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## Collaboration: A Collective Bargain for Achieving Quality Mathematics Classroom Practice

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**Abstract:** This paper sought to look at collaboration as an effective tool for mathematics classroom instruction. Four preservice teachers in a qualitative case study taught mathematics to three senior secondary school classes in two secondary schools in Northern Nigeria for a period of 15 weeks spread over three years. During this period 12 students volunteered to participate in four focus group discussions on the effectiveness of the pedagogy in their classrooms. Observations, research journals and focus groups were used to collect data for the study. A Narrative approach to data analysis was used to analyse the data collected. The findings of the study suggested that, the preservice teachers had initial challenges introducing the framework into their classrooms, they, however, gradually adopted the pedagogy into their classroom teaching. The study suggested that the preservice teachers used collaborative groupings and higher ordered questions to foster collaboration among their students. Some benefits of this strategy were also highlighted from the study. Prominent among them was the effective teacher-student and student-student relationship, help students see mathematics problems as common problems and reduced the domineering attitude of mathematics teachers who see themselves as possessing the monopoly of knowledge. Other findings observed in the study include the replacement of the teacher-centered approach to teaching with a student-centered approach. Therefore, it is suggested that, if collaboration is introduced into Nigerian mathematics classrooms, the traditional teacher-controlled mathematics classroom instruction that has bedeviled our classrooms will be reduced, and a new student-centered learning approach will be put in place.

**Keywords:** *Pedagogies, Collaboration, quality classroom Instruction, Mathematics classroom teaching*

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### Introduction

The world today has identified the importance of collaboration in finding solutions to individual, societal and global problems. Associations, pressure groups and civil societies are also increasing daily with the aim of tackling common problems. The composition of these collaborative groups and the tasks being tackled by the groups have been identified as important factors that determines the success of the groups' objectives. Studies have also showed that collaboration between these groups is yielding great and positive outputs. For example, globalization is playing an increasingly important role in advancing the economy of developing and underdeveloped countries. Benefits achieved by members of such collaborative groups could be in the form of, economic benefits, technological development, political influences, health systems development, social and natural environmental progress. These factors have given the members of the collaborative groups the opportunity to access developed countries' markets, enjoy steady growth, improved productivity and quality of living of its citizens (Collaborative Society, 2013; Hamdi, Ghorbel, Masmoudi & Dupont, 2018).

It is important to note, that there is current global evidence to show that, these collaborative principles are being transferred into classroom practice. In view of these, Scott (2015) in his paper preparing learners for twenty-first century competencies and skills, asserted that:

*"People learn in a variety of ways, so the challenge for teachers is to discover which approaches help them learn most effectively. Until a teacher becomes familiar with a learner's individual strengths and needs, it is difficult to know which learning methods and pedagogy will have a positive impact on that person".*

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Similarly, Hedberg (2018) asserted that in the United States thousands of dollars are being used by the government on new initiatives, with the view of improving classroom instruction and learning. Some of which include the introduction of STEM in Education. One could deduce from their view that, STEM is a driving force which has succeeded in aligning education and the business world together, through a process called collaboration. The vision is designed to enable educators and industry experts to engage through a process of embedding what students learnt in school with the world of work (or business world?). In Australia this process is called connectedness to the world, as a dimension in a wider perspective called productive pedagogies.

Therefore, to assist students develop their different thinking skills, there is the need for students to engaged in meaningful and profitable collaboration that has a genuine value and relevance to their needs. Real-life or real-world learning experiences merge with sustained students' engagement, interactions, dialogue and indeed collaboration can offer students the opportunities to construct their knowledge, engaged in real-world problem solving and the use of enquiry to find solution to their problems(Barron and Darling-Hammond, 2008; cited in Scott, 2015).

It is imperative to reiterate the importance of collaboration in achieving quality classroom instruction. This is because, collaboration is inherent in nature, and community based in supporting students complete their work through a process called community of practice. Previously, classroom instruction and learning encouraged students to accomplish task individually. This was achieved through the traditional process where emphasis was on memorization or the application of simple procedures during mathematics classroom instruction. Abimbade and Afolabi (2012) asserted that such classroom instructional approached did not foster students' critical thinking or independence in learning. This was as a result of students in such classrooms studying alone and seeking assistance mainly from their teachers with little or no opportunity to collaborate, interact or engaged in any meaningful dialogue with their peers. Scott (2015) is of the view that, in today's learning environment students' experiences during mathematics classroom instruction have tremendously improved, because, mathematics teachers in today's mathematics classrooms seek to establish communities in their approach to teaching and learning mathematics. This have been observed from the teaching practices of most mathematics teachers. Currently, teachers are seen providing opportunities for students to interact, dialogue and collaborate with their peers. This process has helped students discover their mathematical identities, engage profitably with their colleagues and indeed with their learning materials through the process of collaboration.

There is a shift in the methodology used in teaching mathematics in the classroom, this shift is attributed to collaboration (reference). The collaboration of teacher educators, teachers, and students seem to be a central focus in many mathematics education research and other areas of education and teaching today. Teamwork, building learning communities, networking between teachers and teachers, students and students; and professionals in general is also taking central stage in developing ways of confronting both individual and common problems associated with the teaching and learning of mathematics across the globe. Networking opportunities are often suggested as ways of tackling complex and difficult situations of learning particularly in mathematics classrooms (Jaworski, 2006; Krainer, 2003). Collaborative learning is largely built on the work of Vygotsky's sociocultural theory. This theory view learning as an inherent social process built around the zone of proximal development (Dillenbourg, 1999). The theory contributed significantly to the development of the social constructivist epistemology, as learning is mediated through experiences students have while interacting with their peers. Similarly, the collaborative approach to learning could also be linked to the Vygotskian theory of situated cognition and scaffolding (Forman & Cazden, 1985). Vygotsky (1978) in his view suggest that the paradigm of collaboration can develop individual cognitive levels when learners collaborate with more capable individuals. In his view, learning is first mediated on a social level between a child and other more capable individuals (teachers or peer) in his or her environment before it is internalized by the student on an individual level. Similarly, Lin (2015) was of the view that:

