International Journal of Learning, Teaching and Educational Research
Vol. 11, No. 3, pp. 41-58, May 2015

Introducing Productive Pedagogies to Nigerian Mathematics Classroom through Collaborative Action Research Using a Community of Practice Approach

Dr. Iliya Joseph Bature,
Australian Catholic University, Sydney,
NSW, Australia

James Jonah Jackson, Aramide Kemi,
Danladi Remkyes Shol and Nengak Sabo,
Abubakar Tafawa Balewa University, Bauchi,
Nigeria

Abstract. In this paper a group of four mathematics student-teachers came together to improved their teaching through a community of practice. They adopted one dimension each of the four dimensions that makes up the Productive Pedagogies framework to setup their classroom teaching practice. The findings of the study suggest that the four teachers achieved a great deal of success in their effort to improve their classroom teaching. Also Productive Pedagogies could be an important tool in improving the deplorable mathematics classroom in Nigeria particularly at the secondary school level. From the findings of this study the researcher conclusion suggested that, for effective mathematics classroom teaching, teachers are advised to adopt the Productive Pedagogies framework as an instrument for achieving quality classroom instruction. It is also suggested that collaboration among teachers should be encouraged. This will help the teachers work in groups and provide opportunity for teachers to talk about their teaching practices, criticise and model one another's thoughts and perceptions about classroom teaching.

Keywords: Productive Pedagogies; Quality classroom Instruction; community of Practice

Introduction

When the word 'pedagogy' is used, it connotes a range of methods of organising ideas that teachers adopt to bring about quality classroom teaching. Mathematics educators in more than six decades had made concerted effort in addressing different perspectives to mathematics and its classroom instruction.

© 2015 The authors and IJLTER.ORG. All rights reserved.

For example notable researchers like Ernest (1991), Freudental (1978) and Skemp (1976) thought of mathematics in a fallibilistic terms. Davis, Maher and Noddings (1990) and Glasersfeld (1987) thought of mathematics learning in a constructive process. Lave and Wenger, (1991) thought of mathematics teaching and learning through situate knowledge. And finally, Lerman (1996) and Steffe and Thompson, (2001) had also debated the commensurability of constructivist and sociocultural learning theories which also suggested that the concept of the philosophical and the epistemological development of mathematics and its teaching and learning.

Looking back over these years one might infer that these learning theories that are highly influential in addressing the teaching of mathematics as keys to the development of strategies for a drastic changes to mathematics classrooms (Jaworski, 2006). This had led to the maturity of the theoretical considerations of mathematics education discipline in the developed and the developing countries. However, the position of mathematics teaching has remains theoretical and underdeveloped (Jaworski, 2006) particularly in Nigerian mathematics classrooms where the traditional teacher-centred teaching still prevail (Azuka: 2006; Kaka, 2007; Odilli: 2006).

Generally, several teaching techniques and or frameworks exist in literature that supports the development of theoretical underpinnings in relation to mathematics, Mathematics education and Mathematics classroom practice (Atweh, 2007). For example, first, the use of multi-tiered scale by teachers to demonstrate their level of expertise in achieving quality student outcome during mathematics classroom teaching (Anderson & Krathwohl, 2001) commonly referred to as *Bloom Taxonomy (*Bloom, 1956). Second, the

> *" Howard Gardner's theory of Multiple Intelligences"* which believed that "*We are not all the same, we do not all have the same kinds of minds, and education works most effectively for most individuals, if...human differences are taken seriously*" (Gardner, 1995, p.208).

Third, the *Debono's thinking Hats*; which provides a model to help students think critically (de Bono, 1991). And finally, the *Myer-Briggs Personality Types* which burthened on how a designed personality test can assist a person identify some significant personal preferences in thinking about learning (Briggs Myers, McCaulley, Quenk, & Hammer, 1998).

These different frameworks possess some characteristics that may be similar to one another. However, none of these frameworks and strategies contains prescriptive teaching tools for the teacher. According to Atweh (2007) these teaching techniques or what he called tools are "u*sed for reflection for teachers to critique their own pedagogy in order to designed alternative pedagogies" (p.98).* Similarly, Atweh when further to suggest that none of these framework or teaching techniques is content based. Atweh noted that the educational research base on which these tools or framework of teaching are built are perhaps limited and

© 2015 The authors and IJLTER.ORG. All rights reserved.

> *Focus more on higher order thinking and intelligence, constructed under the individualistic models of learning…, they don't take into account the social dimension of learning…, While some of them might acknowledge individual differences in thinking style and preference to learning, they do not account for the effects of student background and their social context. (p.98)*

Productive Pedagogies is an example of one of the attempts made by teacher educators and mathematics teacher educators to integrate research findings on effective teaching from a variety of areas to mathematics classroom practice, within education itself, and to classroom instruction. Specifically, Productive Pedagogies is a product of a long study on school reform undertaken in Queensland, Australia (Lingard, Ladwig, Mills, Bahr, Chant, Warry, Ailwood, Capeness, Christie, Gore, Hayes, & Luke, 2001). The basic aim of the framework was to enhance the quality of classroom teaching. It refuses the idea placed on a teaching environment that defined quality education in terms of students' outcomes demonstrated in a standardized test of basic skills (Zyngier, 2005). It however, defines students outcomes in terms of a set of standards based on some powerful, important ideas and concepts which could be related to the students' experiences and the environment around them (Atweh, 2014, Zyngier, 2005). This suggests that Productive Pedagogies framework is concerned with how to help students learn and how to enhance both their academic and social behaviours during classroom instruction.

The developers of Productive Pedagogies framework (Lingard et al. 2001) postulated four dimensions which described and characterised what could be termed quality teaching (Atweh, 2014). These includes; Intellectual Quality, Connectedness, Supportive Classroom Environment, and the Recognition of Difference. Each dimension was further described by a number of elements (Lingard et al. 2001).

