. With this method, the teacher serves as a facilitator whiIle the students alternately take on the role of the "teacher," asking questions, summarizing, clarifying, and making predictions.

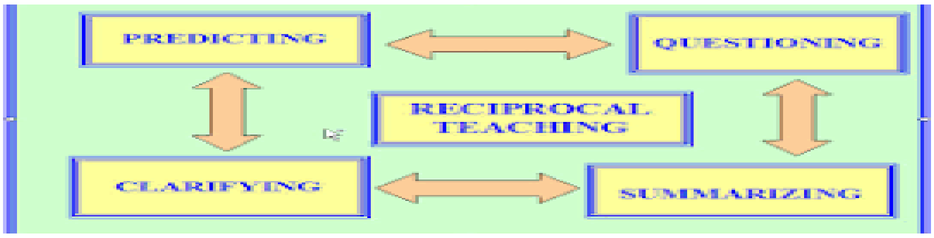


Figure 2: Image of steps in Reciprocal Teaching (RT)

In this situation as shown in figure 2, the focus of teacher-talk changes from traditional instruction to supporting, facilitating, and directing student-driven debates. As the students must explain ideas to their peers, RT fosters deep understanding and active cognitive involvement. As teachers, we should continually ask ourselves how we can use words to pass good information to students, to support their development and learning. Particularly, by positively commenting, encouraging and and probing talks (Gbarbavia & Iravani, 2014). This is because teacher-talk shapes students' attitudes, feelings, and thoughts and it can motivate or hinder interaction among teachers and students. Classroom discourse plays a vital role in fostering student engagement and understanding in mathematics. The diverse processes of classroom talk create unique opportunities for learning mathematics, making discourse a central element of mathematics education research (Erath et al., 2021). A substantial body of research has emerged on mathematics classroom discourse, highlighting its significance in shaping student learning experiences (Erath et al., 2021; Xu & Clarke, 2019). The mathematics classroom is at the heart of mathematics education research, and for many, discourse is the most central element of the mathematics classroom (Erath et al., 2021). Thus, a large body of research on mathematics classroom discourse has emerged over the recent decades (Erath et al., 2021; Xu & Clarke, 2019). Mathematics classroom discourse is, of course, intimately entangled with mathematics itself.

Theoretical frameworks

This study hinged on Social Interdependence Theory (SIT) and Constructivism Theory (CT). The social interdependence theory exists when the accomplishment of each individual's goals is affected by the actions of others (Johnson & Johnson, 1989). The SIT, which was created by Morton Deutsch and others after Kurt Lewin's work, people's outcomes are interconnected in a way that can either encourage competition or cooperation. SIT has been used in the educational setting to examine how student interactions affect learning and performance in the classroom. Recent studies have looked at how teacher-student and teacher-teacher relationships foster social interdependence and impact the learning environment, especially in the teaching of mathematics, even though a large portion of the foundational work has been on student-to-student interactions. (Shin et al. 2020, Planas & Alfonso, 2023)

Teachers can employ language that fosters a welcoming environment where students feel appreciated and included. This is consistent with the SIT, which holds that people perform better when they believe their performance is correlated with that of others (Slavin, 2020). Collaboration and fear reduction can be achieved through teacher-talk that promotes risk-taking and rewards a variety of mathematical approaches. The teacher creates an interdependent learning environment by organizing class activities and utilizing teacher-talk to direct group interactions. This is especially crucial in mathematics, where it has been shown that group problem-solving and peer explanations enhance comprehension and performance (O'Connor & Michaels, 2020; Dweck, 2020). When students work together in team-pair-solo classroom, there is always positive inter-relationship among the students where they share different view.

As a theory of learning, constructivism places more emphasis on students actively creating their own understanding via their experiences than on passively absorbing information. This theory backs up the notion that in order for students to gain a deeper knowledge of mathematical concepts, they need actively engage with them, solve problems, and work with their peers.