*"learning on the social level often involves mentoring provided by more knowledgeable persons..., (adults or peers), who engage in activity with less experienced persons (learner) in a process of guidance or collaboration..." (p. 11).*

In Nigeria, the current reforms in mathematics classroom by the National Policy on Education recommend the replacement of classroom instruction that supports drill and memorization of mathematical procedures with classrooms that foster students-centered instructions and supports students' engagement with conceptual problems of inquiry, collaboration and problem solving (Federal Government of Nigeria, (FGN), 2004). This suggest the move to breaking down the power imbalances between mathematics teachers and their students during mathematics classroom instruction in most Nigerian mathematics classrooms. According to (FGN, 2004) the purpose of this is aimed at providing classrooms effective student engagement as a means of achieving positive outcomes during classroom teaching and learning. This suggest therefore that developing collaborative classrooms should be made the priority in Nigerian mathematics classrooms, given the fact that students sometimes resist being controlled by the normal teacher-centered learning method used in Nigerian mathematics classrooms (Bature, 2014).

Research studies suggest that in today's mathematics classrooms, mathematics teachers are constantly looking for new strategies that are most beneficial to achieving quality classroom instruction with the view of improving students'

achievement and engagement during mathematics classroom instruction (Hannafin & Hannafin, 2010). Similarly, studies have also showed that mathematics teachers always desire to see their students enjoy mathematics during their classroom instruction (Bature & Jibrin, 2015) and ultimately strive to create organized mathematics classrooms (Hannafin & Hannafin, 2010). Consequently, motivating mathematics teachers to create classrooms that encourage collaboration among students may be the solution required to confront the challenges in Nigerian mathematics classrooms. Researchers, Teachers, and teacher educators have considered collaboration as a major tool which can be used for reforming the Nigerian mathematics classroom instruction which have been bedeviled by the teacher-centred monopolistic classroom instructional approach. Research studies further suggest that, facilitating effective and productive collaborative classrooms during mathematics instructions involves organizing classrooms that encourage heterogeneous groupings with roles such as Team Leader, Encourager, Re-teller, Recorder, and Spokesperson (Morganent, 1991).

Collaboration is therefore defined in this paper as a learning process where learning points toward cooperation between teachers and their students and between students and students occur. It is also viewed as the learning process where a group of learners are working together with the view of solving common mathematics classroom problems or critical issues of concern within their mathematics classroom (Laal & Laal, 2012). Morganett (1991) suggest that collaboration in mathematics classroom could be viewed as a classroom where mathematics teachers and their students both make substantial and significant contributions during classroom instruction towards achieving a common objective. Smith, Hardman, Wall and Mroz (2004) and Alexander (2005) were of the view that collaboration during mathematics classrooms among students bring about vital developmental changes in students' learning as against situations where teachers do most of the talking and students do most of the listening with little or no meaningful contribution towards classroom instruction.

Collaboration during mathematics classrooms instructions has been found to be a powerful tool for encouraging mathematics classroom instruction. When mathematics teachers have the skills and knowledge to collaborate with their students through conversations, focused on student learning, the dialogue, reflection, and actions emerge as a form of teacher students' development. Fullan (2011) was of the view that leading students through collaborative learning begins by recognizing the different stages that lead to authentic teacher-students' or student-student collaboration with a view of creating more teams of learners as they move through stages of problem solving, working on problems for which solutions are not readily known.

Some strategies for implementing collaborative learning during mathematics classroom instruction includes creating asymmetric positioning by training students to give better explanations when helping their peers (Webb & Farivar, 1994). In a study which claimed that students created a "collaborative zone of proximal development" in their classroom, descriptions of student interaction suggest asymmetric positioning. Research studies on collaboration suggest that improving mathematics classroom instructions particularly among students, requires the development of classrooms that promote the use of classroom discussions and dialogue groups. Similarly, borrowing from the views of Goos (2004) creating collaborative groups makes *"Some students additionally adopted teacher-like scaffolding strategies to assist less capable peers..., by asking questions that led their partner to locate an error or reconsider a plan"* (p. 282). Another view of implementing collaborative strategies during mathematics classroom instruction suggests that students could be positioned more symmetrically while generating knowledge. According to this view, knowledge need not be possessed by any individual for it to emerge among a group of learners (Davis & Simmt, 2003). That is, students may co-construct new ideas through activities such as reiterating, redefining, or expanding on the ideas of others (Mueller, Maher, & Powell, 2007). Scardamalia and Bereiter (2006) were of the view that there is the need for groups of students to come together, construct new ideas through discourse, and together they could advance their knowledge and thereby solve complex mathematics problems.

Similarly, facilitating collaborative groupings requires the mathematics teacher to establish classrooms structures that are diverse and yet flexible to allow students independences and self-constructions of their learning. However, this depends on classroom behavior the teacher feels are appropriate to fostering effective collaboration among students. I most not also failed to say here that, for effective collaboration, mathematics teachers are expected to develop classroom structures such as rules that are effective and flexible with the view of managing situations that might disrupt classroom instructions. According to (Morganent, 1991) the creation of these structures or rules will provide standards of behaviors requires of students during mathematics classroom instruction. They are also to fulfill several other functions in the group effectiveness, particularly, during groups' interaction.

Mathematics classrooms, especially, in countries like Nigeria, are still concentrating their effort towards the teacher-centered instructional strategy, where mathematics teachers claim the monopoly of knowledge and their students' mere recipients of such knowledge (Bature & Jibrin, 2015). Sometimes the reasons adduced for this method of teaching is the fact that mathematics classrooms in Nigeria are overcrowded, while others believe that the lack of knowledge on the strategies for implementing effective collaborative classrooms makes mathematics teachers find it difficult to organize classrooms that support intensive participation, discussion and collaboration during their classrooms instructions. Hence, it is common today, as in the past and perhaps currently (if nothing urgent is done) to see students struggling with mathematics and its principles, particularly in Nigerian mathematics classroom. Consequently, the

assumption that when students collaborate during mathematics classroom instruction, common goals are achieved is the focus of this study. The study is aimed at looking at the perception of the students on the effectiveness of collaboration during mathematics classroom instruction. The following research objectives guided this study;

1. To investigate the initial perceptions of students on the role of collaboration in mathematics classroom practice.
2. To determine the strategies adopted by mathematics teachers to encourage collaboration among students during classroom practice.
3. To determine the perceptions of students on the role of collaboration in achieving quality mathematics classroom practice?