A brief description of the dimensions suggests that Intellectual Quality is an important dimension in achieving quality classroom teaching. Previous research studies suggested that high Intellectual Quality classrooms assist in improving students' performance during classroom instruction (Boaler, 1997; Hayes, Mills, Christie, & Lingard, 2006). Connectedness attempts to make mathematics more relevant to students' life by connecting students' life experiences either at home or in the society with their lives in school (curriculum and content) or other school subjects. This attempt is with the view to making mathematics more 'relevant' and providing students with more meaningful life experiences (Atweh, 2007). The Supportive Classroom Environment dimension is needed to create and enabled learning environments involving support and engagement in order to foster high Intellectual Quality and Connectedness. Finally, on Recognition of Difference, Hayes et al. (2006) was of the view that teachers should give more emphasis to recognize the diversities that exist among students with different cultural backgrounds and beliefs during classroom instruction in order to provide an equitable outcome for all students.

The framework has become a focus of research and curriculum development efforts for some years now. This is demonstrated in several projects around the

© 2015 The authors and IJLTER.ORG. All rights reserved.

world. For example, in its efforts to improve achievement and interest in the study of mathematics and other subjects across all school levels, the Queensland State Government initiated the New Basic Project in 2001 (Department of Education, Training and Employment, 2001). The New Basics Projects provided new curriculum organisations, authentic assessment tasks, and a framework for designing teaching called the Productive Pedagogies (Tanko & Atweh, 2012). Similarly, Zingier (2005) indicated that the Productive Pedagogies framework has been adopted in many states and regions across Australia as in New South Wales, Tasmania, South Australia and Victoria. Gore, Griffiths and Ladwig, (2002) also used Productive Pedagogies to prepare a series of professional development activities for in-service teachers.

There are several other research studies that have utilised the Productive Pedagogies framework in teacher education across the globe. For example, Alsharif and Atweh (2012) in Saudi Arabia modelled the Productive Pedagogies framework in preservice teachers'- education programs to develop their pedagogical practices during their field experience. Tanko and Atweh (2012) used the Productive Pedagogy framework to improve the teaching and learning of practical numeracy with adult learners in United Arab Emirates. Similarly, Productive Pedagogies framework had been used to introduce social justice practices in classroom instruction (Bacon, 2012; Bartel, 2012; Tanko, 2012). Other studies used 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 (Aveling & Hatchell, 2007; Sorin & Klein, 2002; Wilson & Klein, 2000; Zyngier 2005).

Though, certain principles of Productive Pedagogies had been explored by Nigerian educational researchers. There is no evidence in literature that the concept had been explored as a whole in Nigeria classrooms. For example, Bature and Bundot (2009) worked on setting the classroom climate for effective mathematics classroom instructions which could be regarded as the Supportive Classroom Environment of Productive Pedagogies. Similarly, Kalu (1997) worked on classroom interaction patterns among secondary schools students during classroom instruction which could be regarded as substantive conversation of Intellectual Quality dimension of Productive Pedagogies. While Ajunwon (2012) worked on socio-cultural identities found in different students especially in mathematics classrooms which could be viewed as inclusivity of the Recognition of Difference dimensions of Productive Pedagogies

In this current study, the researchers adopted the Productive Pedagogies framework because on the following potentials. First, the Productive Pedagogies framework is believed to provide opportunities for individual teachers to reflect on their own lessons, either at the planning stage or after conducting the class, using the four dimensions of the framework (Atweh, 2007). The teacher can ask herself/himself whether the lesson demonstrated high quality content in its presentation or whether the lesson provided enough support to students, or whether the increase recognition of differences among

© 2015 The authors and IJLTER.ORG. All rights reserved.

students such as social and cultural groups in the classroom helped improved students learning and engagements. Second, Productive Pedagogies framework is believed to have the potential of helping teachers' obtain or provide critical colleagues' comments on each other's' classroom teaching. This allows the teacher and the classroom observer to enter into substantive conversation about teaching and practices. It also has the potential to be used in collaborative planning for the curriculum in the school for one level in one subject, or across levels and subjects. Third, the researchers believed that the Productive Pedagogies framework can be used for the professional development of Mathematics teachers and as a form of induction to both preservice and in-service teachers in the schools, which could be useful strategy for giving feedback to teachers for discussions about promoting good and quality classroom teaching.

Fourth, the Queensland School Reform Longitudinal Study pointed to certain conditions that make the research on Productive Pedagogies open to other social settings. First, they assert that: - each dimension of Productive Pedagogies is readily defended in an ideal setting and in the context in which it was developed. However, this depends on the prevailing circumstances surrounding the classroom in terms of classroom environments and other socio cultural forces. This makes the research on Productive Pedagogies open to further investigations particularly in other social-cultural environments. Second, the four dimensions of Productive Pedagogies may be good enough for students to do well in school; there is however, no quality evidence to believing that all the dimensions are equally required for success in all socio-cultural settings (Lingard at al. 2001). Third, different classroom activities may reflect some of these dimension more than others (Atweh, 2007) for example, some classes may demonstrate low level Intellectual Qualities, while others demonstrate high level of Intellectual Quality with the attempt to connect learning to students' life experiences.

Therefore, one may conclude by saying that, Productive Pedagogies may work in one environment and fail to work in other environments depending on the prevailing circumstances surrounding the environment. This informed the need for this research to investigate the process and the effect of introducing Productive Pedagogies into Nigerian secondary schools mathematics classrooms with the aim to improving mathematics teachers' classroom teaching. This paper discusses how Productive Pedagogies framework was introduced to four mathematics teachers in an attempt to improve their teaching practices in a community of practice or through an approach called Collaborative Action Research. The following research objectives were adapted to this research.