Analytical framework

The analytical framework served as a guide for this study's qualitative component. The researchers believe that Brodie (2004) is useful for conducting this investigation out of the several analytical frameworks for teacher-talk interactions that are available in the literature. The evaluation step and the subsequent initiating step regarding how teachers engage with students' ideas in the mathematics classroom are specifically recommended by the framework. In order to account for every move the teacher makes in the mathematics classroom, Brodie concentrated on the fused evaluation or initiation move as a single move that is assigned a turn of the teacher-talk. Brodie (2004) creates a two-level classification system and makes a distinction between how students follow up and when teachers follow up on a student's response. In general, level one is focused on instructor discussion, but level two breaks down one of the level one items; follow-up into a different subcategory. Classifying the quality of teacher-talk in mathematics classrooms is done by the coding system. The following is the level one teacher-talk coding as shown in figure 3:

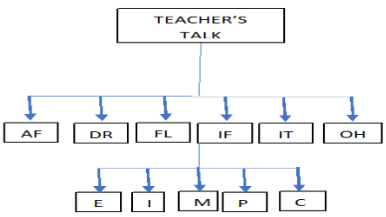


Figure 3: Teacher-talk categorisation framework in the Mathematics classroom

- Affirm (AF): It is the teacher-talk made in the classroom in the form of reacting to the students' contributions as being good or correct.
- Direct (DR): It is the teacher-talk made in the classroom in the form of managing the classroom and asking or calling someone to do something.
- Initiate (IT): It is the teacher-talk made in the classroom when trying to get a mathematical idea from the students' contributions but not directly followed up.
- Inform (IF): It is the teacher-talk made in the classroom to give information or explain an idea to the students.

- Follow-up (FL): It is the teacher-talk made in the classroom to pick up on a contribution made by a student either immediately or later on.
- Other (OH): It refers to the teacher-talk not in the categories afore mentioned.

The second levels which are subcategories of the FOLLOW-UP move are as follows:

- Confirm (C): It is the teacher-talk made in the classroom in the form of following up to check whether the students' contributions are clearly heard.
- Maintain (M): It is the teacher-talk made in the classroom in the form of following up to repeat the idea, ask others for comment or indicate that the students should continue.
- Press (P): It is the teacher-talk made in the classroom in the form of following up to push or probe the students for more on their idea to clarify, justify or explain more clearly.
- Elicit (E): It is the teacher-talk made in the classroom in the form of following up to proceed on a contribution and make the teacher later try to get something from the students.
- Insert (I): It is the teacher-talk made in the classroom in the form of following up to add something in response to students' contributions, elaborate on it, suggest something or make a link

In reviewing this analytical framework, clues on quality of teacher-talk is widely described for all the teachers' moves during lesson delivery in the Mathematics classroom. It is nevertheless required that teachers explore the various acts of teacher-talk when teaching in the Mathematics classroom.

Circle Geometry

The branch of geometry that focuses on the relationships of circles is called circle geometry. The circle geometry has sector, arc, chord, circumference, radius and so on as among its features (as shown in figure 4).