### Method

#### *Design:*

This study employed a qualitative case study approach to seek data for this research. The qualitative case study methodology provides tools for researchers to study complex phenomena within a given context. It also allows researchers to explore subjects of their study through complex interventions, relationships, communities of practice or programs (Yin, 2006), thereby promoting the deconstruction and the reconstruction of the phenomena under study. When the approach is applied correctly, it becomes a valuable approach to conducting qualitative research with the view of developing interventions. Stake (2005) and Yin (2006) view qualitative case study in different perspective, however, they both seek to ensure that the concept under study is well explored and the essence of the concept under study is revealed.

#### *Participants:*

This research is aimed at exploring this methodological approach with a view of studying classroom instruction of four preservice teachers, teaching in two secondary schools in Northern states of Nigeria. The researcher observed each of the preservice teachers for a period of ten weeks for the first phase and another five weeks for the second phase. In the first phase the researcher worked with four preservice teachers (Audu, Abba, Aminu & Amina). They all taught the science students in one secondary school in Bauchi metropolis for one term (10 weeks). Six Senior Secondary Two Science students from the classes taught by these four teachers were purposively selected for three focus groups discussions. In the second phase, the researcher adopted a follow-up approach to explore the progress the two out of the four preservice teachers had made through implementing collaboration in their classroom instruction. The two preservice teachers were Aminu, and Abba. Abba voluntarily selected senior secondary one art while Aminu selected senior secondary one science. Both teachers were teaching in the same school and the content of their mathematics was the same. This suggest that what Abba was teaching in the arts class was the same topic or content Aminu was teaching in the science classes.

In this paper, only the responses of the students were analysed. Hence, the researcher used broadly the focus group interviews and the observations of the preservice teachers' instruction to assess the effectiveness of collaboration in the preservice teachers' mathematics classroom practice. The following students were used for the study in both the main research and the follow-up research periods.

*Table 1: Students Characteristics*

Name	Phase	Class	Stream	Gender	Age
Bisola	1	SS2	Science	Female	15
Bucky	1	SS2	Science	Female	16
Bukola	1	SS2	Science	Female	17
Buba	1	SS2	Science	Male	17
Bisalla	1	SS2	Science	Male	16
Baba	1	SS2	Science	Male	16
Jasmine	2	SS1	Science	Female	15
Jemima	2	SS1	Arts	Female	15
Joy	2	SS1	Arts	Female	15
James	2	SS1	Science	Male	15
Jacob	2	SS1	Science	Male	15
John	2	SS1	Arts	Male	16

*Ethical Issues:* Appropriate ethical issues that involve taking permission from the school and the parents of the students used for this study were followed. For example, all the students used in the study voluntarily consented to participate in the focus group discussions and some intermittent interviews. Prior to conducting this empirical research, the researcher obtained relevant ethical permission from the school to carry out the research. Given that the research was conducted with minors, the principal sent consent forms to the parents of the affected students, and the parents gave their permission in writing to the principal of the schools before the research commenced. Relevant consents were also obtained from the preservice teachers and from their head of departments.

*Instrument and instrumentation:* Classroom instructions and the focus group discussions with the twelve students and their classmates were videotaped, while a Research Journal was kept by the researcher to record observations. The following instruments were used to obtain data for the study.

*Observation:* The researcher adopted the observational strategy to obtain data for the study. There were both in-class observation of teachers and students practice and the out-class observation through reflective interviews and focus groups interviews. The in-class observation was done to measure behaviours of both teachers and students during classroom instruction. The out-class observations were measured either during preservice teacher reflection meeting, questions and answer sessions with both teachers and students or during the focus groups interviews with the 12 students. All actions related to the research objectives were captured both in writing and in video recordings.

*Reflective Interview:* There was a two-hour reflective interview after every three weeks of teaching, the researcher and the preservice teachers held meetings to review the teaching and discussed their weaknesses and strength before launching into the next three weeks. There was a total of four reflective interviews with the teachers.

*Focus Group Interview:* The twelve students selected were invited for focus group interviews after every three weeks of teaching. This was made up of four focus group interviews with the students.

*Research Journal:* The researcher also kept Research Journals to record all other observations and interactions with either the teachers or the students. Particularly those actions and reactions or behaviours that were not captured by the video.

*Data Analysis:* Data analyses in this paper concentrated on the views of the students and the observations of the researcher on the preservice teachers' implementation of the collaborative classroom settings created by the preservice teachers. The narrative approach was adopted to analyse the data collected. This agrees with the views of Clandinin and Connelly (2000) who proposed that narratives could be used in analysing research data to ensure the researcher have access to recorded stories through a journal, diary or that the researcher might have observed the individuals and recorded fieldnotes during data collection. During narratives the researcher seeks to identify patterns, themes, categories codes and structures in analysing qualitative data collected through a process of rigorous and constant comparisons of related themes (Creswell; 2007). In qualitative research, the researcher usually collects junk of data, however, there is the need to break these data into themes, codes and sections (Clarke, 2006).

## Results

The researcher analyzed this section using the three research objectives above. First, the initial views of the students about their classrooms instruction before the introduction of collaboration during their classroom instruction. Second, what strategies developed by the mathematics teachers that encourage collaboration during their classrooms. And finally, what were the perceptions of the students about collaboration during mathematics classrooms instructions.

