



## Achieving Quality Mathematics Classroom Instruction through Productive Pedagogies

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**Abstract:** This paper seeks to investigate the implementation of the Productive Pedagogies Framework in Nigerian mathematics classroom setting. The researcher adopted a qualitative case study approach to seeking data for the three research questions postulated for the study. Three mathematics teachers taught mathematics in two secondary schools in two Central states of Nigeria using the Productive Pedagogies framework introduced to them by the researcher. Two major instruments (observation and reflective interviews) were employed to seek information from the teachers and the students. While the researcher uses the grounded theory approach to interpret and or analyzed the data collected. The findings of this study suggest that the teachers made attempts to use Productive Pedagogies framework to achieved quality mathematics classroom instructions. This was demonstrated in their effort to used problem-solving to achieve intellectual quality classrooms instructions, making mathematics classroom instruction relevant to the world around their students, developing an atmosphere of friendship during classroom instruction and identifying and recognizing the differences existed among students during classroom instruction. It was observed that the used of the Productive Pedagogies can increase students' engagement, collaborations, interactions, substantive conversations and effective inclusion during mathematics classroom instruction in which the research finally recommended the adoption of the Productive Pedagogies framework in the Nigerian mathematics classroom.

**Keywords:** *Pedagogies, productive pedagogies, quality classroom instruction, classroom teaching strategies.*

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### Introduction

There is presently a global concern toward quality classroom instruction with particular emphasis on achieving quality mathematics classroom instruction (Pianta and Hamre, 2009; Matsumura, 2002; Meyer et al. 1993; Pianta et al. 2008). These concerns according to Atweh, (2007) and Alghamdi (2013) focused on issues of the learner's neglects and the crucial role of the mathematics teacher in the educational endeavor of our students. Research studies indicate that most commonly adopted strategies for mathematics classroom instruction in Nigerian is in line with what can be called "traditional teacher-centered approach". This is the approach where mathematics teachers monopolize communication, dominate classroom discussion, and maintain structures that heavily rely on teacher-centered approach (Abanihe, Ifeoma, John and Tandi, 2010; Azuka: 2006; Bature & Jibrin, 2015; Kaka, 2007; Odilli: 2006). Abanihe, et al, (2010) when further to assert that, this approach permits teachers to dominate classroom talk and control classroom activities with little or no opportunity for students' contribution. From this view, students' responsibility is to listen carefully and copy examples given by the teacher (Bature, James, Aramide, Danladi & Nengak 2015; Emaikwu, 2012). It is also sad to not that the traditional classroom instruction had remained unquestioned in Nigerian mathematics classrooms which are a stark contrast to the National Objectives of mathematics as indicated in the National Policy on Education in Nigeria (FGN, 2004; Kaka, 2007).

Bature et al (2015) and Bature and Jibrin (2015) were of the view that, if mathematics teachers hope to achieve quality classroom instruction, there is an urgent need to foster the constructivist view of classroom instruction. This became necessary because constructivism has provided mathematics teachers and teacher educators useful strategies for enhancing quality mathematics classroom instruction. It has made the responsibility for reconstructing mathematics classroom teaching pedagogies a considerable necessity (Simon, 1995). In view of these, there is a global moved for the reformed of mathematics classroom instruction with the view to keep up with the global changes towards student-centered approaches. For example mathematics education researchers, Teachers, and teacher educators are advocating

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for the reform of mathematics classroom instruction grounded in a social constructivist view of classroom teaching, learning and knowledge. One of such researchers and educators is Chinnappan (2008; 182), who was of the view that “*Mathematics educators and teachers have invested considerable effort in exploring instructional strategies that would help learners to develop a better grasp of mathematical concepts.* In view of these, is therefore, pertinent to suggest that high instructional mathematics classroom practice is vital to achieving quality mathematics classroom instruction and if quality mathematics instruction is to be achieved Mathematic teachers most monitor their students’ progress and performance and provide explanations and ideas to the students on areas the students need improvement (Matsumura 2002; Meyer et al. 1993; Pianta et al. 2008).. In addition, achieving quality mathematics classroom instruction requires mathematics teachers to be concept focused, instead of focusing on the answer. Such classrooms environments are progressive in nature which helps students build up their learning through their prior knowledge (Kilpatrick, Swafford, & Findell. 2001).

There is the need, therefore, to encourage mathematics teachers to adopt the constructivist approach to classroom instruction. This is because, the mathematics classroom of the twenty-first century is no longer a place where the teacher ditched out knowledge into his passive and inactive learners, who are waiting like empty vessels to be filled (Jordan, Caelie, & Stack, 2008). It is rather, a model mathematics classroom where mathematics teachers are urged to model their students to be actively involved in constructing their own learning process through collaboration, interaction, and engagement with their learning environment (Ryder 2009). This strategy helped students gradually assume more responsibility over the learning, bring about forge group expectations for higher level thinking among students, and help the students acquire skills that are relevant and important for learning and success in everyday life. Simon (1995) was of the view that the incorporation of the constructivist strategies into our classroom instruction has provided useful guidelines for helping teachers and teacher educators think about mathematics teaching and learning as the main activity in a classroom where students use inquiry methods to ask questions, investigate topical issues, and use a variety of resources to find solutions and answers to their classroom problems (Driscoll, 2005).

One of such constructivist approaches to classroom instruction is the reforms carried out by the Queensland School Reform Longitudinal Study (QSRLS) research team of the University of Queensland in the early nineties. They were of the view that achieving quality mathematics classroom instruction requires mathematics teachers build their classroom instruction around several teaching pedagogies (Education Queensland, 2003). These pedagogies are based largely on the notion of complex instruction such as providing mathematics classroom instruction and its pedagogies that can promote powerful positive impact on students’ learning outcomes (Cohen and Latan, 1997). This complex Pedagogies is what the University of Queensland Research team called the Productive Pedagogies. The Productive Pedagogies stemmed from a long and rigorous study into the classrooms in Queensland, Australia (Lingard, Ladwig, Mills, Bahr, Chant, Warry, Ailwood, Capeness, Christie, Gore, Hayes, & Luke, 2001). The term according to Lingard, Hayes, Mills, & Christie, (2003) suggested a classroom practices that is aimed at making a difference in the academic and social outcomes in students learning. This is in tandem with the social constructivist view of classroom instruction as process of individual and social construction of knowledge and as a conceptual framework with which to improved students’ social interaction with their learning environment (Simon, 1995).