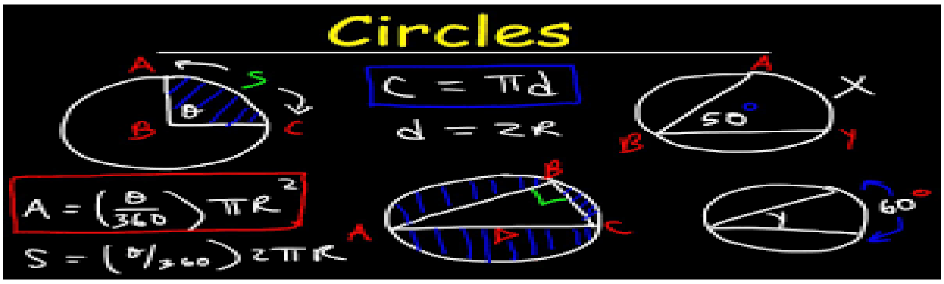


Figure 4: Some features of circle geometry

Numerous ideas, theorems, and characteristics of the circle are covered in the geometry of circles which had been reported by numerous studies. Previous studies emphasized how hard it is for students to comprehend the ideas of circle geometry (Lim, 1992; Hissan & Ntow, 2021; Dogwi, 2014). As a result of a large number of individuals find it difficult to relate to and understand the mathematical, geometric, and numerical representations of these concepts. According to Haylock (2018), a circle is a two-dimensional (2D) shape used in geometry that is made up of all the points that are a specific distance from a fixed point known as the circle's center. It is a flat figure of particular significance (Mollakuqe et al., 2021), and the range of ways in which circles are used in our daily lives demonstrates the value of learning about them. (Arnigo et al, 2018). Learning about circles begins with its fundamental components—radius, diameter, areas, and properties—and progresses to its uses. This suggests that before students can go to reasoning at a high level of complexity, like its application, they should have greater experience and expertise in lower-level skills, in this case definitions and relationships (Arnigo et al. 2018). The study research question examined what is the difference in quality of the teacher-talk in team pair solo and reciprocal strategies Mathematics classrooms and that in the conventional classroom?

Methods

Using a qualitative case study methodology, this research focuses on a limited number of mathematics classes in secondary schools that use TPS and RT techniques. In this aspect of the research study, the researchers used a case study form of research design as a means for describing the teacher-talk in the Mathematics classroom. A case study investigating teacher-talk of collaborative learning in mathematics classes was carried out by Parker and Harrison (2020). This study, which is part of a larger one, conducted as a mixed methods (as shown in figure 5) but concentrated only on the part of qualitative aspect. Though, in mixed methods research, the term "convergent parallel design" refers to a methodology in which both quantitative and qualitative data are gathered concurrently, examined separately, and then combined or contrasted to offer a thorough comprehension of a phenomenon. (See figure 5)

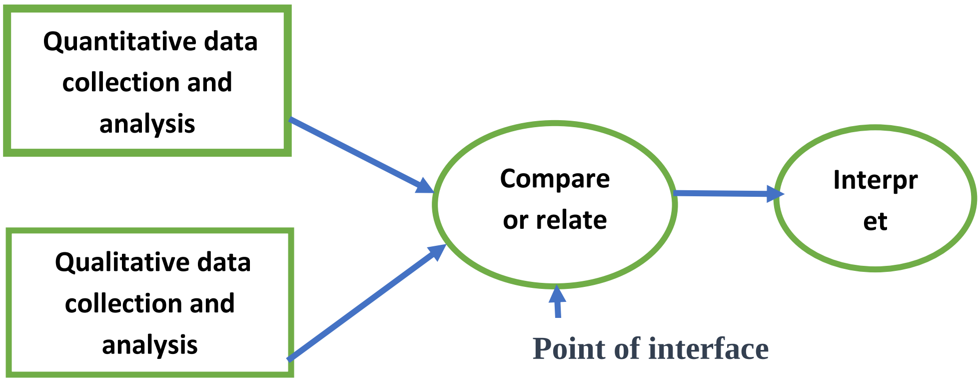


Figure 5: Convergent parallel design

Population and Sample

The population for the study consists of all the Senior Secondary Two, SS2 (equivalent grade-11) students in the public senior secondary schools in Education District V, Lagos State, Nigeria. The choice of SS2 as population for the study was because the selected concepts for students were on SS2 scheme of work. The choice was informed by the WAEC Chief Examiner for Mathematics Report that stated that candidates were unable to solve problems on mensuration, geometry and cyclic quadrilaterals in WAEC (2020). Three schools were randomly selected from Badagry zone of the District V. The study sample involved three teachers and SS2 (Grade-11) students in three intact classes. The treatment groups were two and the control group was one school with 60 students in the treatment group one, 48 students in treatment group two and 79 students in the control group.

Instrumentation

Data on teacher-talk was collected through video recordings of observed classrooms. A total of twelve lessons (four for each school) were recorded. The lessons in the treatment were conducted using team-pair-solo and reciprocal strategies, while the control group involved lecture method. The team-pair-solo lesson was implemented in three strategic stages which include: Team, Pair and Solo steps. On the reciprocal teaching, the teacher allows the students to explain ideas to their peers, which fosters deep understanding and active cognitive involvement. Data obtained from these videos were coded and transcribed before being interpreted using Brodie (2004) analytical framework. This framework helped to critique the transcripts that emerged from the videos. This analytic stage of the study was used to ascertain inter-rater reliability (IRR) which determined the degree of agreement between different scholars or coders. Researchers aimed to create answers for why groups act in particular ways under specific conditions because qualitative researchers believe that people are interconnected with the world in which they live (Taylor, 2017). The researchers were totally involved in the entire data gathering procedure because of this Taylor's assertion.