### Initial Perceptions of Students on Collaboration:

#### Response to Research Objective 1:

*To investigate the initial perceptions of students on the role of collaboration in mathematics classroom practice.*

Data collected during this research suggest that the perceptions of the students on the use of collaboration as a tool for teaching mathematics was initially received with mixed feelings. In the first three weeks, the students had mixed feelings on the effectiveness of the classroom instruction of the preservice teachers using collaboration. However, from their views as the research progressed particularly from the third week forward there were evidences of change of mind among most of the students. In all the classes I observed, particularly the first lessons, the preservice teachers were greeted with initial resistance of getting the students' cooperation for example, the following behavior were exhibited by the students.

*After initial introduction of the preservice teachers to the students guided by the school representative (the HOD of mathematics. The students also introduced themselves to the teachers...., The four preservice teachers (Aminu, Adu, Abba and Amina) discussed their mission to the students. This was important because, being preservice teachers, they were meeting the students for the first time. Therefore, they had to seek for their cooperation throughout the research period. The students also meeting the preservice teachers for the first time, pledged their allegiance to them*

*The preservice teachers then discussed with the students the need to reorganize the class for their maximum benefit and participation. This they did by asking the students to sit in groups of five or six. The students were not comfortable with the idea of the new seating positions; the preservice teachers however, explained their reasons and then persuaded their students to comply, after some resistance the students reluctantly agreed.*

*After setting the class to sit in groups, the preservice teachers also persuaded their students again in each of the groups to elect their group leaders and secretaries. Responsibilities of group leaders and that of the secretaries were given. This they did by explaining to the students that when a problem is raised in the class, the group leader*

*will lead or appoint someone to lead the group on the solution to the problem. The secretary will note all the deliberations and decisions reached during the problem solving.*

*From the groupings, I discovered that boys and girls were made to sit together, this was actually the reason why the students demonstrated some resentment at the beginning. I also observed that the preservice teachers (through the assistance of the mathematics teacher and the classroom captain) made sure no two friends sat together and students with different learning abilities and/or disabilities were made to sit together.*

*Finally, I observed that the preservice teachers asked their students to please interact together and make sure every member of the group knew what was going on as there would be times for defense of group solutions. The preservice teachers challenge their students that they will call on anybody irrespective of ability or disability to represent the group during the defense. (Research Journal)*

From my observation of the classroom activities during the first day, the preservice teachers had difficulties getting their students' cooperation in the classroom's activities. In view of this, from my interaction with the focus group students, their responses were rather odd and scary to the progress of the research. For example, James said;

*This is a mission school, the school authority is strict or firm against any male-female relationship, and we are made to believe that there should be some restrictions in our relationships. Therefore, making us sit together..., talk together (though in groups) seems a new thing all together to some of us and indeed very strange..., but..., my first thought was that it might be distractive to the classroom teaching..., but it seems the teachers were very smart, active and good..., we had no opportunity to do other things. (James)*

Jemima was of the view that,

*This was very strange..., I thought we have been taught that when problems are given in the class we should cover our work or we should not allow anybody to see what we are doing..., but asking us to work together looks strange..., sincerely..., to tell you the truth, I initially felt this is morally wrong..., as if these teachers did not know that we are Christians..., but our teachers were with them and supported the idea..., it was strange..., however, as we progressed, I discovered I learnt more from my colleagues, especially, as you know mathematics is a very difficult subject..., (laugh...,) (Jemima)*

This suggest that the students initially felt the approach was strange to them. One may not blame their fears because they are used to the traditional teacher-centered approach to classroom instruction generally adopted by most of the mathematics teachers in Nigeria, shifting to a new student-centered approach was rather strange to them. From Jamine's view

*..., "I thought we have been taught that when problems are given in the class, we should cover our work, or we should not allow anybody to see what we are doing. (Jasmine)"*

This suggest that the teachers' classroom instructions were generally traditional; that is the teachers' classroom teaching was teacher-centered, and it was sad to observe that, these students are used to this traditional teacher centered approach and were not interested in the shift to a more students centered approach that encourage collaboration between students.

From the side of the teachers also, the focus group students also observed some elements of the authoritarianisms among the preservice teachers. In their views, they were not the only people that had initial challenges adjusting from the traditional teacher-controlled classroom instruction to the students centered classroom instruction that adopts collaboration. The students were of the views that, the authoritarian and pragmatic approach to classroom instruction employed by some Nigerian mathematics teachers was still being observed during the preservice mathematics teachers' classroom instruction. One of the student's (Bucky) statement was of concern when she detailed the situation in the mathematics classroom in Nigeria by saying...,

*The mathematics teachers were too strict..., too over-serious..., they were not friendly, I mean they did not allow the students a breathing space...; they sometimes shout the student down when a student makes little mistake..., (Bucky).*

From the view of Janet, it suggests that, the preservice teachers still needed more scaffolding that will help them adopt classrooms that promote collaboration, instead of the teacher domineering classroom instruction. From the comments of the students and from my initial observation of some of the preservice teachers, the students were also not comfortable with this form of classroom instruction. The students sometimes resist this using some form of demonstration or showing some negative behavior during classroom instruction. For example, Julie, the outspoken students among the focus group asserted that;

*See sir, sometimes, the mood in your face alone makes people to be attracted or run away from you, if your mood is friendly the students will be willing to listen to you. But when your mood is not friendly and you tide your face..., I...,smiled..., (the group also join her to laugh)..., personally sir....Hmn..., will be scared of you..., and whatever you are saying; I will not pay attention to you, and I will not enjoy or understand what you are saying as a teacher in*

*the class..., because, I will be scared to contribute or engaged into any form of discussion with my mates..., (Bukola).*

Janet supported Julie by being more realistic in mentioning the names of the preservice teachers that were so authoritarian. She said;

*It's true sir..., Bucky was correct..., when Aminu came to our class..., mere looking at his face..., is enough to scare you away from the class and from whatever he was saying..., This other teacher..., emnnn..., Audu..., yes., that is he's name..., he will not even talk to you, he was too quiet, serious, not smiling at all...he was too serous for my liking..., he was just facing the board, talking to himself... such teachers..., Hmn... Smile... I fear them..., they don't talk..., they only act...I was scared.... (Bucky).*

Janet asked a question that mathematics teachers who adopt teacher-centered approach to teaching have to think about. The remarks made by Janet brought concerns about how mathematics teachers take their classroom teaching and their relationship with their students, she asked...