1. To determine the teachers implementation of Productive Pedagogies framework during their classroom instruction.
2. To determine the improvement observed in the teachers classroom instruction using the Productive Pedagogies Classroom Observation Manual developed by the Queensland School Reformed Longitudinal Study.

© 2015 The authors and IJLTER.ORG. All rights reserved.

3. To determine the perception of the teachers on the role of Productive Pedagogies in improving their teaching practice using the community of practice.

Methodology

This research adopted the Collaborative Action Research approach to investigating the classroom teaching of four teachers working in the community of practice to improve their teaching using Productive Pedagogies framework. Collaborative Research is a form of research that is authentic and meaningful to teachers. It is conducted by teacher in their own classroom, to identify their challenges and find possible solutions to such classroom problems. It helps the teacher to pick up issues suggested in academic circles, and weave them in his own classroom to uncover new strategies to be used to improve his/her teaching practices (Ferrance, 2000, p.13; Johnson and Button, 2000; Sagor, 2004)

Four preservice mathematics teachers of Jimmy, Jackson, Jerry and Jennie (pseudonyms) were conducting their final year research project in a community of practice. They decided to each pick one dimension of the Productive Pedagogies framework to set their classes in their effort to achieve quality classroom teaching. These four teachers decided to adopt the Productive Pedagogies Classroom Observation Manual developed by the Queensland School Reformed Longitudinal Study commissioned by the Education Queensland (2001) as an observational tool during their classroom instruction. The 24-page manual contains explanations and examples of all 20 elements (see Appendix) of the Productive Pedagogies along with a 5 point Likert type scale. The teachers used the elements and the dimensions of Productive Pedagogies as outlined in the Productive Pedagogies Classroom Observation Manual to determine their level of implementability of the framework during their classroom instruction.

The data generation period was divided into three cycles of two weeks. After each data collection session the teachers will meet for a period of another two or more hours to reflect on their practice, discuss the challenges they faces and possible solutions proffered before progressing into the next cycle or section. The quantitative data generated during the research were used by each of the participating preservice teachers for their final year research project. However, for this paper, the qualitative data collected were coded using the grounded theory approached to data analysis. While the quantitative data which constituted the major data used were collated and analysed using descriptive and inferential statistics to determine the improvement of each of the participating teachers across the three cycles or sections.

Result

© 2015 The authors and IJLTER.ORG. All rights reserved.

The results of the classroom teaching of the four mathematics teachers were analysed independently. This is because the teachers adopted different dimensions of the Productive Pedagogies framework to improve their classroom instructions. Secondly, since they were working in a community of practice, the picture of how each of the teachers implemented his/her dimension needed to be analysed separately.

Response to Research Objective 1

To determine the participating teachers implementation of Productive Pedagogies framework during their classroom instruction using the Productive Pedagogies Classroom Observation Manual developed by Queensland School Reformed Longitudinal Study.

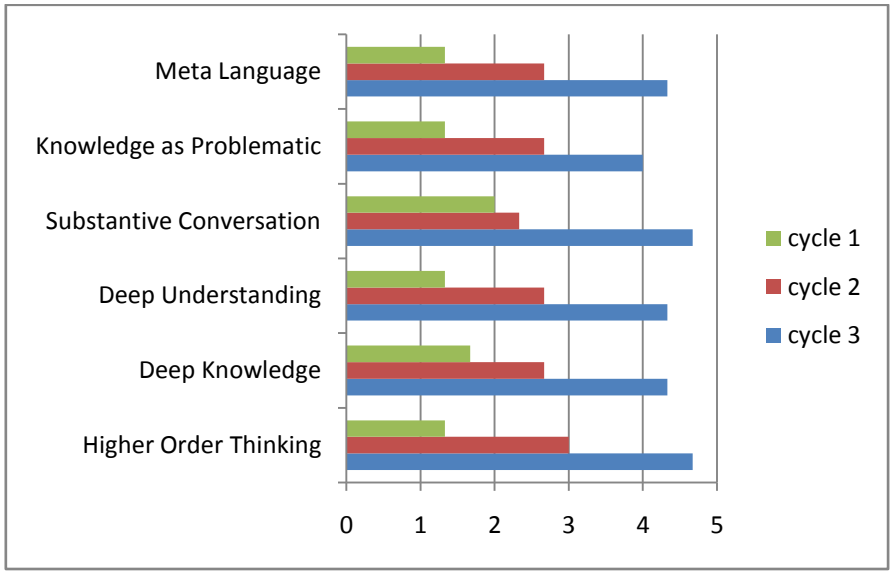

Figure 1: Jimmy's Classroom Instruction. The Figure above described the implementation of Jimmy's classroom instruction using the Intellectual Quality Dimension of Productive Pedagogies. The Intellectual Quality dimension has six elements: - Metalanguage, Knowledge as Problematic, substantive conversation, deep knowledge, deep understanding and higher order thinking. See table in appendix.

The figure suggested that Jimmy's implementation in each element show a progressive improvement from cycle to cycle. From the figure, Jimmy demonstrated competences in all elements on the three cycles with particular improvement in higher order thinking and substantive conversation in cycle three. However, Knowledge as problematic was the elements with least competence in implementation particularly in cycle 3. The progressive improvement could have been achieved as a result of the reflections meetings after each cycle.

© 2015 The authors and IJLTER.ORG. All rights reserved.