Results

The research question asks that: 'What is the difference in quality of the teacher-talk in team-pair-solo and reciprocal strategies Mathematics classrooms and that in the conventional classroom?

To answer the research question, the researchers started by categorising the teacher-talk using Brodie 2004 codes, which categorise teacher-talk as AFFIRM, DIRECT, INITIATE, INFORM, FOLLOW-UP and OTHER. The analysis of the teacher-talk showed that 453 teacher-talks were recorded in the Treatment group 1, TG1, (team-pair-solo strategy), 447 teacher-talks were recorded in the Treatment Group 2, TG2 (reciprocal strategy) and 294 teacher-talks were recorded in the Control group, CG. These counts were recorded over twelve lessons, four lessons per group in the three groups which resulted to twelve lessons that lasted for 149 minutes 20 seconds in the TG1, 168 minutes and 31seconds in the TG2, and 189 minutes 13 seconds in the CG.. The researchers then computed the percentages of the teacher-talk across all the four lessons each in the TG and CGs. These percentages are presented in Table1 below:

Table 1: Teacher-talk/turns in the treatment and CGs across all the lessons

Code	Frequency counts			Percentage counts		
	TG1	TG2	CG	TG1	TG2	CG
AFFIRM	47	36	19	10%	8%	7%
DIRECT	97	65	42	21%	15%	14%
INITIATE	53	77	30	12%	17%	10%
INFORM	136	158	147	30%	35%	50%
FOLLOW-UP	117	111	52	26%	25%	18%
OTHER	3	0	4	1%	0%	1%
Total	453	447	294	100%	100%	100%

In unfolding the level of domination of the lessons, extracts from the lesson transcripts in all the groups were examined. These extracts were considered based on the three dominant teacher-talks in the classroom which were INFORM (most characterized), FOLLOW UP (more characterized) and DIRECT (much characterized) talks with total counts of 431 (representing 36%,) 290 (representing 24%), 204 (representing 17%) out of 1194 teacher-talk counts generated in study. This shows that the INFORM code is mostly used by the teachers in the study. The researchers interacted with the data from TG1 as contained in the transcript extract below to see the dominance of the INFORM code in one of the classes, how teacher gives information and explain ideas in the classroom. This extract is as follow:

Extract from TG1L1

63 Teacher: Now, we now want to prove now that OA is equal to…

Chorus: OB

64 Teacher: Why, because anytime you are proving, you have to give the reason for
your proof. Are you getting what I am saying?

Chorus: Yes, ma.

65 Teacher: You must give reason for your proofing. You must tell them why it is like
that? The reason for the proofing is, what is the reason, you stand up now, what is the reason, why are you standing like that?

Sofiat: Ma, because they are equal.

The extract above shows the typicality of the INFORM codes in TG1. In turns 64 and 65, the teacher makes the students to see the importance of providing reasons in proofing. The researchers also interacted with the data from CG as contained in the transcript extract below to see the dominance of the DIRECT code in one of the classes, how teachers manage and direct students to engage in classroom activities. This extract is as follow:

Extract from CGL2
31 Teacher: Clap for him
26 Students: *Students are clapping for Tope*
32 Teacher: If you tell me LO, I agree, who can tell me,who can define radius, definition of
radius, definition, yes
27 Sehude: A radius is half of a diameter that divides the line of a circle to a semicircle
33 Teacher: Cool it down, don't rush, cool down!
28 Sehude: Radius

The extract above shows the dominance of the DIRECT codes in CG. In turns 31, 32 and 33, the teacher is asking for the definition of radius and the same time encouraging the student to be composed. This move serves as an act of managing the classroom and shows that teacher allowed students to contribute in the classroom conversations. In considering FOLLOW-UP code dominances, the researchers interacted with the data from TG1 as contained in the transcript extract below to see the dominance of the FOLLOW-UP in one of the classes, how teacher picks up a contribution made by a student in the classroom. This extract is as follow:

