



Use of Peer Interaction Method in Teaching Algebra in Selected Rwandan Secondary Schools

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Abstract

This study aimed to assess the effectiveness of the peer interaction method in the teaching and learning of algebra in selected secondary schools in Nyarugenge District, Rwanda. Utilizing a case study design, the research focused on the application of peer instruction strategies within algebra content. Three public secondary schools were deliberately selected for their strong focus on advanced education and mathematics as a core subject and their strategic locations to ease data collection. Teachers with more than three years of teaching experience were purposively selected to capture their perspectives. Data collection was conducted from three mathematics teachers who relied primarily on structured interviews and systematic classroom observations guided by a pre-established checklist. Thematic analysis was employed to interpret and categorize qualitative data into meaningful insights. Findings from interviews and observations revealed the nuanced implementation of peer interaction in mathematics classrooms. While some teachers effectively fostered individual accountability within group work, challenges remained particularly in ensuring task clarity and defining roles. Common shortcomings in face-to-face interactions included limited positive feedback, vague cooperative learning goals, and weak lesson openings. Nevertheless, developing interpersonal and small-group social skills such as active listening, clear communication, and mutual respect contributed positively to collaborative learning environments. The study recommends establishing clear structures for individual accountability, integrating positive reinforcement strategies, and enhancing face-to-face interaction techniques to improve student motivation, engagement, and collaborative competence.

Keywords: Algebra Education, Nyarugenge District, Peer Interaction, Teaching Mathematics

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Introduction

In secondary education, the ideal instructional approach emphasizes the use of innovative teaching methods to enrich student learning experiences (Orlich et al., 2010; Fink, 2013; Kwangmuang et al., 2021). Specifically, in algebra instruction, peer interaction has emerged as an effective strategy for raising collaborative engagement and deeper conceptual understanding among students (Chien et al., 2020; Calkins, Grannan, & Siefken, 2020).

Ideally, teachers in Rwanda, including those in Nyarugenge District, would incorporate this method seamlessly into their classrooms to promote critical thinking, problem-solving skills, and positive attitudes toward algebra. However, the prevailing reality in many of the district's secondary schools reflects continued reliance on traditional, teacher-centered practices that limit opportunities for active student participation (Bature, 2020; Soubra et al., 2022). Factors such as inadequate resources, insufficient teacher training, and institutional inertia may contribute to this gap between ideal and actual practice (Aruleba, Jere, & Matarirano, 2022; Kim et al., 2020).

This study examines how peer interaction is currently applied in teaching algebra in selected Rwandan schools in Nyarugenge District and explores the factors influencing its adoption. The focus is on understanding existing practices and challenges to provide insights for improving interactive teaching strategies in secondary mathematics education.

Related Literature

Peer instruction has become an active learning approach that enhances student engagement and promotes deeper understanding through structured peer-to-peer discussions. This method involves students individually responding to conceptual questions, discussing their reasoning with peers, and revisiting their responses, fostering critical thinking and collaborative learning. Such strategies have proven valuable in both face-to-face and online contexts, particularly in supporting continuity in higher education during times of disruption (Nerantzi, 2020). By encouraging active participation and shared problem-solving, peer instruction helps maintain high levels of interaction and comprehension across different learning environments.

The study acknowledged the critical role of teacher considerations, as highlighted by Tay, Lee, and Ramachandran (2021). While the primary emphasis was on evaluating the impact of digital storytelling tools on mathematics achievement, the research design incorporated elements aligned with their recommendations. Specifically, teachers were provided with structured guidance on selecting appropriate digital tools and designing lessons that fostered peer interaction and engagement. This approach ensured that the home-based learning (HBL) activities maintained cognitive rigor while leveraging digital interaction, in line with best practices for learning environments.

Additionally, the role of peer interaction in enhancing cognitive development and emotional well-being has been well-documented, with implications for both in-person and virtual learning contexts. Peer interaction programs, where students function as both teachers and learners, have demonstrated benefits such as improved self-esteem and academic performance (Bang, Won, & Park, 2020). However, the success of these programs is highly dependent on structured training and guidance

(Youde, 2020).

Within mathematics education, cooperative teaching and learning approaches have shown promise in elevating teachers' pedagogical content knowledge and shifting instruction from teacher-centered to student-centered (Asomah, Agyei, & Ntow, 2023). Moreover, Kristiansen (2022) revealed that face-to-face promotive interaction plays a vital role in small-group learning but must be well-facilitated to overcome challenges such as communication barriers and uneven group participation. Collectively, these studies advocate for intentional design and support structures that promote effective peer engagement, classroom environments to optimize student learning, and social interaction.