The proponents of the Productive Pedagogies framework developed some pedagogies which they believe are quality indicators that can be seen in a quality and effective mathematics classroom instruction (Lingard et al. 2001). These pedagogies according to the proponents are group into 4 dimensions of Intellectual Quality, Connectedness, Supportive Classroom Environment, and, Working with and Valuing Difference (Education Queensland, 2003). Although the 4 dimensions of the Productive Pedagogies were drawn from the research work of Newman and Associate (1996), the SRLS research team reviewed literature on these pedagogies more generally and identified 20 elements that they feel constituted quality classroom indicators in the 4 dimensions of Productive Pedagogies (Education Queensland, 2003, Zyngier, 2005). These elements according to Education Queensland (2003) are *Intellectual Quality* with 6 elements of higher order thinking, deep knowledge, deep understanding, substantive conversation, knowledge as problematic and metalanguage. *Connectedness* has 4 elements which include; connectedness to the world, problem-based curriculum, knowledge integration, and background knowledge. *Supportive Classroom Environment* has 5 elements of student direction, social support, academic engagement, self-regulation and explicit quality performance criteria. While, *Recognition of Difference* has 5 elements of inclusivity, narrative, group identity, cultural knowledge, and active citizenship.

The table below gives a brief picture of the 20 elements that constitute the Productive Pedagogies framework as suggested by the QSRLS of the education Queensland (2003).

Table 1. A brief picture of the 20 elements that constitute the Productive Pedagogies framework

<b>Strategy</b>	<b>Focus questions</b>
Higher-order thinking	"This requires students to manipulate and combine facts and ideas in order to synthesize, generalize, explain, hypothesize or arrive at some conclusion or interpretation. Manipulating information and ideas through these processes allow students to solve problems and discover new meanings and understandings" (Alsharif, 2011; 5). Are higher-order thinking and critical analysis occurring?
Deep knowledge	Does the lesson cover operational fields in any depth, detail or level of specificity?
Deep understanding	Do the work and response of the students provide evidence of the depth of understanding of concepts or ideas?
Substantive conversation	This constitutes a considerable student-teacher and student-student interaction about the ideas in the topic. Does classroom talk break out of the initiation/response/evaluation pattern and lead to sustained dialogue between students, and between teachers and students?
Knowledge as problematic	Are students critiquing and second-guessing texts, ideas and knowledge?
Metalanguage	Are aspects of language, grammar, and technical vocabulary being foregrounded?
Knowledge integration	Does the lesson range across diverse fields, disciplines, and paradigms?
Background knowledge	Is there an attempt to connect with students' background knowledge?
Connectedness to the world	Do the lesson and the assigned work have any resemblance or connection to real-life contexts?
Problem-based curriculum	Is there a focus on identifying and solving intellectual and/or real-world problems?
Student direction	This element seeks to determine the degree of student influence on the classroom activities and the way they are implemented. Do students have any say in the pace, direction or outcomes of the lesson?
Social support	In this element the teacher supports students by conveying high expectations for all students, it is necessary to take risks and try hard to master challenging academic work, encouraging the class to learn important knowledge and skills in a climate of mutual respect among all members of the class and contributes to classroom goals and see to their achievement by all irrespective of ability. Is the classroom a socially supportive and positive environment?
Academic engagement	This involves keeping students on-task that signal serious investment in class work which may include attentiveness, doing the assigned work showing enthusiasm for this work taking the initiative to raise questions, contribute to group tasks and help peers achieved valuable learning outcomes. Are students engaged and on-task?
Explicit quality performance criteria	This involve presenting to students frequent, detailed and specific statements about what it is students are required to do in order to achieve. Are the criteria for judging student performance made explicit?
Self-regulation	In this element self-regulation by students is high when teachers are not making or not having to make statements that aim to discipline students' behaviour or to regulate students' movements and dispositions. Is the direction of student behavior implicit and self-regulatory or explicit?
Cultural knowledges	Are diverse cultural knowledge brought into play?
Inclusivity	Are deliberate attempts made to increase the participation of students of different backgrounds?
Narrative	Is the style of teaching principally narrative, or is it expository?
Group identity	Does the teaching build a sense of community and identity?
Active citizenship	Are attempts made to foster active citizenship?

Source: {School Reform Longitudinal Study (SRLS) Report, October 2001, p. 10}

Research studies on these Pedagogies emphasizes that all students irrespective of needs and background are to be provided with intellectually challenging classrooms work (Blackhall 2002; Boaler, 1997; Hayes et al., 2006) and that if such students are engaged with intellectually challenging work during their classroom instruction, there is the

probability of having their learning outcomes improved (Ramsey, 2000; Sorin & Klein, 2002). Similarly, giving students intellectually challenging classroom task could also help foster students' collaboration and interaction during classroom instruction (Bature, 2014). Bature et al (2015) were also of the view that making mathematics classroom instruction more relevant to students' lives could give them the opportunity for meaningful learning experiences that may help reduce their challenges during classroom instruction. Alsharif & Atweh, (2012) and Atweh, (2007) were of the view that providing students from diverse background a supportive classroom environment possesses the possibilities of creating classrooms where students are given the opportunity to 'take risks' without being ridiculed or pull down by their classmates and or their teachers. Finally, the recognition of different social groups in a mathematics classroom suggests the need to recognize and value the cultural backgrounds existed among students with the aimed of developing the learning experiences of different students in a mathematics classroom (Hayes et al., 2006).

In the stride to improving mathematics classroom instruction and other subjects across school levels there are several research studies in the literature that have explored and utilized the Productive Pedagogies framework in teacher education across the globe. For example, Alsharif and Atweh (2012) in Saudi Arabia modeled the Productive Pedagogies framework in preservice teachers' education programs to develop their pedagogical practices during their field experience. Alsharif and Atweh (2012) introduced the framework to their pre-service teachers in a unit on mathematics education for a semester after which the preservice teachers were observed during their field experience in the following semester to ascertain their level of understanding and the used of the Productive Pedagogies framework. The results of the study suggested that there was a high level of acceptance among the preservice teachers in Saudi Arabia on the use of the framework as an effective tool for mathematics classroom instruction. They were also of the view that, the preservice teachers demonstrated a shift towards student-centered classroom instruction as against the traditional domineering teacher-centered instruction. In a similar study in the United Arab Emirates, Tanko and Atweh (2012) used the Productive Pedagogy framework to improve the teaching and learning of practical numeracy with adult learners. In that study, they discussed how the elements of Productive Pedagogy were utilized to design student projects in order to enhance the teaching and learning of practical numeracy among young adult Arab women. The findings of the study suggested that the adoption of Productive Pedagogy framework in this context helped to improve the teaching and learning and contributed to the increase of students' engagement, which also promoted active citizenship among these adult students.