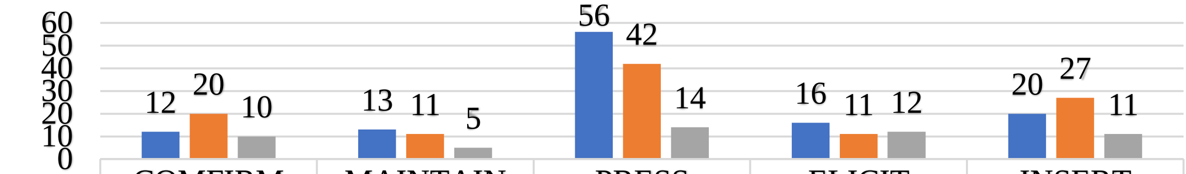
Extract from TG1L1
39 Teacher: And a line that start from a chord is now drawn
39 Chorus: Radius
40 Teacher: Is not radius. This is radius because it starts from the what
40 Chorus: Centre
41 Teacher: And stop at the where?
41 Chorus: Chord
42 Teacher: It does not touch the what!
42 Chorus: The circumference
43Teacher: You can not say it is radius. It is not. Are you getting what I am saying? It is only
when it starts from the centre and
touches this place, circumference, that you now
refer it as what
43 Chorus: Radius

The extract above shows the dominance of the FOLLOW-UP codes in TG1. In turns 40, 41, 42 and 43. The teacher is picking up a contribution from the student that line OD in the above circle is not a radius because the line did not touch the circumference of the circle from centre O. This move serves as an act of following up on specific student's contribution to enhance more understanding of contents.

Consequently, the researchers made comparison of difference in quality of the teacher-talks observed due to the records taken in team- pair-solo, reciprocal strategies and the conventional classrooms. Firstly, the AFFIRM code is often recorded after the teacher-talk in the three groups where the teacher ask the students to contribute to class discussion and the feedback is superb. The use of AFFIRM code was more in the treatment groups than in the CG. The difference in the AFFIRM code is 3% higher in TG1 than CG and 1% higher in TG2 than CG. Also, the DIRECT code occurred mostly at the start of lessons in the three groups. In treatment groups, it was observed that the teacher desired using FOLLOW-UP code at a stage where the DIRECT code is used in CG of the same concepts. The difference in the DIRECT code is 7% higher in TG1 than CG and 1% higher in TG2 than CG.

In addition, the INITIATE code was rarely used to introduce the new initiative about the concepts at hand. Particularly, it is used at the beginning of the lesson after the introduction of the concepts in the three groups. The difference in INITIATE code is 2% higher in TG1 than the CG and 7% higher in TG2 than the CG. Furthermore, the INFORM code usually follows the DIRECT code in the commencement of every lesson so as to introduce concepts to students in the three groups. In the CG, it was observed that the teacher continued using this code because no effective classroom interaction was put in place. The difference in the INFORM code is 20% higher in the CG than the TG1 and 15% higher in CG than the TG2. The difference in the FOLLOW-UP code was 8% higher in TG1 than the CG and 7% higher in TG1 than the CG. Lastly, the OTHER code is uniformly recorded in the three groups but had no disparity over one another. The TG1 and CG OTHER codes represent 1% while the TG2 OTHER code represents 0%. The table 2 shows the distribution of subcategories of FOLLOW-UP codes across all four lessons which included TGs and CG.