Despite these insights, there remains a notable gap in how digital storytelling tools can be systematically integrated into mathematics instruction to foster both academic achievement and collaborative engagement, particularly in contexts like Rwanda, where home-based and blended learning approaches are still emerging. Existing studies have largely focused on general cooperative strategies or traditional classroom interactions, with limited attention to technology-driven storytelling methods that combine cognitive rigor and peer learning principles. This study sought to address this gap by exploring innovative, contextually relevant approaches that leverage digital storytelling to enhance mathematics learning outcomes while promoting active student participation.

This study aimed to address the following objectives:

1. To examine how teachers implement individual student accountability in the teaching of algebra.
2. To explore how teachers facilitate face-to-face promotive interaction during algebra instruction.
3. To investigate how teachers incorporate interpersonal and small group social skills in algebra teaching.

Methods

Research Design

Peer learning, as conceptualized by Johnson and Johnson (1994) in the cooperative learning framework, emphasizes structured student collaboration with clearly defined goals to promote both academic and social development. Its primary objective is to ensure that learners work together in a way that maximizes individual responsibility while fostering collective success. The three themes guiding this study, individual accountability, face-to-face promotive interaction, and interpersonal and group social skills, were selected because they represent core elements of effective peer learning environments that influence cognitive engagement and positive interdependence. These themes have been widely acknowledged in literature as critical components for improving students' problem-solving abilities and social competence within mathematics classrooms (Gillies, 2016; Slavin, 2014). Consequently, focusing on these dimensions allowed the study to comprehensively understand how teachers in Rwanda implement peer learning strategies in algebra instruction.

Participants

The study involved three mathematics teachers, two males and one female, each with over three years of teaching experience. These teachers were drawn from three different public secondary schools in Nyarugenge District, Rwanda, to capture diverse instructional practices. All the schools are day schools, offering education for grades S1 to S6, and have an average student population of 600–800 learners. The schools were purposively selected based on their accessibility, willingness to participate, and the teachers' experience in teaching algebra, ensuring that the participants could provide informed insights into the application of peer interaction strategies in mathematics instruction.

Instruments

Data were collected using two qualitative methods: classroom observations and semi-structured interviews. The classroom observations focused on real-time teaching practices during algebra lessons, guided by an observation checklist designed to assess three key components of peer interaction: individual accountability, face-to-face promotive interaction, and interpersonal and group social skills. This checklist contained specific indicators under each component to ensure systematic and consistent observation across all three classrooms. To complement the observational data, semi-structured interviews were conducted with the same teachers to gain deeper insights into their perspectives on peer interaction, strategies used to foster student collaboration, challenges encountered, and perceived impacts on student learning. The interviews were recorded, transcribed, and thematically analyzed to identify recurring patterns and key themes.

We collected data from three mathematics teachers in Nyarugenge District, Rwanda, through 12 classroom observations (four consecutive lessons per teacher in May 2023) and semi-structured interviews. The study was initiated with a two-day training workshop to introduce the teachers to peer instruction, as they were not previously familiar with the strategy. Their understanding was assessed with a pre- and post-training questionnaire. The classrooms in typical secondary schools had varying student populations (45, 52, and 48 students). Before data collection began, teachers were fully informed and gave their consent, with an assurance of confidentiality.

Data Analysis

The data collected from both observations and interviews were analyzed using thematic analysis. The observation notes were organized into themes corresponding to the three elements of peer interaction. Similarly, interview transcripts were coded and analyzed to draw out recurring themes and teacher perspectives. The triangulation of data from observations and interviews enhanced the credibility and reliability of the findings.

Validity and Reliability

To enhance the validity and reliability of the study, triangulation was employed by cross-verifying information from multiple data sources. Additionally, member checking was conducted by allowing participants to review and confirm the accuracy of the interview transcriptions and the researcher's interpretations.

Ethical Considerations

Before data collection, informed consent was obtained from all participating teachers. They were assured of the confidentiality and anonymity of their responses. The research adhered to ethical guidelines, including voluntary participation, the right to withdraw at any time, and the responsible use of data.

Findings

Insights from Classroom Observation

The results of Table 1 show that Individual Accountability: Teacher A actively promoted individual responsibility, establishing clear learning objectives and encouraging students to contribute meaningfully. This structure facilitated student ownership of learning and peer collaboration. Teacher B also emphasized individual accountability through reflective questioning and group discussions, helping students recognize their contributions to group tasks. In contrast, Teacher C's approach was less effective; the lack of task clarity, limited student engagement, and absence of clear objectives led to confusion and diminished group accountability.