Several other researchers have also work on the Productive Pedagogies framework. For example Bacon, (2012); Bartel, (2011) and Tanko, (2012) used Productive Pedagogies to introduce social justice practices in mathematics classroom instruction. Aveling & Hatchell, (2007) Sorin & Klein (2002) Wilson and Klein, (2000) Zyngier (2005) adopted the Productive Pedagogies framework to increase preservice teachers' awareness of teaching pedagogies that could improve classroom engagement, participation, and to implement critical reflection among teachers and students. Chinnappan, (2006) in his own study uses Productive Pedagogies to build a community of learners through online mathematics classroom instruction with the view to improving interaction among preservice teachers in the context of collaborative activity in which the preservice teachers were required to reflect on, critique, and share views with their colleagues and or peers. The findings of these studies suggested that Productive Pedagogies is an integrated alternative to several other frameworks that are available to preservice teachers who are looking for something innovative in which to anchor their beliefs and practices about mathematics classroom instruction.

The desire, therefore, to introduce the Productive Pedagogies framework into the Nigerian mathematics classroom with the view to reforming its instruction is not out of place. In view of these, this study attempts to use Productive Pedagogies as a framework to reforming the teaching and learning of mathematics in Nigerian mathematics classroom with the view of achieving quality classroom instruction. This paper which was derived from a wider study seeks to investigate the changes observed in the mathematics classroom practice of three mathematics teachers as a result of their implementation of Productive Pedagogies framework in which the following research questions guided the study.

1. To what extent did the mathematics teachers implemented the Productive Pedagogies framework during their classroom instruction?
2. What are the possible challenges that impeded the implementation of the Productive Pedagogies framework among the participating teachers?
3. What are the benefits of using the Productive Pedagogies framework in Nigerian mathematics classroom as observed by both the teachers and their students during the research?

### **Methodology**

**The design:** In order to achieve quality classroom instruction through the use of the Productive Pedagogies framework, this research adopted a qualitative case study approach to seeking information for this study. In his study, Yin (2003) was of the view that case study design could be considered during research when: the researcher's focus is to answer

questions like “how” and “why”; when there are no possibilities of manipulating the behaviour of the respondents involved in the research and when the researcher want to cover contextual conditions because of their relevance to the concept under study. A Qualitative case study is an approach to research that facilitates exploration of phenomena within its natural context using a variety of sources. This source ensures that the issue raised in the research is not investigated through a one-way approach. Different approaches are employed to look into the problem with the view to achieving a holistic solution to the problem (Baxter & Jack, 2008; Stake; 1995). In this study, the researcher draws data from field notes; observations and interviews conducted for a period of five weeks between the month of January and March 2013, which falls within the second term of the 2012/2013 academic year in Nigeria.

**The Samples:** Three mathematics teachers Adamu, Aminu and Ahmed (Pseudonyms) from two Secondary Schools in two states of Central Nigeria where used for the study. These were preservice teachers of one of the universities in the North Eastern Nigeria. The preservice teachers had been teaching mathematics for an average of five years before deciding to further their education to obtain a graduate degree in Mathematics education which suggest that they were experienced teachers. They were purposively selected for the study as they indicate voluntarily their willingness to participate in the study. The first two teachers Adamu and Aminu taught a senior secondary school one while the third teacher Ahmed taught the junior secondary schools three. Both schools were mission schools as they belong to Christian Churches. Schools belonging to churches in Nigeria are called mission schools. They schools observed strict religious rules as taught in their churches.

**Data collection Strategies:** The researcher introduced the mathematics teachers to the principles of Productive Pedagogies through a two-day workshop. The purpose of the workshop was to familiarize the mathematics teachers with the basic understanding of the Productive Pedagogies concepts and its application to mathematics classroom instruction. The mathematics teachers then used the knowledge gathered during the workshop to teach mathematics for a period of 5 weeks using the principles of the Productive Pedagogies framework they learned during the two-day workshop. During this period, the researcher personally observed the classroom teaching of the teachers and also had reflective interviews with some randomly selected students in their classes to receive more insight to the implementability of the framework by the teachers. Similar interactive or reflective interviews were conducted with the teachers. The normal ethical issues and the necessary permissions were obtained earlier before the research started.

**Analysis:** Data collected were analyzed using a general qualitative analysis approach (Corbin & Strauss, 2008; Strauss & Corbin, 1998) to find patterns in the mathematics teachers’ possible implementations of the Productive Pedagogies framework during their classroom instruction. Transcripts of the observational notes during the lessons, as well as transcripts from interviews with both the three teachers and the selected students, were the main data sources for analysis. Field notes taken by the researcher were secondary documents that provided additional and multi-dimensional points of view on the mathematics teachers’ classroom instruction using the Productive Pedagogies framework. The analysis in these articles was not limited to anticipate themes that are those issues the researcher thinks are important, but, emergent themes from the participants were also considered by the researcher to establish the trustworthiness of the data collected. The data generated were collated, coded, and analyzed. The researcher, therefore, selected quotes that are most representative of the research questions and weaved them together to discussed and interpreted with the view of make meaning before drawing conclusions from them.

## Results

To answer the research questions in this study, the researcher identified some themes particularly in research question 1 and discussed how the mathematics teachers implemented the Productive Pedagogies framework. In research question 2 the researcher identified some comments raised by both teachers and their students on the benefits of the Productive Pedagogies framework introduced to the teachers.

### Response to Research Question 1

*To what extent did the mathematics teachers implemented the Productive Pedagogies framework during their classroom instruction*

To respond to this research question, the researcher was interested in investigating the changes observed in the mathematics classroom teaching of the mathematics teachers as a result of their implementation of the Productive Pedagogies framework. This was discussed using the following themes; the role of the problem solving in achieving high intellectual quality, making mathematics classroom activities relevant to the students, developing an atmosphere of friendship among students that is full of support during classroom instruction and Recognizing students differences

during mathematics classroom. The researcher also looked at areas the participating teachers had challenges in the implementation of the productive pedagogies framework.