*But..., sir..., why are math teachers always looking too difficult...? too serious? Un approachable...? They don't seem to smile at all.... (Bucky)*

*Except Amina..., she was too nice to be call a maths teacher..., I initially had my doubts about her being able to teach mathematics, because in my view maths teachers are strict and firmed ..., I was wondering if she was truly a good mathematics teacher, but..., she was kind, good..., though firm and had control over her class...however, ... she was different from all the maths teachers that had taught me since nursery school ..., because as we continued..., I observed, she knew what she was doing., she was also a better maths teacher ..., (Bucky).*

Comments made by Bucky about Amina's teaching methods suggest that mathematics teachers have to improve their teaching style if they hope to foster effective collaboration in their mathematics classroom. Amina, according to Bucky was a different mathematics teacher to her. She was able to notice the difference in her teaching style in comparison to the other mathematics teachers that have taught her since nursery school. From her view, she had initial mixed feelings about her ability to teach mathematics, judging from her simplicity. however, she had a change of mind after interacting with her.

*... she was different from all mathematics teachers that had taught me since nursery school ..., because as we continued..., I observed, she knew what she was doing., she was also a better mathematics teacher too..., (Bucky).*

Finally, data collected in this research suggest that, apart from being authoritarian, the preservice teachers were observed to be teacher-centered in their classroom instruction. The focus group students were of the view that, the preservice teachers controlled all the classroom activities, students were not involved. For example, Bisola and Bucky were of the view that, the preservice teachers were merely talking to themselves, they were not paying attention to their students' needs, neither were their students carried along in their classroom instruction.

*This other teacher..., emnnn..., Audu..., yes., that is he's name..., he will not even talk to you, he was too quiet, serious, not smiling at all...he was too serous for my liking..., he was just facing the board, talking to himself... such teachers..., Hmn... Smile... I fear them..., they don't talk..., they only act...I was scared.... (Bucky).*

*That is true Janet, some of the teachers ... were just talking to the board..., there was no room for students to share ideas of what they were saying..., the interaction was just between the teacher and the chalkboard, the teachers did not have us (students) in mind ..., why did they put us into groups in the first place, if they will not allow us to contribute to the teaching..., (Bisola).*

From Bucky and Bisola 's view, the teachers were just speaking to the board, without really engaging the students in a two-way conversation. This was supported by the view of another students (Buba) ..., who said,

*The teachers were just working alone; they were just writing on the board..., even when they gave us problems to solve..., they will not give us enough time to think or allow us to finish the problem..., before you know..., they will just go to the boards and solve the problems and asked us to copy..., generally, we were not part of the class..., (Buba).*

These statements suggest that the level of collaboration among students at the initial stages of the research was limited, this however improved during the life of the study, the students observed it and made positive criticism. This guided the teachers' first discussion, and I also used the comments and the criticisms of the students to initiate further scaffolding for the teachers. (details of the scaffoldings and the comments of the preservice teachers is outside the scope of this paper as only the students' perceptions and views were analysed for the paper).

## Strategies for Fostering Collaboration among Students

### Response to Research Objectives 2:

*To determine the strategies adopted by the mathematics teachers to encourage collaboration among students during classroom practice.*

After receiving feedback from the students' first focus group meetings, data collected from the Preservice teachers suggest that they studied and discussed extensively within themselves with the help of the leading researcher and adopted some strategies to implementing collaboration in their classroom instruction. One of the strategies adopted was that, the preservice teachers explore the collaborative groupings they created at the beginning of the research project to achieved effective problem solving among their students. The preservice teachers had earlier created collaborative groups which were initially resisted by the students....

*After initial introduction of the preservice teachers to the students guided by the school representative (the HOD of mathematics. The students also introduced themselves to the teachers..., The four preservice teachers (Aminu, Abba, Audu and Amina) discussed their mission to the students. This was important because, being preservice teachers, they were meeting the students for the first time. Therefore, they had to seek for their cooperation throughout the research period. The students also meeting the preservice teachers for the first time, pledged their allegiance to them*

*The preservice teachers then discussed with the students the need to reorganize the class for their maximum benefit and participation. This they did by asking the students to sit in groups of five or six. The students were not comfortable with the idea of the new seating positions; the preservice teachers however, explained their reasons and then persuaded their students to comply. After some resistance the students reluctantly agreed.*

*After setting the class to sit in groups, the preservice teachers also persuaded their students again in each of the groups to elect their group leaders and secretaries. Responsibilities of group leaders and that of the secretaries were given. This they did by explaining to the students that when a problem is raised in the class, the group leader will lead or appoint someone to lead the group on the solution to the problem. The secretary will note all the deliberations and decisions reached during the problem solving.*

*From the groupings, I discovered that boys and girls were made to sit together, this was actually the reason why the students demonstrated some resentment at the beginning. I also observed that the preservice teachers (through the assistance of the mathematics teacher and the classroom captain) made sure no two friends sat together and students with different learning abilities and/or disabilities were made to sit together.*

*Finally, I observed that the preservice teachers asked their students to please interact together and make sure every member of the group knew what was going on as there would be times for defense of group solutions. The preservice teachers challenge their students that they will call on anybody irrespective of ability or disability to represent the group during the defense. (Research Journal)*

From my observation of the four preservice teachers' classroom instruction after the first discussion, they all explored the grouping strategy they initially created at the beginning of the research to influence collaboration in their classroom teaching.