Table 1: Practice of Peer Interaction

Peer Interaction	Items Checked	Observed Practices
1. Individual Accountability	1. Personal Contribution 2. Preparation 3. Reflection	- Teacher A strongly emphasized individual responsibility by setting clear objectives, encouraging collaborative engagement, and promoting reflection and comprehension through diverse student perspectives. - Teacher B reinforced accountability by helping students recognize their role in group success, encouraging critical thinking, and promoting peer feedback. - Teacher C showed weaknesses in this area, with poor task clarity, limited student ownership, and a teacher-centered approach that inhibited reflection and peer collaboration.
2. Face-to-Face Promotive Interaction	1. Encouragement 2. Cooperative Learning 3. Active Listening	- All three teachers lacked consistency in providing positive feedback when teaching quadratic equations, negatively affecting student motivation. - None established clear group or individual goals for cooperative learning, reducing shared responsibility and hindering teamwork. - Teacher A lacked clarity in lesson introductions, failing to set expectations for respectful communication, while Teacher C succeeded in this area by clearly outlining expected behaviors and

Peer Interaction	Items Checked	Observed Practices
3. Interpersonal and Small Group Social Skills	1. Corroboration	raising attentiveness.
	2. Coordination	- All teachers emphasized interpersonal skills, fostering a collaborative classroom climate. - Teacher A promoted open communication, respectful exchanges, and logical organization in problem-solving. - Teacher B focused on mutual respect and active listening, strengthening group coordination. - Teacher C, aligned with Teacher A's approach, raised open discussions and flexible thinking, enhancing collaborative problem-solving.
	3. Flexibility	

Face-to-Face Promotive Interaction: All three teachers showed limitations in raising promotive interactions. A lack of positive feedback and absence of collaborative goal-setting hindered motivation and student engagement. Teacher A, in particular, did not adequately communicate behavioral expectations for respectful interaction. However, Teacher C distinguished themselves by clearly establishing norms for communication and promoting active listening, which supported a more respectful and engaging learning environment.

Interpersonal and Small Group Social Skills: Despite the challenges in accountability and promotive interaction, all three teachers prioritized interpersonal and group social skills. Teacher A encouraged respectful communication and idea-sharing, while Teacher B emphasized active listening and team collaboration. Teacher C promoted adaptability in group discussions, aligning with Teacher A's style. These practices created a cooperative atmosphere, helping students develop essential social and communication skills.

Insights from Teacher Interviews

The interviews provided additional insight into how teachers supported peer interaction. They outlined several strategies to motivate students, including: Encouraging students to defend their answers during presentations using clear reasoning and examples. Using applause, praise, and rewards (e.g., bonus marks) to acknowledge student contributions. Structuring groups carefully by mixing students with varied abilities and assigning roles (e.g., secretary, group leader). Promoting reflection by revisiting previous group work, identifying gaps, and providing targeted feedback.

One teacher explained, “Learners are motivated by providing them with questions from easy to complex and praising them for their correct work” (Teacher B). Feedback was consistently cited as essential for increasing student engagement in group activities. Teachers also used a variety of questioning techniques to spark critical thinking and kept learning dynamic through varied tasks.

Reflection and Lesson Integration: Teachers used reflective practices to bridge past and present learning. They set learning objectives, prompted students to explain their progress, and addressed conceptual gaps before introducing new material. Constructive feedback and rewards were integral to

reinforcing participation and supporting a growth-oriented classroom environment.

Encouraging Student Voice: Teachers emphasized stimulating student thinking through group discussions to build memory retention and confidence. Mistakes were treated as learning opportunities, and verbal contributions were rewarded. Students were involved in decision-making (e.g., selecting group leaders), enhancing their sense of responsibility and cooperation.

As Teacher B shared, *“Bonus mark (1 mark) is awarded to students who share their thoughts with others—this is how I motivate students.”*

Promoting Collaboration and Adaptability: Teachers highlighted the importance of balancing student autonomy with guided collaboration. While some groups were self-formed based on friendships, others were intentionally created to mix strengths and learning levels. Teachers assigned specific questions to each group and encouraged inter-group explanation and knowledge sharing. Verbal expression was emphasized to strengthen students’ cognitive engagement.