***The Role of Problem Solving in Achieving Intellectual Quality classrooms:*** In demonstrating how the teachers used problem-solving in their classroom teaching, what happened in Aminu classroom could be a good example. Aminu attempted to convey knowledge and skills to his students (average aged 14 years old), on the topic “*Calculation of Area of a Given Shaped*”. Aminu exploited problem-solving as a strategy to achieving substantive conversation, higher order thinking and knowledge as problematic which are elements in the intellectual quality dimension of Productive Pedagogies. The researcher observed;

*I entered the class and walked to the back and sit down to observed what is happening in the class. The teacher had successfully introduced the Area of different two-dimensional shapes to his students. He had also demonstrated this by solving some examples in the class and he asked if the students understood what he was explaining and the students responded positively.*

*He then gave them three problems to solve. He had initially sat the class in five groups of six students each and hence asked them to cooperatively solve the problems in their groups. I observed that he walked around to observed what the students are doing and offer assistance where necessary. I also walked around in my curiosity to know what is happening in each group. I observed that the students did not find question one and two difficult, as the two questions where mere lower order thinking and the students did not take time finding the solution to the two questions. However from my observation question three was technical and required the reconstruction of new knowledge in order to achieve the required solution. The question required the students to find the Area of the shaded portion inscribed in an irregular shape. Aminu (the teacher) also observed the same and hence gave them more time and suggested they intensified and expands their dialogue within the groups to other groups.*

*In my observation from group to group, I discovered in two of the groups the students had identified different approaches to the solution of the problem, the first group reconstructed the irregular shape into a big regular rectangle and found the Area of the rectangle and also found the Area of the unshaded part of the rectangle, and find the difference between the two shapes to get the Area of the shaded part. The second group also reconstructed their own irregular shape by creating smaller but regular shapes from the initial irregular shape given and find the Area of each shape and sum-up the Areas of all the shapes to get their own shaded part. I became interested in what they were doing hence I compared the two answers when the two groups presented their results to the whole class and discovered their answers were the same and correct. Feedback was given to the students by Aminu and he commended the two groups for their wisdom. At the end, conversions were held especially to help the groups that were not able to successfully solve the problems. I also observed despite defending their solution openly some students still approach these two groups for further explanations (Reflective Journal).*

In this scenario, certain elements in the intellectual quality dimensions were demonstrated. From the activity above Aminu created activities that required knowledge as problematic since the students came up with different approaches to the solution of the problem given to them. Similarly for the students to have reconstruction the question in their own understanding and came up with an appropriate solution to their problem contrary to the general approach given to them by the teacher demonstrated that the students used their higher order thinking skills, and deep knowledge in the solution to their problem, one of the teachers who was with me during the observation of Aminu’s classroom said;

*These were not easy tasks for the majority of students as it is not part of their normal classroom routine. This is contrary to what obtained in my classroom before now, most students depend mostly on teachers examples to solve their problems especially where the teacher claimed the monopoly of knowledge (Adamu, Reflective Interview).*

From the activity, the students through the encouragement of their teachers engaged themselves into long conversations which are an indication of the concept of substantive conversation.

***Making Mathematics Classroom Activities Relevant to the World around the Students:*** Most mathematics classroom teaching in Nigeria is not only traditional in approach, but sometimes mathematics teachers tend to approach the teaching of mathematics focusing on algorithms and procedures with little emphasis on students understanding and applications. In this research, the mathematics teachers made attempt to make their mathematics relevant to the daily lives of the students. For example, Adamu attempted using connectedness during his mathematics classroom instruction. He wanted to introduce the concept of the perimeter to his student; he created an activity that

demonstrated students' background knowledge and some elements of connectedness to the world. The researcher observed;

*I entered the class..., it was his second lesson with senior secondary one students. Adamu wanted to introduce the concept of perimeter of regular and irregular shapes to his students. In introducing the lesson, he started by revising what he taught in the previous class which is the identification of different shapes. He then when further to create an activity where he brought four students and asked them to stand at the four angles of the class. He gave the first student an improvised baton and asked the student to run and give the baton to the second student, then to the third and.... to the fourth student. The students ran round the class and brought back the baton to the teacher. He then asked the class*

*Teacher: what were these students doing?*

*Jamil: They were running a relay race..., but..., what has this to do with mathematics? Curiously asked...*

*Teacher: The teacher answered the student..., then asked..., who can tell me how long did these students run?*

*Bosam: it is not possible sir, we have to measure..., or ... can we use the ruler to measure the distance they covered?*

*Teacher: you are right .... We could..., but....*

*The teacher stopped them, and when further to ask more questions and the students responded positively, from the questions he asked, led to the topic perimeter. The students through self-discovery were able to see perimeter as the distance round a given shape..., he further sketched the shape of the class showing the four students at different points in the shape. From my observation I expected Adamu to ask the students to use either their feet or the meter ruler that was in the class to measure the distance each of the students ran as suggested by Bosam, but even though he did not use that he did something similar, he asked the students to estimate the length in metres each of the students ran. The students looked at the difference distances and suggested the distances covered by each of the students (Reflective Journal)*

From the activity, Adamu was able to use his student's background knowledge to make connection with the lesson he intended to teach. This he did by helping the students to link the mathematics they are learning to their background knowledge, that is, the knowledge of exchange of baton in athletics. He was also able to link the mathematics he was teaching with the knowledge of other subject area such as physical and health education which could be viewed as knowledge integration. This demonstrated an application of Connectedness during Adamu classroom instruction. However, Adamu could have also achieved connectedness to the world, if he had asked the students to use their feet to measure the distance in feet round the class or better still, used the chalkboard ruler as suggested by one of the students to measure the dimensions of the class. The student said;

*It is not possible sir, we have to measure..., or ... can we use the ruler to measure the distance they covered? (Bosam: Reflective Journal)*

But he, however, choose to asked the students to estimate and suggest the distance covered by each of the four students. This could perhaps be view as using the students higher order thinking. However, I confronted Adamu during the interview as to what he did not allow the student to use their foot or the meter ruler to measure the distance round the class. Adamu insisted;

*This is a senior secondary one class, achieving higher order thinking skills is very important, and was my priority; and not just using the lower order thinking as suggested by Bosam. You (researcher) expected me to ask the students to use the ruler to measure the distance. That is good but it would have been too simple (lower order skills) to asked the students to use ruler or their foot as if they are in primary school. I decided to ask them to estimate the distance to know their critical thinking ability. Since estimation as a topic exists in what they learned in Junior secondary two and three which could also be viewed as connectedness. (Adamu, Reflective Interview)*

From the views of Aminu above many more issues were in his mind as against the views of the researcher who was only looking at one aspect of Productive Pedagogies which was background integration. Aminu had the concept of higher order thinking in his mind and knowledge integration.

**Developing an Atmosphere of Friendship and Support:** Data collected during the research demonstrated that the mathematics teachers created supportive classroom climate suitable for effective instruction. For example in Aminu classroom, the researcher observed that when the problem was challenging to the students the teacher provided support for them, and encouraged his students to seek and provide support for one another.