*From my observation of the classroom teaching of the preservice teachers, and the relinquishing of their role as teachers having the monopoly of knowledge. I observed the preservice teachers progressively dissociated themselves from being dictators to negotiators of learning during their classroom teaching. From the side of the students, I also observed that, they gradually adjusted to the collaborative groupings created by the preservice teachers. Their over-dependence on their teachers for everything they needed to know due to the withdrawal of the teachers from being dictators to negotiators of learning also gradually reduced. I discovered that the students started appreciating the collaborative groupings which they initially resisted in the first lesson. (Research Journal)*

Data from the research journal above suggested that, the adjustment of the students to the creation of collaborative groupings were gradual and not immediate. For example, Bisola was of the view that

*"..., it was strange making us sit together..., however, as we progressed, I discovered I learnt more from my colleagues, especially, as you know mathematics is a very difficult subject..., (laugh...)" (Bisola)*

It was also observed that the students appreciated the creation of the collaborative groups. For example, Bucky was of the view that, collaborative groupings help in facilitating their problem-solving skills and learning, it takes away her initial fear of the classrooms being distractive if collaborative groups are created or allowed....

*..., making us sit together..., talk together (though in groups) seems a new thing all together to some of us and indeed very strange..., but..., my first thought was that it might be distractive to the classroom teaching..., but it seems the teachers were very smart, active and good..., we had no opportunity to do other things. (Bucky)*



Still on collaborative groupings, Bisola was of the view that creating collaborative groups help in facilitating slow learners' understanding of mathematics concepts.

*We were made to sit in groups, like in a circular form, and we were made to interact with one another in the group..., This sitting posture created by the teachers, tends to encourage slow learners; they were not left out, they were carried along. (Bisola)*

Bisalla was also of the view that, collaborative groupings make students see mathematics problems as a general problem and not individual problem as against what operates in the Nigerian Mathematics classroom,

*The approach brings all students together to see a mathematics problem as a group problem not as an individual problem. The approach was very interesting, we sit in groups to solve the problems together, we worked on our own, without the unnecessary interference from our teacher..., the teachers assisted us by simply explaining the basic formulas..., however, the approach to the solution was left for us to figure out..., the teachers only come in to help when they discovered we are frustrated and that is good for us. (Bisalla)*

From the comment made by Bisalla, one could deduce that, there was the decomposition of power from the teacher to the students, thereby making learning student-centered in comparison to the teacher-centered learning they were conversant with..., Bisalla said,

*"we worked on our own, without the unnecessary interference from our teachers..., the approach to the solution was left for us to figure out..., (Bisalla)".*

This suggest that the students were independent and had control over their learning which makes them take responsibility of their learning.

One could also deduce from the comments of the students that; collaboration groupings influences student-centered learning in comparison to the general teacher-centered learning that had prevailed in most Nigerian mathematics classrooms.

Data collected from this study also suggest that apart from the creation of collaborative groups in achieving effective collaboration into the mathematics classroom teaching of preservice teachers, the preservice teachers also adopted a strategy of providing difficult mathematics question to foster effective collaboration among the students.

*This I observed in Abba's class who was teaching mathematics to arts and social science students. The students seem to be slow learners, compared to Aminu's class. Abba's class also showed high level of mathematics anxiety and phobia, thereby makes Abba a bit nervous at the beginning. From my observation of Abba's class, there was no problem initiating collaboration among students. This is because, the students were not confident to solve mathematics problems on their own, hence, creating collaborative groups was an opportunity for them to seek assistance from their colleagues. (Research Journals).*

However, the case was different from Aminu 's class. Aminu encountered some resistance initiating collaboration among his students, according to him, the students he was teaching were from a very good academic background. Therefore, Aminu had difficulties implementing collaboration in his classroom teaching. He therefore, complained to me...,

*In my first class after receiving feedback from my students, I make up my mind to adopt collaborative strategy in my teaching, but, my students..., though good and intelligent..., tend to prefer working independently as against the collaborative classroom learning that I encouraged them to do. When I give them problems to solve..., before you know..., they have finished solving the problems independently..., introducing them to classroom dialogue and discussions looks too complex to me..., and I feel..., to them..., collaborating with other students is a waste of time. (Aminu)*

Aminu was teaching very good students and by Nigeria standard, high achieving students are always advised and encouraged to be in the science class, while the arts and social sciences classes takes the average and low achieving students. Aminu wanted to use these potentials to encourage collaboration among his students, but the students were not interested, they tend to prefer their usual traditional individualistic approach to learning. This constituted a great concern to Aminu. I however, advised him to introduce highly challenging problems that go beyond their usual mathematics classroom syllabus; I said,

*Give them challenging work to do... and reduced your role as a teacher and your involvement to the problem solving to that of an adviser ..., allow them to battle the problem themselves..., only come in when you discover they are frustrated..., and your contribution should only be that of leading them to the solution and not solving the problem for them. This will force them to seek assistance from one another, hence collaboration among your students will be achieved through that.... (Research Journal)*

It was with this view Aminu approached the class with the topic "The Length of an Arc" that also motivated me to follow him to observe what his intended method was to achieve collaboration in his classroom teaching;

*I entered the class and the students were already seated, Aminu was at the chalkboard ready to start his lesson. In his characteristic way, I observed, he first reviewed the previous lesson within two to three minutes and appropriately linked the previous lesson with the present. He then asked the students to draw a circle for him on the board. They were also asked to indicate the diameter, the radius and so on..., after some explanation of the properties of the circles, he then asked the students to derive the length of an arc using the formula for calculating the circumference of the circle they had derived the previous day and also the properties of a triangle. I thought Aminu was joking..., looking at the caliber of the students he was working with, and knowing that most mathematics teachers avoid asking their students to do so. I also remembered I had advised him the previous day to provide his students with challenging mathematics problems. Hence, I watched with keen interest to see what would happen next and how he intend to achieve this...,*

*I observed that the students were confused..., the problem was highly challenging ..., subsequently, he raised some questions relating to circumference, angles, properties of a circles, triangles..., etc. He then asked the students to interact within their groups..., and he moved round and gave them some clues to the solution through question and answer techniques without really telling them what to do. I also moved around to observe what the students were doing in the groups. The students started grasping the clue, I also observed that this forced the students to be engaged in intensive dialogue within their groups...,*