Figure 6: Distributions of subcategories of FOLLOW-UP codes in the teacher-talks



	COMFIRM	MAINTAIN	PRESS	ELICIT	INSERT
TG1	12	13	56	16	20
TG2	20	11	42	11	27
CG	10	5	14	12	11

The figure 6 shows the Percentages of the subcategories of FOLLOW-UP counts in the treatment and CGs. The frequency counts of the TG2 (111) shows more counts than CG with 52 counts. Also, the frequency counts of TG1 (117) shows more counts than CG with 52 counts. These frequency counts were converted to percentage values as indicated in table.2. The table reveals frequency of the subcategories of FOLLOW-UP counts for all the lessons delivered in the TGs and CG. The table shows that the FOLLOW-UP moves in all the lessons are predominantly PRESS with 48%, 38% and 27% in TG1, TG2, and CG respectively. It is important to note that quality of teacher-talk of the subcategories of FOLLOW-UP code vary among all groups. So, the researchers interacted with the data to examine the dominance of the PRESS code in the TG1 classes. This was to see how teacher push or probe the students to clarify, justify or explain their ideas.

Firstly, the FOLLOW-UP CONFIRM code is used more in the CG than in the TGs. The difference in the FOLLOW-UP CONFIRM code is 1% higher in CG than TG2 and 9% higher in CG than TG1. The FOLLOW-UP CONFIRM code was used more in TG2 than in TG1. The difference in FOLLOW-UP CONFIRM code is 8% higher in TG2 than TG1. Secondly, there was no evident difference in FOLLOW-UP MAINTAIN code in the TGs and CG. The difference in the FOLLOW-UP MAINTAIN code was 1% higher in TG1 than the TG2 and CG. Also, there was evident difference in FOLLOW- UP PRESS code in the TGs and CG. The difference in the FOLLOW-UP PRESS code was 21% higher in the TG1 than the CG and 11% higher in the TG2 than the CG. The FOLLOW-UP PRESS code was 10% higher in the TG2 than the TG2.

In addition, the FOLLOW-UP ELICIT code was used more in the CG than in the treatment groups. The difference in the FOLLOW-UP ELICIT code was 9% higher in the CG than the TG1 and 13% higher in CG than the TG2. Furthermore, the FOLLOW-UP INSERT code was used more in TG2 than in CG. The difference in the FOLLOW-UP INSERT code was 3% higher in the TG2 than the CG but 4% higher in the CG than the TG1. The difference in the FOLLOW-UP INSERT code was 7% higher in the TG2 than the TG1. The use of team-pair-solo and reciprocal strategies in the TGs affords the teacher and students to interact more in the classroom than in CG classroom. This shows that the teachers in the TGs took time to explain the lesson in details and responded to students' contributions in the classroom.

Discussion of Findings

The findings of this study revealed differences in the proportion of teacher-talk in team-pair-solo, reciprocal and those in the conventional classroom. Considering the means of the teacher-talk, the findings revealed the FOLLOW-UP code as the most prevalent code in team-pair-solo and reciprocal classrooms while the INFORM code was the most prevalent in the conventional classroom as illustrated in Table 1. So, students in the treatment groups contributed actively in the classroom because of the strategies involved which prompted the dominance of the FOLLOW-UP code in the teacher-talks. So, this active participation prompted through team-pair-solo and reciprocal strategies is in line with Zakaria et al. (2013) who asserted that cooperative learning strategies in the classroom allows an increase in the quality of the students' participation in the classroom discussions, add values to the knowledge of the students, and increases their self confidence in answering questions.

On the other hand, the dominance of the FOLLOW-UP code is a characteristic of the forms of teacher-student interaction in mathematics learning that help students build and improve mathematical understanding (Irma & Dwi, 2021). It is also a characteristic of the teacher's questioning as reported in the literature (Peter et al., 2016; Brodie, 2008). They explained that the teacher's questioning is an important diagnostic tool in engaging the students in deep thinking about mathematical ideas, as well as measuring the academic progression and comprehension of the learner and bringing about improvement in the students' participation in the classroom discussion. Now, it was discovered in the control group that the students participated less in the classroom as a result of the conventional way of teaching which prompted the dominance of the INFORM code in the teacher-talk as against the classroom discussion in the treatment groups. This move has the attribute of giving information or explanation and lacked the act of questioning as many teachers find it complex to ask meaningful questions (Sanni & Alabi, 2021; Sofyan & Mahmud, 2018).