*I entered the class and the students were already seated, Aminu was at the chalkboard ready to start his lesson. In his characteristics way, I observed he first reviewed the previous lessons within two to three minutes and appropriately links the previous lesson with the present. He then asked the students to draw a circle for him on the chalkboard. They were also asked to indicate the diameter, the radius and so on..., after some explanation of the properties of the circle he then asked the students to derive the length of an arc using the formula for calculating the circumference of the circle they 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 highly Intellectual Quality problems to the student. Hence I watched to see what will happen...,*

*..., I observed that the students were confused..., the problem was highly challenging ..., subsequently, he (Aminu) raised some questions relating to circumference, angles, properties of a circles, triangles..., etc. and he moved round and gives them some gist or clues to the solution through question and answer techniques without really telling them what to do*

*The students started grasping the clue, I also observed that this forced the students to engaged into intensive dialogue within their groups..., he (Aminu) encouraged them further by suggesting they could seek assistance from other groups..., (within and outside their groups)...*

*The teacher further assisted the students through asking them questions like what is the circumference of a circle. 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 help the students to develop the Length of an arc (Reflective Journal).*

From the activity, it clearly demonstrated that the mathematics teacher (Aminu) uses support to help his students find the solution to their classroom problem. This he did by using different forms of support. For example, Aminu moved around the class to see what the students were doing and offer his support which could be termed teacher-student support. Second, Aminu used the students to offer support to one another, which could be term Students-student Support. Third, the teacher uses questions and answer techniques to triggered the collaborative thinking of his students which could be seen in term of cooperative work. As the students comply with the suggestion of their teacher, the solution to their problem became easier. This suggests that creating an atmosphere of friendship and Support during mathematics classroom practice is instrumental to effective classroom teaching. If mathematics teachers made effort to create classrooms environment that is supportive and engaging to their students, students' participation and engagement in mathematics classroom activities will increase.

**Recognizing Students Differences in Mathematics Classrooms.** Starting with the activities created by the mathematics teachers to demonstrate Recognition of Difference, the researcher was in Aminu, Ahmed, and Adamu classroom during the research. The researcher observed that before the teachers started their classroom teaching they first reorganized the classroom structures or the classroom settings to make sure their students are in groups. From the researcher's observation of mathematics teachers' classrooms throughout the research period, the teachers made deliberate attempts to recognize the different social groups in their classes' right from the first day. For example, Ahmed explains;

*When we got to the class, we discovered that the students were seating according to their identities- boys with boys; girls with girls- even among these students we discovered we had another problem, students from the same tribe or culture sits together and you find them interacting in their own language. You also find friends also sitting together. Therefore, the only thing we did was to reorganize the class..., and that really help us created a more cohesive classroom atmosphere..., though they attempted resisting the approach..., we however succeeded is convincing them (Ahmed: Reflective Interview)*

From the comments of Ahmed above and his effort to achieved quality classroom teaching right from the first day they all reorganized their classrooms seating arrangement and made the students sit in groups; for example in Ahmed's class, the following steps were taken to reorganized the class;



*I followed Admed to the class, being the first day of my classroom observation. The first thing he did was to discuss his mission with the students, and sought their cooperation with him throughout the research. The students also pledge their allegiance to him. He then discussed also with the students the need to reorganize the class for their maximum benefit and participation. This he did by asking the students to sit in groups of five or six. The students were not comfortable with the idea on the new sitting posture; he, however, explained his reasons and then persuaded them which they reluctantly agreed. After setting the class to sit in groups, he also persuaded the students again in each of the groups to elect their group leaders and secretaries.*

*Responsibilities of group leaders were given and that of the secretaries. This he did by explaining to the students that when a problem is raised in the class, the group leader will lead the group or appoint someone in the group to lead or solve the problems while the secretary notes all the deliberations and decisions reached in each group. From the groupings I discovered that boys and girls were made to sit together, this was actually the reasons the students demonstrated some resentments at the beginning. He also made sure with the help of the mathematics teacher for the class and the classroom captain no two friends sit together. With the assistances of the mathematics teacher also students with learning abilities and disabilities were made to sit together. He asked the students to please interact together and make sure every member of the group know what is going on as there will be the time for the defense of group solutions which he can pick anybody in respective of ability or disability to represent the group (Reflective Journal).*

From the observation of the researcher on the classroom activities the first day, there were difficulties getting the students cooperation in the classroom activities in Admed's classroom. The reasons for this perhaps is as a result of his students' religious upbringing which affected their perception of seating in groups; for example Admed's school was a mission school as the name implies in Nigeria to represent schools owned by churches and Christian religious organization. In these types of schools, religious discipline is highly upheld. Therefore anything that will bring boys and girls at this age together could be termed inappropriate. In supporting this claim the researcher interacted with one of the students after the first classroom instruction. The student was of the view that they find it difficult believing that their teachers could allow continued interaction between boys and girls and even encourage it. This student 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 relationship with boys. Therefore making us sit together..., talk together (though in groups) seems a new thing altogether; to some of us, it is indeed very strange..., but my first thought was that it might be distractive to the classroom teaching..., but it seems the teachers were very active and good..., we had no opportunity to do other things else..., (Student: Reflective Interview)*

A student from Adamu's class also made a similar observation, though in terms of problem solving;

*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 feels this is morally wrong..., as if these teachers did not know that this is a mission school..., but our teachers were with them and supported it..., it was strange..., but as we progress I discovered I learnt more from my colleagues especially as you know mathematics is a very difficult subject..., (laugh....) (Student: Reflective interview)*

From these views, it demonstrated that the students initially felt this is strange to them. Because they are accustomed to the traditional mathematics classrooms of individualized learning.

## **Response to Research Question 2:**

*What are the possible challenges that impeded the implementation of the Productive Pedagogies framework among the participating teachers?*

This research question looks at the area of challenges the mathematics teachers faced in their attempt to introduce the Productive Pedagogies framework. Particularly, the section looks at the initial Skepticisms and nervousness of both the teachers and students on the concept of Productive Pedagogies, challenging traditional teacher-centered approaches and challenges of implementing some elements of Productive Pedagogies.

**Initial Skepticisms of the Productive Pedagogies Framework:** The first challenge I had with the teachers was how they greeted the concepts of Productive Pedagogies. When we started, the teachers greeted the idea with mixed feelings.

They were of the view that, this is just another research project, others felt that there is nothing new or good that will come out of it, while others were indecisive. For example, the initial comments raised by Aminu were that:

*Sir, in education, if you are dealing with human beings in the area of teaching-learning, one has to be careful. Now, as you know there are so many methods of teaching and learning people are coming out with today which has not really helped the system. Is this Productive Pedagogies framework a savior to the teaching learning problems we have with our students in Nigeria today? (Aminu; Reflective Interview)*

However, despite these reservations, the researcher kept faith to the project and kept moving step after step. At the end of the research, the perceptions of the mathematics teachers were beginning to change. For example, one of the teachers asserted the gradual development of interest in Productive Pedagogies framework as they progressed. This initial skepticism was not only from the teachers, the students had the same skepticisms. For example, were of the view that, the used of supportive classroom environment and substantive conversation of the intellectual quality among students during classroom instruction, should not form part of the Productive Pedagogies framework. This is because, since their school is a mission school, owned by churches and Christian religious organization, where religious discipline is upheld, any form of interaction between students during classroom instruction should be avoided.