*The preservice teacher encouraged them further, by suggesting they could seek assistance from other groups..., (within and outside their groups) collaborative conversations within groups were intensified, the class became interactive, dialoguing, while negotiations, debates and collaborations were intensified among the students. The teacher further assisted the groups that seem confused, through asking them further questions like; what the circumference of a circle is. Can you remember the formula for finding the circumference of the circle? Now, what do you do when you are calculating the perimeter of a shape? What is the sum of the angles in a circle? How do you calculate the perimeter of a triangle? And some other thought provoking questions that helped the students to derive the length of the arc.*

*After much debates and collaborations among students within and outside their groups, the students were able to come up with the formula for calculating the length of an arc. After they had all derived the formula in their groups; the teacher made each group to present their findings and share their results with the rest of the class. The teacher provided further feedback for the students...; further discussion on the formula helped or aided deeper understanding among the students. At the end of the class, questions were asked, and Jackson and the students interacted on the questions raised by the students. Jackson achieved his objective..., the class became interactive..., as collaboration between students was achieved. Subsequently, the students started feeling that when they worked together ideas are shared. (Research Journal)*

The observation above demonstrated the preservice teachers' attempt to achieving collaboration through creating challenging and difficult problems for his students. Before now, his students had stuck to their traditional way of learning. Being good students, they had the tendency to believe that they do not need others to succeed. However, after this activity the students' views toward solving mathematics problems collaboratively began to change. For example, one of the students said;

*To me, this type of approach to teaching is good..., because ..., before, I prefer working on my own..., this is because I sometimes want to contribute something during classroom instruction, but I feel..., what I will say will not be correct and others might laugh at me..., but this activity and the encouragement of our teacher made us feel that what we felt were mistakes or wrong might end up being the idea the class is looking for to move forward. (Jamima)*

### **Perceptions of Students on the Benefits of Collaborative Strategy.**

#### **Response to Research Objective 3:**

*To determine the perceptions of students on the role of collaboration in achieving quality mathematics classroom practice?*

Data collected during the focus group discussion suggests that the students had positive perceptions about collaboration during their mathematics classrooms. From the data collected the students were of the view that, collaboration provides opportunities for students to think collaboratively while solving challenging mathematics problems.

*All the group members solve the problems together..., I think it's good...; you bring your own idea... I bring my own idea... we join it together... and solve the problem. I think this is good..., (Bukola).*

At another time, Bukola was of the view that during collaborative mathematics classroom sessions, ideas are multi-dimensional, that is, it's not only one person thinking, the thinking is in groups and the students in the group unite to come up with a unified solution to the problem being solved. Bukola said,

*This is not only you alone thinking on how to solve a particular problem, the thinking is in group, by the time we join our heads together and think on a solution to a particular mathematics problem, you bring your idea... I bring my idea..., the solution becomes easier (Bukola).*

Similarly, data collected suggested that working collaboratively during mathematics classroom instruction makes students feel more confident in tackling challenging and difficult problems, arguably, more difficult than routine exercises that they were used to.

*The approach brings all students together to see mathematics as a common problem not as an individual problem. The approach was very interesting, we sit in groups to solve the problems together, and we worked on our own, without the unnecessary interference from our teacher..., (Buba).*

In support of the view of Bukola and Buba, Bucky was of the view that,

*...during the classroom teaching, the question given was somehow difficult to solve, but everybody put his head together and the solution was at least obtained, and the problem was eventually solved (Bucky).*

Data collected during the focus group discussion suggested that collaboration during mathematics classroom instruction did not only improve relationships between students, but it also improves relationship between the teachers and their students. This provided a more trusting and open relationship between the teachers and their students, which gave the students confidence to seek help from their teachers and from colleagues as against the traditional teacher dominated classrooms. Jane posited;

*It's like someone is always there... very close to you... to say, O girl? Is there any problem? Do it this way..., this way..., and this way. The classmates also... the teachers... are always there... willing to assist... willing to show the way..., its good..., (Bisola).*

*In my view these teachers really tried..., they..., like..., made sure everybody is carried along and should be able to solve problems in the class. Jackson made it clear to us that everybody must make sure he/she understands and be prepared to solve the problem..., because he can call anybody in the group to solve it..., therefore, we made sure everybody in the group understand the solution of the problem. (Bukola).*

*That is true Bukola, when he said he can call anybody to solve the problem: it makes everyone of us to sit up and make sure he/she understands..., because..., you don't know if you are going to be called to solve the problem on behalf of your group. (Bisola)*

### Findings and Discussions

The findings of this study suggest the need for a shift to a more student-centred learning to replace the teacher-centred learning approach that has not been result oriented Nigerian mathematics classrooms. The general consensus among the students that participated in this research suggested that the teacher dominated classroom system of instruction is long overdue for a change. This section will discuss the findings of the study in the following areas. First, the initial perception of both the teachers and the students on the introduction of collaborative strategy into the Nigerian mathematics classroom will be discussed. Second, findings regarding the strategies the teachers employed to foster effective collaboration among their students will be discussed. Finally, the perceptions of the students on the benefits of collaboration in their classroom practice will be discussed.

#### Initial Perception of Students on Collaboration:

The findings of this study suggest that both the teachers and the students had initial challenges implementing collaboration in their mathematics classrooms. First, the findings suggest that, the students had initial reservations about the collaborative teaching approach. The students were not comfortable with the creation of collaborative grouping adopted by the preservice teachers as a strategy for influencing collaboration during classrooms instruction. The students were of the view that based on their earlier orientation, it was unethical for them to work together during problem solving, share ideas with their classmates or contribute to teaching of their classmates during classroom instruction (Ertmer, 1999)

From the preservice teachers' perspective, the focus group students were of the view that the preservice teachers were finding it difficult implementing the collaborative strategy during their classroom instruction. They were of the view, that the teacher authoritarian approach to classroom instruction were still observed. Secondly, most of the teachers at the initial stage of the research adopted the teacher-centered teaching approach with little or no involvement of their students. The students were mere recipients of knowledge as against the constructivist view of students constructing their knowledge through collaboration and dialogue with their colleagues (Ertmer & Hruskory, 1999).