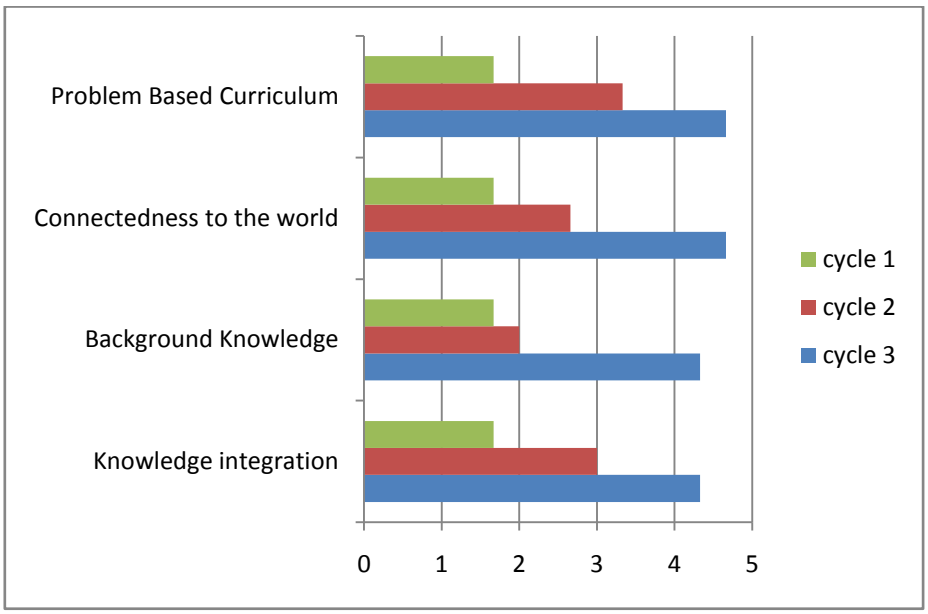

Figure 2: Jackson's Classroom Instruction: The figure above demonstrated the implementation of Jackson's classroom instruction using the Connectedness dimension of Productive Pedagogies. The connectedness dimension which is also called relevance has four elements: - Problem Based curriculum, connectedness to the world, Background knowledge and Knowledge integration as stated in the appendix below.

The figure suggested that Jackson had a progressive improvement in all the elements of Connectedness with particular improvement in connectedness to the world and problem based curriculum. This suggested that Jackson pays particular attention to helping his students solved real life related problems. He also gave them the freedom to solved high intellectual quality problems that had varied approaches to solution. Background knowledge and knowledge integration where the list implemented elements in Jackson classroom practice. Perhaps reasons to these could be adduced to his inability to relate his mathematics content to other subjects as observed by his colleagues. This notwithstanding does not imply that he did not relate them well but rather they were not rated as high as the other elements in his dimension. However, this progressive improvement in Jackson classroom instruction in all the elements perhaps was as a result of the reflective meetings between the teachers during the research period. This period was dedicated to discussing the challenges faced in the previous cycles and how best it could be achieved in the next cycle.

© 2015 The authors and IJLTER.ORG. All rights reserved.

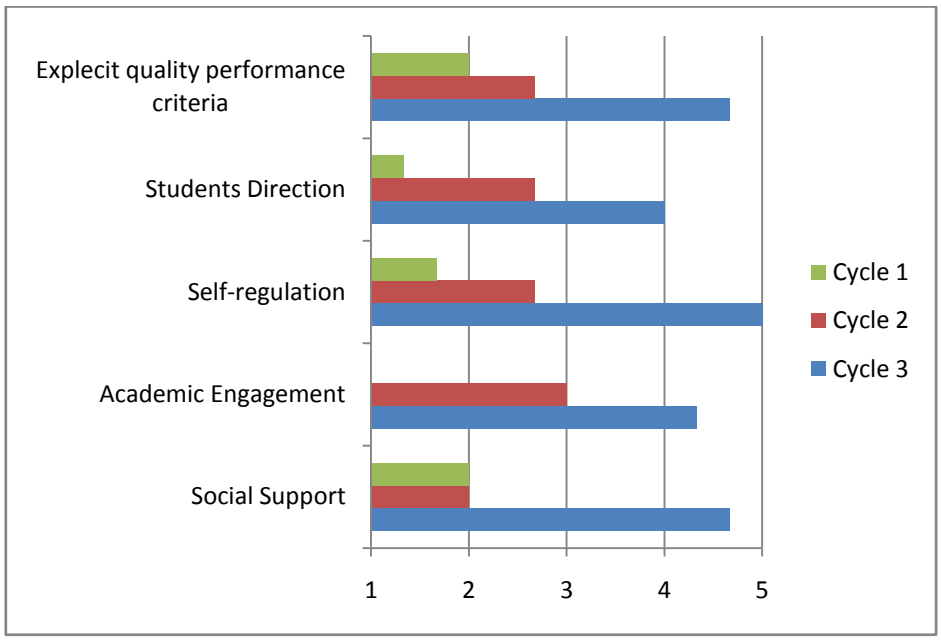

Figure 3: Jerry's Classroom Instruction: The figure above demonstrated the implementation of Jerry's classroom instruction using the Supportive Classroom Environment dimension of Productive Pedagogies. The dimension has the following elements as described in the table below: - explicit quality performance criteria, students' direction, self-regulation, academic engagement, and social support.

The figure demonstrated improvement in Jerry's classroom instruction from cycle to cycle. The figure also revealed no improvement in social support between cycle 1 and cycle 2. It was also observed that there was a high level of students' self-regulation in cycle 3. However the students did not fully have the control of the classroom activities as students' direction was shown to be least implemented in cycles 1 and 3. This does not implies that Jerry did not improved in his implementation but rather some elements were better implemented that others. The implementability of the elements and their effectiveness was as the result of the explanations given in Jimmy and Jackson classroom instruction. There was a very high observation on self-regulation also in Jerry classroom instruction in cycle 3. This perhaps was as a result of the topic Jerry was handling coupled with the reflection meetings.

© 2015 The authors and IJLTER.ORG. All rights reserved.