*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. (Students: Reflective Interview)*

Therefore, the students were of the view that any interaction that will bring boys and girls at this age together could be termed inappropriate. The researcher interacted with the students after the first classroom instruction. Their initial views were that, they find it difficult believing accepting the productive pedagogies framework as the right teaching strategy. These students argued:

*Look, sir, making us sits together..., talk together (though in groups) seems a new thing altogether to some of us and indeed very strange..., (Reflective Journal)*

A student from Adamu's classroom 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 feel this is morally wrong..., as if these teachers did not know that this is a mission school..., (Student: Reflective Interview)*

These views demonstrated that teachers and students initially felt that Productive Pedagogies framework was strange to them because they were used to the traditional mathematics classrooms instruction.

**Initial nervousness in the implementation of the Productive Pedagogies Framework:** Nervousness is viewed as situations where teachers demonstrate some feelings of tension while using Productive Pedagogies framework. Data collected suggested that the participating teachers demonstrated initial nervousness during the implementation of the Productive Pedagogies framework. For example, the researcher observed that Ahmed demonstrated some elements of nervousness during his classroom instruction, which affected his first classroom teaching as the classroom management was very poor.

*I observed that Ahmed showed some nervousness, there was no confidence in the presentation of his facts to the students. This led to some problems in their teaching. For example, I observed that there were weak classroom controls, as the teacher did not really have the grip of the class. I also observed in one of the classes that there were constantly used of phrasal expression, I mean the teacher sometimes starts a sentence without really completing it..., which I think affected his classroom instruction (Reflective Journal).*

In supporting the researcher's observation above one of the students also observed these elements of nervousness in the classroom teaching of Ahmed, the student was of the view that Ahmed demonstrated nervousness during his teaching through the teacher-centered teaching approach he adopted. The student observed;

*Ahmed's teaching was mostly teacher-centered..., he was doing most of the talking without involving the students..., he made incomplete sentences which involve frequent missing of relevant words, his steps were*

*inconclusive..., and his lips were shaking while talking... I think..., all these are evidence of nervousness in his teaching (Student: Reflective Interview).*

In Aminu and Adamu classroom instruction, similar observations were made by the students. The students were of the view that the teachers were afraid,

*Aminu and Adamu were like a little bit nervous at the beginning. They were jittering in their talking which makes them make some mistakes ....they were like afraid of the class (Students: Reflective Interview).*

Another student was of the view that some of the participating teachers demonstrated nervousness by showing the lack of confidence in presenting their lessons. For example, Aminu demonstrated lack of confidence and in order to overcome this initial challenges he was looking too serious and unfriendly to the students, as a result, his teaching was boring and uninteresting;

*It was like the teacher lacked courage and confidence in himself. He was like looking too serious for my liking and was also unfriendly with the students. In fact sir, this makes the class looks too boring and uninteresting..., we were like afraid of him..., (Student: Reflective Interview)*

In view of these observations and possible effects behind the exhibition of nervousness by the teachers; the researcher and the teachers suggested strategies that could be used to help improved their confidence. The first suggestion was that the teachers should create activities that are real and practical to their students and get the students engaged in such activities. This is in line with connectedness to the world and students direction. The researcher was of the view that;

*If you make your mathematical concepts too abstract to your students it will make the lesson uninteresting and as such increases your frustration of coping with the negative attitude of students towards mathematics. Therefore, provide the students with real life-related problems and engage them into profitable mathematics discussions. (Reflective Journal)*

**Challenges in implementing the Productive Pedagogies' Framework:** Observation of the classroom practice of the mathematics teachers suggested that certain elements of Productive Pedagogies were either not properly implemented or completely absent or misunderstood. For example, the concept of metalanguage, active citizenship, student direction, self-regulation and explicit quality performance criteria were observed not to be properly understood or not implemented. The teachers, therefore, found it difficult to really identify the existence of them during their classroom teaching. The perception of the teachers during the reflective interviews suggested that some of these elements were not necessary, while others felt there was no need implementing them. For example, in the case of misunderstanding of metalanguage, the teachers were of the view that metalanguage had to do with difficult words in mathematics and if teachers are able to explain these difficult words to the students during classroom teaching suggest the implementation of the element. For example, Aminu was of the view that:

*During my classroom instruction, there was this case that requires the explanation of some difficult concepts in the topic I treated..., I tried explaining them to the students though not well explained..., I think ..., this could be viewed as metalanguage. (Aminu: Reflective Interview)*

At another time Aminu insisted:

*Since I had no difficult words to explain during my third class there was no need implementing the concept of Metalanguage? (Aminu: Reflective Interview)*

However, Adamu was of the contrary view by saying:

*Metalanguage is not only about explaining difficult words, it also involves the re-explanation of what had been said before which the students did not understand. Definitions of terms involve in a topic could also mean Metalanguage. (Adamu: Reflective Interview).*

Similarly, from the data collected, the participating teachers had varied opinions on the implementation of metalanguage. Some were of the view metalanguage was partially implemented, while others were of the view they

were implemented. The comments made by some of the teachers suggest that they had limited understanding of what metalanguage means.

*There was an improvement in almost all the elements of Intellectual Quality in my classroom teaching. However, metalanguage was totally absent; though I feel there was no need for it in my lesson since this was my revision class. (Aminu: Reflective interview)*

Aminu's point of view above shows that there was no application of metalanguage in his class because there was no need for its implementation. However, Adamu who was also in Aminu's class during his teaching was of the view that he observed cases of metalanguage during Aminu's classroom teaching, because, according to him, "metalanguage goes beyond the mere explanation of difficult words", "it could be definitions of terms which could be axioms, theories, laws, etc". This suggests that Adamu had a better perspective of the concept of metalanguage.

*To me Aminu implemented all the elements of intellectual quality very well including the metalanguage..., since metalanguage is not only on difficult words..., it involves the definitions of terms..., re-emphasis on difficult words..., retreating to explain..., the concepts of axioms, Theories, Laws etc are all metalanguages concepts. So, the Metalanguage was there during his classroom practice. (Adamu: Reflective Interview)*

The interactions between the teachers on metalanguage suggest that the teachers did not really have agreement of the concept of metalanguage and its implementations. Perhaps the teachers had limited understanding of the element and its applications to mathematics and indeed mathematics classroom instruction. Probably, the little discussion in mathematics education literature on metalanguage could have also led to their misunderstanding of the concepts and its application to mathematics classroom instruction.