#### Strategies for Fostering Collaboration Among Students:

The preservice teachers adopted the collaborative groups as a strategy to achieve effective problem solving among their students, assist students that require more attention in their learning journey achieve and understand difficult

mathematics concepts. The creation of collaborative groupings helped the students to see mathematics problem solving as a common classroom problem that need to be jointly solved and not an individualistic problem. This support the findings of Scott, (2015) who was of the view that students' experiences during mathematics classroom instruction today had tremendously improved because mathematics teachers seek to establish a community approach to teaching and learning by providing opportunities for students to collaborate with their peers, thereby, helping the students to construct their mathematical identities.

Finally, the findings of the study in research objective 2 suggest that the students from educationally advantage groups tend to prefer individualistic approach to classroom instruction compared to students from the educationally disadvantage group. However, providing difficult mathematics classroom problems can encourage collaboration among students from the educationally advantaged group. This aligns with Emmer and Gerwels (2006)'s view who proposed that collaborative conditions helped group members have a change of mind about their members while competitive conditions make members see others less as peers or members of the learning community. They went further to suggest that students' behaviors are changed when teachers encourage their students to dialogue and reflect on their communities which are useful tools for collaboration during classroom instruction.

### **Perceptions of students on the Benefits of Collaborative Strategy:**

The finding from the research objective 3 suggest that there are benefits and advantages when collaboration is introduced into mathematics classroom instruction. Some of the benefits were identified in research objective 2 to include, aiding effective inclusion of learners that require more assistance with high achieving students into the mathematics classroom and provision of cooperation among students in solving difficult mathematics problems. The findings from the views of students aligns with the findings of Abimbade and Afolabi (2012), Mansaray and Amosun (2002) who proposed that effective collaboration during mathematics classroom instruction helped in developing critical thinking capabilities of students during classroom instruction. This suggest that there is need for mathematics teachers to emphasize teaching strategies that encourage critical analysis of issues, and a democratic classroom atmosphere that encourages exchange of ideas and opinions among students.

Similarly, the findings of the study also suggest that effective collaboration during classroom instructions enhances students' collaborative thinking while solving difficult and challenging mathematics problems, thereby helping to boost students' confidence in solving challenging mathematics classroom problems. This is a necessary ingredient to effective mathematics classroom instruction as suggested by Felder & Brent (2003) Lloyd, (1999) which is also against the general teacher dominated mathematics classroom relationship that have bedeviled the Nigerian mathematics classrooms Abimbade and Afolabi (2012).

The findings of this study also suggest that effective collaboration during mathematics classroom helps in improving relationship between students, relationship between students and their teachers and also makes students see their ideas as multidimensional thereby increasing students' confidence during mathematics classroom instruction. These findings support the findings of Morgannett (1991) who was of the view that effective collaboration increases students' relationships and fosters teachers' positive and supportive relationships with their students, which tends to help students' performance during classroom engagements. The findings of this study also suggest that the use of collaborative classroom instruction helped building students' confidence in interacting freely with the teachers and their class mates as supported by (Alexander, 2005).

### **Conclusion**

In conclusion, this paper sought to look at collaboration as an effective tool for mathematics classroom practice. Four preservice mathematics teachers participated in a qualitative case study research. These teachers taught mathematics in two secondary schools for a period of 15 weeks. These 15 weeks were divided into two phases. In phase one four preservice mathematics teachers taught mathematics for ten weeks. During this period Six students willingly participated in three focus group discussions on the effectiveness of the new mathematics classroom setting created by the preservice mathematics teachers. In the second phase, two preservice teachers also taught mathematics for 5 weeks where six students also voluntarily participated in one focus group discussions on the implementation of the strategy in their school.

In the first phase, the preservice mathematics teachers held three reflection meetings after every three weeks to reflect on their practice. This research reports on the collaborative aspect of the study, focused on the perception of the 12 students on the effectiveness of introducing collaboration during mathematics classroom instruction on their learning. Three research objectives guided their discussion during the 15 weeks. Observations, research journals and focus groups were used to collect data for the study. The focus groups meetings and some of the classroom instructions particularly during the second phase were video recorded.

The findings of the study suggest that the preservice teachers had initial challenges introducing collaboration into their classroom instructions, however, as they progressed in the implementation of the strategy, they gradually adopted it into their classroom instruction. The findings of this study also suggest that the preservice teachers used collaborative

groupings and higher ordered Questions to foster collaboration among their students. Some benefits of this strategy were also outlined by the focus group students who were of the view that if collaborative strategy is properly implemented in classrooms there will be effective teacher-student and student-student relationship, it will help students see mathematics problems as common problems and also reduced the domineering attitude of mathematics teachers who see themselves as possessing the monopoly of knowledge. Finally, the findings of the study revealed the replacement of the teacher-focused practice with a student-centered approach in facilitated collaborative mathematics classroom practice with students leading the class and hence taking responsibility of their learning.

### Recommendations

In view of these findings the researcher made the following recommendations:

- The researcher recommended the introduction of collaboration into the Nigerian mathematics classroom instruction as against the tradition teacher-controlled mathematics classroom instruction that have bedeviled Nigerian classrooms.
- A new student-centred learning approach which encouraged students' collaboration be implemented in the Nigerian mathematics classrooms.
- The usual teacher-domineering attitude to classroom instruction, teacher-centred classroom instruction and teacher-chalk approach to teaching should be replaced with a more students-centred learning where students will take responsibility for their learning as promoted by the constructivist epistemologist.
- Constant teachers' development program on teaching strategies, like the innovation employed in this research is highly recommended. This will help teachers learn new teaching pedagogies and develop new teaching strategies to foster effective learning in mathematics classrooms.

Therefore, it is recommended that if collaboration is introduced into the Nigerian mathematics classroom instruction the tradition teacher-controlled mathematics classroom instruction that have bedeviled mathematics classrooms will be reduced. A new student-centered learning approach will be put in place where students will take responsibilities of their learning.

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