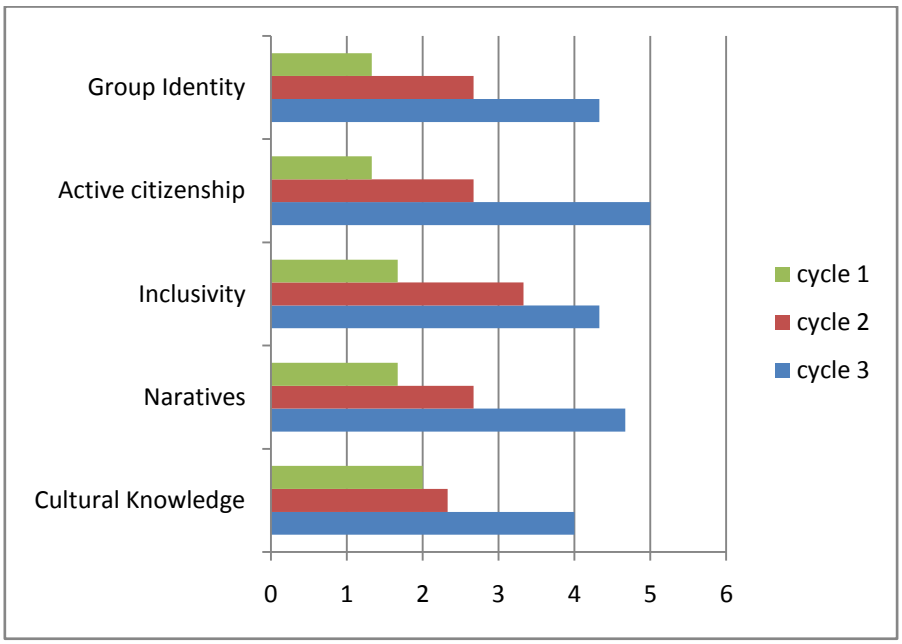

Figure 4: Jennie's Classroom Instruction: The figure above demonstrated the implementation of Jennie's classroom instruction using the Recognition of Difference dimension of Productive Pedagogies. This dimension is divided into 5 elements thus: - Group Identity, Active citizenship, Inclusivity, narratives and cultural knowledge

The figure demonstrated that Jennie had a progressive improvement in the implementation of Recognition of Difference dimension of Productive Pedagogies, with particular improvement in active citizenship in cycle 3. This suggests that Jennie recognises the differences that exist among students in her classroom and uses them to improve her classroom instruction. Active citizenship was observed to be higher than all other elements in Jennies' classroom practice might be as a result of the preservice provides a more democratic setting in her classroom instruction. As discuss above, other factors that could influence her performance were not far from what is said about the other researchers.

Response to Research objective 2

To determine the improvement observed in the participating teachers classroom instruction using the Productive Pedagogies Classroom Observation Manual developed by Queensland School Reformed Longitudinal Study

© 2015 The authors and IJLTER.ORG. All rights reserved.

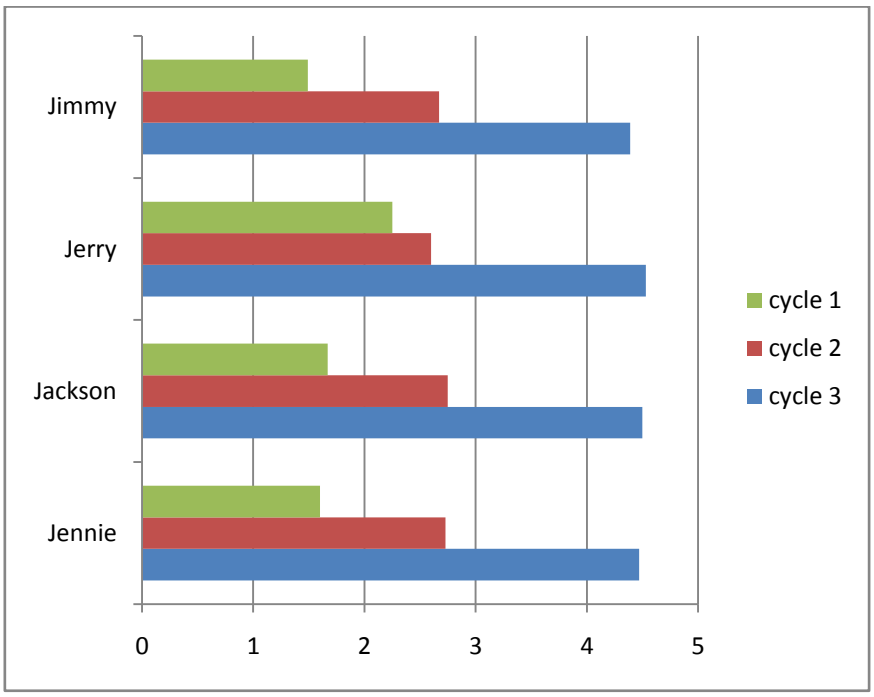

Figure 5 Participating teachers improvement in classroom instructions. Figure 5 above demonstrated the improvement of all the participating teachers across the cycles.

The figure above demonstrated the picture of the participating teachers' classroom instruction across cycles which suggested improvement in classroom teaching of all the teachers across the cycles. Their performance across cycles also suggested uniform performances as they fall within the same range in all the ratings except in cycle one where Jerry's performance was a bit better than the other teachers. Factors that are likely to bring about better performance among the teachers perhaps could be as a result of the years of teaching experiences or the dimensions selected for the research. However, all the preservice teachers showed potentials in their effort to improve their classroom instruction. Uniformity in their performance could also be as the result of the reflection meetings as stated in research objective 1 above.

Response to research objective 3

To determine the perception of the teachers on the role of Productive Pedagogies and Collaborative Action Research in improving their teaching practice using the community of practice.