More so, the subcategories of the FOLLOW-UP code revealed the level of moves prompted by the teacher-talk in connection with the students' contributions. Among the subcategories of the FOLLOW-UP code, the PRESS code is dominant in treatment and control groups as indicated in the previous chapter (Table 2). The level of the follow-up code is pinpointing the acts of the teacher-talk to push or probe the students on their contributions in order to clarify, justify or explain more on their ideas clearly in the classrooms. This finding is in conjunction with the literature, that probing questions helps students to explain their thinking, offer justifications or proof, and use prior knowledge in attending to the task at hand. It also served the role of extending students' conceptual understanding and encouraging them to relate new ideas to prior notions in the classroom (Brodie, 2008; Sahin & Kulm, 2008; Sanni & Alabi, 2021). In the case of team-pair-solo and reciprocal classrooms, teacher-talks were basically to probe the students' thinking and allow classroom interaction to take place while in the control group, the teacher talk were basically to inform the students of the desire to accept their utterances and not to allow students' contributions to take place.

The study's underlying the study suggested that cognitive growth and interactions with the environment shape knowledge, which could account for the significant achievement gap between the treatment and control groups' classrooms (Vygotsky, 1978; & Piaget, 1973). Teachers who regularly used open-ended questions, gave constructive criticism, and promoted peer exchanges saw higher levels of student engagement and improved mathematics ability (Shin et al. 2020). One of the most crucial components of social interdependence theory is arguably illustrating the shift from self-interest to mutual interest, which would lead to constructive interdependence that encourages classroom interaction (Planas & Alfonso, 2023). Learning in a constructivist framework requires that students feel free to experiment and make mistakes, which these teachers were able to provide. In constructivist classrooms, effective teacher-talk increases student motivation, engagement, and mathematical proficiency. In mathematics, where many students find abstract concepts difficult, student engagement is especially crucial. Students become more engaged in the learning process when teachers employ language that promotes critical thinking and active engagement, which improves retention and comprehension.

Conclusion

We found out that there was a quality teacher-students and students-students interaction in the team-pair-solo and reciprocal strategies Mathematics classrooms than in the conventional classroom setting. The implication here is that for some time in the lessons, teacher-talk was centred on the act of probing students on their contributions to clarify, justify, explain ideas and proofs. As the teacher does the probing, the students contribute in return to the teacher-talk and even interact among themselves. So, the students become active participants and have the courage to meaningfully contribute to the classroom conversation. However, in the control group, there was also an indication that the classroom was largely dominated with the acts of giving information to the students without considering if they understand it. Although constructivist teacher-talk has advantages, there are drawbacks to its application. Teachers frequently find it difficult to strike a balance between helping pupils and letting them figure things out on their own. Additionally, a lot of educators are acclimated to conventional, teacher-centered methods, in which knowledge is mainly conveyed through teacher-talk. It may take some time to establish the mentality and instructional strategies needed to transition to a constructivist approach.

Ethical Considerations

The researchers sought and got permission from the appropriate authorities to gain access to the sites. At the sites, the researchers also sought an informed consent of the participants, both teachers and students for voluntary participation, after providing details of the research and the expected levels of participation. Since the permission was given for voluntary participation, an undertaking to keep the identities and information from all the participants as well as their schools confidential was given to the participants. As promised in the consent forms, the participants were given pseudo names for identification rather than direct use of their real names to protect their true identities. To achieve all the letters of the informed consent, the researchers were honestly pleased to guard against the actions and utterances that were intimidating to ethical considerations in the conduct of this research study.

Recommendations

Considering the findings of this study, the following recommendations towards improvement are made:

1. Teachers of mathematics should raise awareness of the importance of considering high-quality teacher-talk contributions in the classroom.
2. Since team-pair-solo and reciprocal tactics have been shown to significantly improve learning, all secondary school teachers at all levels should recognize their use as an instructional strategy.
3. To optimize students' communication and support students in constructing a deeper understanding of mathematical concepts.
4. The value of classroom conversations, particularly the quality of teacher-talk, should be promoted by professional bodies in mathematics education.
5. In order to gain the fundamental skills necessary to effectively transfer knowledge in mathematics classrooms, it is necessary to frequently arrange seminars or workshops to train instructors on the most recent ideas in mathematics education.

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