The second challenges observed from the implementation of the Productive Pedagogies framework among the teachers is what the researcher called the "lower order thinking". For example, in Aminu's classroom, the researcher observed that

*The activities Aminu pose did not challenge the students because the content of the activity was meant for students in Junior Secondary one or two. Perhaps, one may argue that this was Aminu's first class with the students and as such he might not have had the basic knowledge of their abilities. Notwithstanding that, as a mathematics teacher at Senior Secondary School level in Nigeria, it is expected that he must have had enough knowledge and understanding that science classes in Nigerian secondary schools are mostly regarded as classes with high achieving students. (Reflective Journal)*

In defending his action, Aminu was of the view that he feels the students from the school are students from poor socio-economic background and cannot be given content that are far above their abilities; he argued:

*Because of the level of these students I mean students from low socio-economic background and from the semi-urban society, one cannot compare their abilities with the students in urban cities which are from the urban society and from a better and higher socio-economic background. (Aminu: Reflective Interview)*

Perhaps, from Aminu's defense, he might have fallen into the trap that many teachers in mathematics are likely to fall into, which is contrary to the very basis of Productive Pedagogies. One of the principles of Productive Pedagogies framework is that teachers should not attempt to reduce the quality of what the students are to learn because of their socio-economic status, gender or learning abilities.

Thirdly, during the classroom instruction and the reflective interviews with both the teachers and the students, the researcher and the participating teachers discussed extensively on the importance of student direction and self-regulations, some of the teachers were of the view that student-direction should not have been included as an element of Supportive Classroom Environment. They argued that relinquishing classroom control to students is not a wise idea as this could make some students take over the class and make the classroom ungovernable and be distractive to classroom teaching. One of the arguments presented was from Aminu who supported the view that;

*Mathematics teachers are to explicitly determine what activities students should do and how such activities should be done if teachers hope to meet their classroom objectives. (Aminu: Reflective Interview)*

He went further to state that,

*When the teacher is in the class, he is supposed to be in control of all the activities in his class. He should be in charge of directing all the affairs of his class, allowing students to take control of the classroom activities might be counter-productive. (Aminu: Reflective Interview)*

Such views about strict control of classroom are widely held among Nigerian teachers, for example, on classroom discipline; Ahmed argued that there are students who will never learn anything in the class if the teacher did not subject his students to some sort of punishment, in his view self-regulation might not be possible for students at this age. The teacher argued if we hope to have a classroom where every student needs in the class is identified and met, discipline should be enforced even if the teacher is going to “use the cane”. The teacher was of the view that there are students in our classes that will never learn if they are not “pushed to the wall”. Ahmed teacher argued,

*Yes, that one is being done. But there are students if there is no pain there will be no gain and the idea of Productive Pedagogies is to carry everybody along whether slow learners or the gifted ones. So, in order to carry them along and make sure they participated in the classroom activities, we have to cause them some pains to get the best out of them. You know there are some students that are best identified through these. (Ahmed: Reflective Interview)*

Finally, another challenge observed in the mathematics teachers' classrooms was the fact that the teachers were not able to effectively connect some topics during their classroom instruction to the world. For example, Aminu was not able to connect the topic mensuration as expected in the curriculum with activities around the world. Mensuration in its literal meaning is the study of Measurements. This is generally used where geometrical figures are measured to determine various physical quantities such as length, area, and volume. Similarly, in Ahmed's classroom, relating the concept of the development of the quadratic formula to the world was observed not to be possibly right to connect to the world. The researcher observed and noted in his Research Journal that:

*While the major problem Ahmed had was that his work was abstract, and there was no way he could have related the derivation of quadratic formula to the world. Since he was in the class to develop the quadratic formula that day..., how do you relate the quadratic formula to the world? Asked one of the students? In his attempt to demonstrate this, he made many mistakes. (Reflective Journal)*

This suggests that the development of a quadratic formula is purely theoretical and cannot be related to the world. In view of these, the mathematics teachers were of the view that there are topics in mathematics that connectedness to the world is not possible. However, from the analysis above, one may comment here that it is not in all cases the mathematics teachers were not able to implement connectedness to the world in their classroom instruction, they succeeded in doing that in some other cases.

### **Response to Research Question 3**

*What are the benefits of using Productive Pedagogies framework in Nigerian classroom as perceived by the teachers and their students during the research?*

The researcher's discussion with the teachers and the students suggested that they both appreciated this classroom approach and wished the approach is allowed to thrive in the Nigerian mathematics classroom. For example discussion with the students suggested that they wished their mathematics teachers will continue with this classroom approach to teaching mathematics. For example, one of the students was of the view that the used of the Productive Pedagogies framework help students to work together with one another. This according to the students makes mathematics a bit easier.

*This grouping approach is good..., I wished my teachers continued with it; because since we started this work, we solve problems together in the class, in the hostel and even during prep in the evening..., I discover mathematics is a bit easier when you work with your classmates than when you are alone..., (Student: Reflective Interview).*

Similarly, the used of Productive Pedagogies framework during mathematics classroom instruction help students take the responsibility for their learning with little or no interference from their teachers. This suggests that the used of Productive Pedagogies framework in mathematics classrooms tend to reduces the teacher traditionally dominated mathematics classroom instruction to a more constructivist student-centered dominated classroom teaching and learning. One of the students supported this view by saying,

*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, we worked on our own, without the unnecessary interference from our teacher..., the teachers assisted us on the board by simply explaining the basic formulas to use, how we approach the solution was left to us..., the teachers only come in to help when they discovered we are frustrated and that is good for us (Students: Reflective Interview).*

The views of the teachers on the benefits of Productive Pedagogies suggested that, the teachers were not much different from that of the students. The teachers were of the view that when a teacher creates classroom scenario that allows all members of the class have the equal opportunity to learning in respective of abilities or disabilities, students tend to solve problems that are challenging. For example, the researcher observed in one of the classes that,

*The teachers got their students working on their own, and in groups, they were only moving around to see what the students were doing and offer help where necessary. The problem the students were solving were so challenging that the students had to use their background knowledge and knowledge integration most times. For example, the question given to the student in Aminu's class which was beyond their abilities, I observed in one of the groups they had to use their knowledge of Angles in order to really bring out the solution of the problems they were solving. Without this, the students would have found it difficult to crack the difficult and the highly Intellectual Quality question given to them. (Reflective Journal)*