Data collected suggested that the use of Productive Pedagogies framework was not the only factor that helped improve the teaching effectiveness of the preservice teachers. The teachers were of the view that discussions held after each cycle during their reflection meetings contributed a lot to helping them see the concept of Productive Pedagogies and its implementations in new dimensions. The reflection meetings gave them the opportunity to look back on what they did which helped them look forward on what they needed to do to

© 2015 The authors and IJLTER.ORG. All rights reserved.

improve their practice in the next cycle. For example, one of the teachers was of the view that,

> *The way the program was structured emphasises very challenging learning objectives, we received and provided support to one another, and not only is feedback given throughout the program but we actively sought for it, not only from the researcher, but also from colleagues. (Jerry: Research Journal)*

Another teacher said,

> *The experiences of discussing with colleagues help my problem solving skills, it provided opportunity for cooperative learning, and there is an enhanced level of immediate feedback from colleagues during the implementation, particularly, during reflection meetings. (Jennie: Research Journal)*

Similarly the preservice teachers suggested that the framework help reduced the domineering approach to teaching, commonly observed in most Nigerian mathematics classrooms. For example one of the teachers was of the view that,

> *The setting that makes mathematics teachers have the monopoly of knowledge and students depending on them for everything does not portrayed good Productive Pedagogies classroom. But in a situation where we are teachers and we are students; makes our students relax..., the teacher brings the knowledge and the students analysed and discussed it … this tends to boast my student's confidence and encouraged independent learning among them. (Jennie: Research Journal)*

From the comment of the preservice teacher above suggests that using the Productive Pedagogies framework in mathematics' classroom help reduced the mathematics phobia that is commonly observed among secondary school students in most mathematics classrooms in Nigeria. Every member of the classroom community has a role to perform during the classroom instruction as against the teacher centred instruction that had pervaded most of the Nigerian mathematics classrooms for decades. Jackson acknowledged this by saying,

> *My classroom used to be like a graveyard as students dare not talk, but to my amazement as I introduced 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. (Jackson: Research Journal)*

Conclusions

The findings of the study suggested that the used of Productive Pedagogies framework by the teachers improved their teaching effectiveness. It brought about positive changes in their classroom instructions. This was demonstrated in figures 1, 2, 3, 4 and 5. The figures showed positive improvement from one cycle to the other. This improvement according to the teachers was as a result of adopting the Productive Pedagogies framework in their classroom teaching as observed in research objective 3. These tallies with the findings of most notable

© 2015 The authors and IJLTER.ORG. All rights reserved.

researchers on Productive Pedagogies which were of the view that Productive Pedagogies framework had been used to help mathematics teachers improved their mathematics classroom instruction (Bacon, 2012; Bartel, 2012; Tanko, 2012). Other researchers also observed that the Productive Pedagogies framework could also be used to increase teacher awareness of teaching pedagogies that could improve classroom engagement and participation. This helped bring about critical reflection among teachers and their colleagues on their teaching practices (Aveling & Hatchell, 2007; Sorin & Klein, 2002; Wilson & Klein, 2000; Zyngier 2005).

On using Productive Pedagogies as a tool for improving mathematics classroom instructions, the findings of the study 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. Every member of the classroom community has a role to play during the classroom instruction as compared to the traditional teacher-centred approach that has dominated most Nigerian mathematics classrooms (Azuka: 2006; Kaka, 2007; Odilli: 2006). These findings also coincided with the findings of Atweh (2014) who asserted that Productive Pedagogies can be used to improve mathematics teachers teaching effectiveness, because they provide a vocabulary for teachers and their students to interact during classroom instruction.

Similarly, the findings of the study also suggests that it was not only the use of the Productive Pedagogies framework alone that helped improve their teaching effectiveness, but that, the discussions held after each cycle during their reflections meetings contributed a lot to helping the teachers see the concept of Productive Pedagogies and their implementations in new dimensions. The reflection meetings gave them the opportunity to look back on what they did, which helped them look forward to what they needed to do to improve their practice. This supports the Collaborative Action Research principles of reflections which postulate that reflection helps improved teachers performance during classroom instruction, provides opportunities for teachers to discuss problems observed and suggest possible ways to resolve them (Sagor, 2004).

This also suggested that collaboration among teachers provide opportunity for teachers to talk about their classroom instruction and also provides a framework for reflection after classroom instruction with colleagues (Aveling & Hatchell, 2007; Sorin & Klein, 2002; Wilson & Klein, 2000; Zyngier 2005). Similarly, studies has also demonstrated that participating in Collaborative Research has been found to be one of the most important tools for effecting positive changes in teachers' classroom instruction. This is exemplified by teachers' improvement in their practice, self-reflection, improved students overall learning and enhances mathematics teachers' classroom teaching effectiveness (Ferrance, 2000; Johnson & Button, 2000; Ross, Rolheiser, & Hogoboam-Gray & Campbel, 2002; Sax & Fisher, 2001).

In conclusion the findings of this study suggest that, for effective mathematics classroom teaching, teachers are advised to adopt the Productive Pedagogies

© 2015 The authors and IJLTER.ORG. All rights reserved.

framework as a tool for achieving quality classroom instruction. It is also suggested that collaboration among teachers should be encouraged. This will help the teachers work in groups and provide opportunity for teachers to talk about their teaching practices, criticise and model one another's thoughts and perceptions about classroom teaching.

References

Ajuwon, P. M. (2011). *Trainees' Perceptions of Inclusive Education in Nigeria:* A Preliminary Report. On contemporary Issues in the Education of Persons with Visual Impairment. Ibadan, Nigeria: Glory-Land Publishing Co. 6-24.

Alsharif, K & Atweh, B. (2012). Productive Pedagogies as Framework to Improve Preservice Teachers' Practices; *The international Journal of learning*, *18*(4), pp.223-235

Anderson, L.W., Krathwohl, D.R., eds. (2001). *Taxonomy for learning, teaching, and assessing: a revision of Bloom's taxonomy of educational objectives*; abridged edition. NY: Addison Wesley Longman, Inc.