However, teachers acknowledged challenges, particularly students’ difficulty adapting to new learning approaches due to limited skills and access to resources such as textbooks. As Teacher A noted, *“The students who are able to adapt to new situations are not many because of their levels of skills and understanding... they lack materials like books which can help them.”*

Discussion

The primary outcome of this study is that while peer interaction is being utilized in mathematics instruction in Nyarugenge District, its application is inconsistent and often constrained by a variety of factors. The findings from both the classroom observations and the teacher interviews revealed that teachers have successfully integrated some elements of peer-based learning, particularly focusing on interpersonal and small group social skills. All three teachers, for instance, created a cooperative atmosphere by encouraging respectful communication, active listening, and adaptability. However, the implementation of other key components, such as individual accountability and face-to-face promotive interaction, showed significant variation and weakness. These results align with literature from scholars like Tay, Lee, and Ramachandran (2021), who argue that for peer interaction to be effective, both students and teachers must be equipped with the necessary skills and resources. The study confirms that without adequate professional development and support, the full potential of peer-based learning remains unachieved.

A key unexpected finding was the significant disparity in teachers’ implementation of individual accountability. While Teacher A and B actively promoted student responsibility, Teacher C’s approach was less effective, leading to student confusion and disengagement. This can be attributed to the lack of clear learning objectives and task clarity that were observed in Teacher C’s classroom. A similar weakness was observed across all teachers in the area of face-to-face promotive interaction. Despite the general success in raising social skills, teachers struggled to provide positive feedback and set collaborative goals, which are crucial for maintaining student motivation and engagement. These weaknesses highlighted a gap between teachers’ theoretical understanding and their practical application of peer

instruction principles, suggesting that the initial training workshop may have been insufficient in preparing them to fully implement all aspects of the strategy. The teachers' varied instructional styles, as evidenced by the observation data, also underscore why a one-size-fits-all training approach may not be sufficient for all implementers.

The differences observed among the teachers attributed to their varying levels of experience, pedagogical beliefs, and perhaps their individual adaptation to the provided training. For instance, Teacher C's less effective approach to accountability and engagement was a result of a pedagogical style that is more teacher-centered, making the transition to a student-led, collaborative model more challenging. In contrast, the successes of Teachers A and B in certain areas reflected a greater personal inclination towards or prior experience with student-centered methods. The teachers were not previously aware of formal peer instruction strategies, so their baseline pedagogical approaches heavily influenced how they adopted the new techniques. Their different backgrounds and teaching contexts, as described in the methods section, directly contributed to the differences in how they implemented the same instructional strategy, reinforcing the idea that implementation is highly dependent on the individual implementer.

The findings from this study have several practical implications for implementing peer instruction in similar educational settings. Firstly, the study highlighted the need for a more comprehensive and sustained professional development program for teachers. A two-day workshop was insufficient to bridge the gap between theoretical knowledge and practical application. Training should include follow-up sessions, peer coaching, and in-class support to help teachers master all components of peer instruction, especially those where weaknesses were identified (e.g., individual accountability and promotive interaction). Secondly, there is a clear need to address the lack of resources, such as textbooks and other instructional materials, which was noted as a significant challenge by Teacher A. Schools and educational policymakers must prioritize providing these resources to support both teachers and students in adopting new learning approaches. Lastly, the study highlighted the importance of training that considers the unique teaching styles.

The current study focused on teaching that also requires considering the student perspective. During the classroom observations, student behavior directly reflected the teachers' implementation of peer interaction strategies. For instance, in Teacher A's classroom, students were observed actively engaging in discussions and taking ownership of their learning, indicating that the teacher's emphasis on individual accountability was effective. In contrast, some groups appeared confused and disengaged during Teacher C's lessons, demonstrating that the lack of clear objectives negatively impacted student collaboration and learning outcomes. Similarly, despite the teachers' struggles with promotive interaction, students in all classes demonstrated improved interpersonal skills. This suggests that while teachers have limitations, engaging in group work provides students with a valuable opportunity to develop essential social skills. This link between teacher practice and student behavior confirms that effective peer instruction directly influences how students learn and interact in the classroom.

Conclusion

This study explored how mathematics teachers incorporate peer interaction through individual accountability, face-to-face promotive interaction, and interpersonal and group social skills. Observations and interviews revealed that while Teachers A and B showed commendable efforts in raising individual responsibility, Teacher C struggled with clarity and task delegation. All three teachers faced challenges in implementing effective face-to-face promotive interactions, particularly in providing positive feedback and setting clear cooperative goals. However, they demonstrated strong interpersonal and group social skills, emphasizing mutual respect, communication, and collaboration.

Recommendation

Based on the study's findings, which showed discrepancies in how the three teachers implemented peer interaction, future research should focus on the factors contributing to these inconsistencies. It is recommended that future studies investigate a larger and more varied group of teachers better to understand the range of implementation challenges and successes. Additionally, future research should explore the effectiveness of different professional development models, moving beyond short-term workshops to a more sustained, in-depth approach that includes follow-up support and peer-to-peer coaching. This would help identify the most effective training methods in bridging the gap between theoretical knowledge and practical classroom application.

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