From the views of the teachers, the used of Productive Pedagogies framework encouraged representative participation of students during classroom instruction and in decision making on how classroom activities are handled. For example, Adamu commented on Aminu's classroom instruction by saying that,

*Aminu made use of the students do most of the classroom activities during class instruction. For example, he used the students to cite examples of daily happenings or activities like going to the markets to buy things. He also used two students working together to described how two line could be parallel... in short, the students were fully involved in his teaching compared to the strict teacher-centered approach adopted by most mathematics teachers particularly in Nigeria... our students were relaxed to discuss their problems during the classroom instruction with us. (Adamu: Reflection interview)*

In support of what Adamu said, Aminu asserted that

*My classroom used to be like a graveyard..., students dare not talk when I am teaching..., but to my amazement as I used the Productive Pedagogies framework in my class, the class naturally became interactive, the students interacted in their groups, before you know, the solution to the problem is gotten and even those who fear mathematics you see them ready to defend their answers. (Aminu: Reflection Interview)*

Thirdly, the data from this study suggest that the used of Productive Pedagogies help students have deep understanding of their classroom activities. For example, Admed was of the view that the used of Productive Pedagogies help his student not to only look for the answer to a problem but a deeper understanding on how the solution to the problem would be achieved.

*My students began to feel that arriving at a particular solution to any mathematics problem is not the issue...; the main issue is their understanding of how and why such a solution was gotten. (Ahmed: Reflective Interview)*

## **Discussions**

The implication of the findings to this study suggested that mathematics teachers' change in pedagogy has a positive influence in their students' interest towards mathematics and its teaching. Bajah (1999) was of the view that productive mathematics teachers are those that have the ability to stimulate their students' interest and have clarity of presentation of mathematical. Bajah went further to suggest that the important characteristics of productive mathematics teachers include good pedagogical approaches, and interpersonal traits such as helpfulness, openness, and friendliness which could be seen as ingredients for effective mathematics teaching. These pedagogical approaches, which are important characteristics of productive mathematics teachers, are clear reflections of the various elements of Productive Pedagogies.

The findings of this study suggest that the teachers made attempts to used Productive Pedagogies framework to achieved quality mathematics classroom instructions in their classes. This was demonstrated in their effort to use problem-solving to achieve intellectual quality classrooms instructions, making mathematics classroom instruction

relevant to the world around their students, developing an atmosphere of friendship during classroom instruction and identifying and recognizing the differences existed among students during classroom instruction. These findings tallies with the views of the proponents of Productive Pedagogies (Atweh, 2007; Aveling & Hatchell, 2007; Lingard et al. 2001; Sorin & Klein, 2002; Wilson & Klein, 2000; Zyngier 2005) On using Productive Pedagogies as a tool for reforming and improving mathematics classroom instructions. And the global view of the reformed of the mathematics classroom instruction generally as suggested by Matsumura, (2002), Meyer et al. (1993) Pianta and Hamre, (2009), and Pianta et al. (2008)

However, the study was not without its challenges. Prominent among the challenges was the fact that the mathematics teachers used for this study and their students greeted the introduction of Productive Pedagogies into the Nigerian mathematics classrooms with mixed feelings. These teachers were of the view that Productive Pedagogies is just another research, as researchers come to use them and after the research, the findings of such research add nothing to the classroom abilities of the teachers.

*Now, as you know there are so many methods of teaching and learning people are coming out with today which has not really helped the system. Is this Productive Pedagogies framework a savior to the teaching and learning problems we have with our students in Nigeria today? (Aminu; Reflective Interview)*

While the students looked at the introduction of the productive pedagogies framework in their classrooms on religious or moral ground, they were of the view that allowing student interaction and collaboration during classroom instruction is morally wrong. One of the students argued;

*This was very strange..., I thought we have been taught that when problems are given work 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 feel this is morally wrong..., as if these teachers did not know that this is a mission school..., (student: Reflective Interview)*

The study also revealed that some elements of the framework were completely absent from the classes observed. For example, the elements of narrative in Recognition of Difference and explicit quality performance criteria of Supportive Classroom Environment dimension were absent in the teachers' discussions. This absence could possibly be as a result of the teachers' inexperience in these pedagogies this is in support with the view of (Way, 2008) that the absence of such discussion in the mathematics education exists in the literature. Alsharif and Atweh (2012) made similar comments by asserting that some of the teachers indicated that certain elements of Productive Pedagogies framework were not easily applied during their own research similarly, the teachers misunderstood other elements of Productive Pedagogies such as metalanguage, student direction, and self-regulation.

The findings of the study also suggest that Productive Pedagogies seems to be an important tool for effective classroom instruction as it makes teachers and students responsible for what goes on in the class during classroom instruction which supports the views of Anderson & Brophy (1998), Cooper (1998) Elmore (2005) and Sewell (1984), that to achieve quality classroom, mathematics teachers had to adopt classroom instructions and classroom environments that are Student- friendly and introducing classroom activities that are relevant to students needs and daily life's endeavor. The findings of the study also suggested that the teachers and the students benefitted from the use of Productive Pedagogies framework in achieving quality mathematics classroom instruction. This was seen from the shift observed from the teacher-dominated mathematics classroom instruction to a more students-centered approach to classroom teaching as supported by (Afolabi, 2008; Okwo, 2000; Usman, 2001). Similarly, research findings in literature had suggested that achieving quality classroom instructions depends mostly on the context established by teachers about their willingness to shift grounds on their teaching process which if properly facilitated could lead to achieving quality mathematics classroom instruction (Mouly 1982). The findings of the study suggested the views of both teachers and students on the learning process at various levels of constructivist approach which informed the different teaching practices that could lead to the reforms and the modification of teachers and students on their perception of the new mathematics classroom teaching as suggested by Bature et al (2015)

In conclusion, the researcher recommended that if mathematics teachers hope to achieve quality mathematics classroom and indeed reform their mathematics classroom practice, effort must be made to use the Productive Pedagogies framework. This according to the finding of this study could make mathematics classroom instruction engaging, easy and student friendly. The researcher will also want to recommend that the adoption of the Productive Pedagogies framework during mathematics classroom instruction could be an effective model that could be used to improve the teacher-student and student-student relationships which had been the bane of mathematics classroom instruction in Nigerian secondary schools. The findings in this research also suggested that mathematics classrooms

teachers should take deliberate steps in creating friendly classroom climate as recommended in this research. This was demonstrated by the mathematics teachers and enjoyed by their students during the research. This from the findings of the study increased students' engagement, collaborations, interactions, substantive conversations and effective inclusion during mathematics classroom instruction.

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