Atweh B. (2014) *Improving teaching through Productive Pedagogy*; A paper presented at the Department of Mathematics Education in the College of Education research and Innovation week, university of South Africa (April 4th 2014)

Atweh, B. (2007). *The social turn in understanding learning and its implications for facilitating learning: ripples for change. A journey of preservice teacher education reforms in the Philippines Commission for Higher Education*. Print house, Quezon City.

Aveling, N., & Hatchell, A. (2007). *Good intentions are not enough: promoting quality teaching and Productive Pedagogies in teacher education programs*. Paper presented at the Australian Association for Research in Education, Fremantle. Retrieved May 24, 2010, from http://aare.edu.au/07pap/ave07116.pdf

Azuka, B. (2006). *Active learning in the mathematics classroom implications to secondary mathematics and UBE*. Proceeding of Annual national conference of MAN September 181-187

Bacon, C. (2012). Implementing Social Justice in Maths during the Standard Era.*Rising tide*; 5 pp. 1-22

Bartell, T. G. (2011). Learning to teach mathematics for social justice: Negotiating social justice and mathematical goals. National Council of Teachers of Mathematics

Bature. I. J & Bundot G. B. (2009) Setting the classroom climate for effective teaching and learning process: implications for classroom environment and learning. *International Journal for Contemporary Issues in Education (Special edition) 198-201.*

Bloom B. S. (1956). *Taxonomy of Educational Objectives,* Handbook I: The Cognitive Domain. New York: David McKay Co Inc.

Boaler, J. (1997). Setting, social class and survival of the fittest. *British Educational Research Journal: 23*(5), 575-595

Briggs Myers, I, McCaulley, M.H., Quenk, and N.L., Hammer, A.L., (1998), *'MBTI Manual. A Guide to the Development and Use of the Myers-Briggs Type Indicator'*. 3rd edn. Consulting Psychologists Press Inc. Palo Alto. p. 21.

Davis, R.B., Maher, C.A., & Noddings, N. (Eds.). (1990). *Constructivist views on the teaching and learning of mathematics*. Reston, VA: National Council of Teachers of Mathematics

© 2015 The authors and IJLTER.ORG. All rights reserved.

de Bono, E, (1991) "Why Do Quality Efforts Lose Their Fizz?" Quality is No Longer Enough, The Journal for Quality and Participation, September 1991

Department of Education Training and Employment (2001) New Basis.

Education Queensland, (2001) *"Productive Pedagogies Classroom Observation Manual"*. The original booklet was from the Queensland School Reform Longitudinal Study (QSRLS) commissioned by Education Queensland.

Ernest, P. (2000). The Teaching and Learning of Mathematics', in Koshy, V., Ernest, P. and Casey, R. Eds. *Mathematics for Primary Teachers, London: Routledge,* 2000: pp. 3-20. (ISBN 0415200903).

Ferrance, E. (2000). Themes in education: Action research. *Brown University: Educational Alliance, 1- 34.*

Freudenthal, H. (1978). *Weeding and sowing: Preface to a science of mathematical education*. Dordrecht: Reidel

Gardner, H. (1993). Frames of Mind: The Theory of Multiple Intelligences. New York: Basic Books.

Glasersfeld, E. von (1987). 'Learning as a constructive activity.' In C. Janvier (Ed.), *Problems of representation in the teaching and learning of mathematics*. Hillslade, NJ: Erlbaum.

Gore, J. M., Griffiths, T., & Ladwig, J. G. (2001). *Productive pedagogy as a framework for teacher education: Towards better teaching.* Paper presented at the annual conference of the Australian Association for Research in Education, Fremantle, Western Australia,

Gray J.& Campbel-Evans G (2002). Beginning Teachers as teacher-Researchers; *Australian Journal of Teacher Education* Volume 27| Issue 1 Article 4, 2002

Hayes, D., Mills, M., Christie P., & Lingard, B. (2006). *Productive Pedagogies: Teacher, and schooling making a difference: Productive Pedagogies, Assessments and Performance*. Allen and Unwin 83 Alexander Street, Crows Next NSW 2065, Australia, 32-81.

Johnson, M., & Button, K. (2000). Connecting graduate education in language arts with teaching contexts: The power of action research. *English Education, 32, 107-126.*

Jaworski B. (2006). Theory and practice in mathematics teaching development: Critical inquiry as a mode of learning in teaching. *Journal of Mathematics Teacher Education, 9*, pp. 187-211.

Kaka, M. O. (2007). Games assisted instructional materials – A strategy for enhancing students' achievement in integrated sciences. *Journal of Research in Curriculum and Teaching, 2* (1), 120 – 128.

Kalu, I. M. (1997) *Classroom interaction patterns, teacher and student characteristics and students' learning outcomes in Physics*. (Unpublished doctoral dissertation), University of Nigeria, Nsukka.

Lave, J., & Wenger, E. (1991). Situated learning: Legitimate peripheral participation. New York: Cambridge University Press.

Lerman, S. (1996). Inter-subjectivity in mathematics learning: A challenge to the radical constructivist paradigm. *Journal for Research in Mathematics Education*, *27*(2), pp. 133-150.

Lingard, B., Ladwig, J., Mills, M., Bahr, M., Chant, D., Warry, M., Ailwood, J.,Capeness, R., Christie, P., Gore, J., Hayes, D. & Luke, A. (2001). *The Queensland school reform longitudinal study*. Brisbane: Education Queensland.

Montessori, M. (2003). *Montessori Method Book* .Berne Nobles

© 2015 The authors and IJLTER.ORG. All rights reserved.

Newmann, F. M. and Associates. (1996.) *Authentic Achievement: Restructuring Schools for Intellectual Quality*, San Francisco: Jossey-Bass Publishers.

Odilli, G.A. (2006). *Mathematics in Nigeria Secondary Schools; A teaching perspective.* Port-Harcourt; Rex Charles & Patrick.

Piggott, J. (*2004,*). Developing a Framework for Mathematical Enrichment. *Conference Proceedings, "Critical Thinking", University of the West Indies, Trinidad.*

Ross, J., Rolheiser, C., & Hogoboam-Gray, A. (1999). Effects of collaborative action research on the knowledge of five Canadian teacher researchers. The Elementary School Journal, 99 (3), 255-274.

Sagor, R. (2004). The action research guidebook: A four-step process for educators and school teams. Thousand Oaks, CA: Sage.

Sax, C., & Fisher, D. (2001) Using qualitative action research to effect change: Implications for professional education. Teacher Education Quarterly, 28 (2), 71-80.

Skovsmose, O. & Borba, M. (2004). *Research Methodology and Critical Mathematics Education.* In Paola Valero & Robyn Zevenbergen (Eds.), Researching the Socio-Political Dimensions of Mathematics Education. Issues of Power in Theory and Methodology. *Mathematics Education Library* Dordrecht: Springer., *35*, pp. 207-226.

Skemp, R. (1976). Relational Understanding and Instrumental Understanding. Mathematics Teaching, 77, 20-26

Sorin, R., & Klein, M. (2002). *Walking the walk and talking the talk: adequate teacher preparation in these uncertain times?* Paper presented to AARE, Brisbane, Australia

Steffe, L. P. & Thompson, P. W. (2000). Interaction or Intersubjectivity? A Reply to Lerman. *Journal for Research in Mathematics Education*, *31*(2), pp. 191-209.

Tanko, M. G. (2012). *Teaching practical numeracy through social justice pedagogy: case study of Abu Dhabi women's college (*unpublished Doctoral dissertation), Curtin University, Perth Australia.

Tanko M. G. & Atweh B. (2012) Using Productive Pedagogy to Improve the Teaching and Learning of Practical Numeracy with Adult Learners. *Journal of Education and Practice 3*(16), pp. 88-95

Valero, P. (2009). *Mathematics education as a network of social practices*. Invited keynote lecture at the 6th Conference of the European Society for research in Mathematics Education (CERME6) (forthcoming proceedings). University Joseph Fourier, Lyon, France.

Wilson, E. & Klein, M (2000). *Promoting Productive Pedagogies: Preservice Teacher Education for New Times in Queensland State Schools*. Paper presented at the Australian Association for Research in Education. Sydney.

Zyngier, D. (2005). Choosing our ideas, word and action carefully: is the language of Productive Pedagogies intelligible for pre-service teachers? *Issues in Education Research, 15*(2), 225-248.

© 2015 The authors and IJLTER.ORG. All rights reserved.

Appendix

The Dimensions of Productive Pedagogies and their Associated Elements Summarised by Atweh (2007)

ELEMENTS OF PRODUCTIVE PEDAGOGIES	DESCRIPTION
INTELLECTUAL QUALITY	
Higher Order Thinking	Involves transformation of information and ideas. This transformation occurs when students combine facts and ideas to synthesize, generalise, explain, hypothesize or arrive at some conclusion or interpretation.
Deep Knowledge	Deep knowledge is concerned with the central ideas of a topic or discipline which are judged to be crucial to it.
Deep Understanding	Deep understanding is indicated when students grasp relatively complex relationships between the central concepts of a topic or discipline. They can produce new knowledge by discovering relationships, solving problems, constructing explanations and drawing conclusions.
Substantive Conversation	There is considerable interaction among students, and between teacher and students, about the ideas of a substantive topic. The interactions are reciprocal and promote shared understanding
Knowledge as Problematic	This involves an understanding of knowledge not as a fixed body of information, but rather as being constructed, and hence subject to political, social and cultural influences and implications
Meta-language	Such instruction incorporates frequent discussion about talk and writing, about how written and spoken facts work, about specific technical vocabulary and words, about how sentences work or don't work (syntax, grammar).
SUPPORTIVE CLASSROOM ENVIRONMENT	
Student Direction	Students influence the specific activities or tasks they will do in a lesson or how they will undertake them.
Social Support	Social support is characterised by an atmosphere of mutual respect and support between teacher and students, and among students.
Academic Engagement	Students are engaged and on task. They show enthusiasm for their work by raising questions, contributing to group activities and helping peers
Self-Regulation	The direction of student behaviour is implicit and self-regulatory
Explicit Quality Performance Criteria	The criteria for judging the range of student performance is made explicit. Using tools such as rubrics.
CONNECTEDNESS	
Knowledge Integration	This occurs when explicit attempts are made to connect two or more sets of subject area knowledge.
Background Knowledge	Opportunities are provided for students to make connections between their own background knowledge and experience and the topics, skills and competencies they are studying and acquiring
Connectedness to the World	This describes the extent to which the lesson has value and meaning beyond the instructional context, making a connection to the wider social context within which students live.
Problem-Based Curriculum	Such curriculum is one in which students are presented with specific practical, real or hypothetical problems to solve. Problems are defined as having no single correct solution, requiring the construction of knowledge by the students and requiring sustained attention beyond a single lesson.
RECOGNITION OF DIFFERENCE	

© 2015 The authors and IJLTER.ORG. All rights reserved.

Cultural Knowledge	A range of cultures, an acknowledged and given status. Cultures are valued when there is implicit appreciation of beliefs, languages, practices and ways of knowing.
Group Identity	Teaching practices build a sense of community and identity.
Narrative	The use of narrative in lessons involves an emphasis both in teaching and in student responses or personal stories, biographies, historical accounts and literary and cultural texts.
Inclusivity	Inclusive classroom practices intentionally acknowledge, support and incorporate the diversity of students' diverse backgrounds, experiences and abilities.
Active Citizenship	This element involves acknowledging that in a democratic society all individuals and groups have rights and responsibilities.

© 2015 The authors and IJLTER.ORG. All rights reserved.