PRODUCTION-BASED DEMONSTRATION INSTRUCTIONAL APPROACH ON PRE-SERVICE CHEMISTRY TEACHERS: A PANACEA FOR STEM ACADEMIC ACHIEVEMENT

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ABSTRACT
This study investigated the production-based and demonstration instructional approach on pre-service Chemistry teacher's academic achievement. One research question and one hypothesis guided the study. The study adopted a non-equivalent control group quasi experimental design. The study was conducted in four Colleges of Education in the South East Geo-political zone. Out of the four schools, two colleges were exposed to the use of production-based and demonstration instructional approach (experimental group), while the other two were exposed to conventional lecture method (control group). 150 pre-service Chemistry students participated in the study. Production-based chemistry achievement test (PCAT) which was developed by the researchers was used as an instrument for data collection. PCAT was subjected to face and content validation. Its reliability was established at 0.87 using Kuder-Richardson formula 21(K-R-21). Mean and standard deviation as well as analysis of covariance (ANCOVA) were used to answer the research question and test the hypothesis at 0.05 level of significance respectively. The result of the study revealed that the production based and demonstration was significance at 0.05 probability level in enhancing the academic achievement in pre-service Chemistry teachers. It also revealed that gender had no effect on the level of academic achievement of pre-service Chemistry teachers. Based on these findings, recommendations were made which included that Chemistry teachers should adopt demonstration with production-based instructional approach in enhancing academic achievement in pre-service Chemistry teachers.
Keyword: Production-based Demonstration, pre-service teachers, panacea, capacity building.

INTRODUCTION
Production-based teaching method according to Nnoli (2016) is the process of using materials or reagents to produce useful products. It helps the learner to learn faster and helps to minimize the abstract nature of chemistry. For example, the production of car-wash using the following materials; Antisol, Soda ash, Sulphonic Acid, Formalin, Colorant and Perfume. Nnoli maintained that demonstration method can be used as a technique within a method of teaching and sometimes as a method itself for example, when you do the experiment by yourself so that students will watch and

learn from your action, especially if you emphasize the use of apparatus or reagents. Osisioma (2015) posited that production- based method is a systematic process of applying creativity and innovations, it involves the acquisition of skills, knowledge and competences that enable learners to maximize the use of existing resources for firm career commitments such as setting a business, marketing services or being produce-employee of an organization.

One key way of which one can develop skills for production in individuals is through education. This is because education *provides a lot of opportunities, values and resources that will equip an* individual to contribute to national economic growth (Nnoli, 2016). One of the objectives of National Policy on Education (NPE, 2013) is that education will be used to build among other things, a great and dynamic economy. Science, Technology, Engineering and Mathematics (STEM) Education (Chemistry inclusive) to a larger extent provides a conducive opportunity to achieve the stated national objective. This is because STEM are powerful tools for the development of academic achievement and socio-economic growth of many nations. Many developed countries of the world like China, USA and Japan have continued to invest their resources in STEM education for proper and improved economy and for achieving self-reliance. A self-reliant person can be described to be creative, productive, resourceful and objective. Such an individual can be viewed to be scientifically literate.

Nnoli (2014) stated that a scientifically literate person is critically minded, creative, objective and can apply skill where necessary. These qualities are what productive-based stands for. However, in any developed countries, STEM curricula (Chemistry inclusive), are designed to prepare students towards the acquisition of skills and competences for self- reliance. Unfortunately, the percentage of skill acquisition is noticed to be poor in most developing countries of the world such as Nigeria. Some researchers noted that poor acquisition of skills emanates from poor availability of infrastructure, lack of integration of entrepreneurship education in curriculum and poor utilization of innovative instructional approach in teaching (Nnoli 2015). Furthermore, most secondary schools and tertiary institutions in Nigeria, neglect practical aspect of STEM teaching and adopt only the theoretical aspect leading to poor acquisition of productive and demonstration skills.

Chemistry is a branch of pure science which deals with the properties, compositions and uses of matter. It is taught to students at all levels of education including tertiary education. The knowledge of chemistry is important for professional growth and for personal adaptation to one's environment. Acquisition of chemistry knowledge could expose learners to acquire skills on how to set up and manage small business such as production of wine using grape and pineapple flavor. Chemistry knowledge can also be used in setting up small enterprises such as production of soaps (saponification), car-wash, disinfectants, paints as well as detergents (Nnoli, 2016). In chemistry

classroom teaching, students are expected to be exposed to many innovative teaching approaches that can foster active participation and skill development. It is expected that skill acquisition in STEM (chemistry inclusive) should be through the activity/production-centered instructional approach. Nnoli (2014) posited that activity-centered instructional approach is student centered, uses science process skills and investigative teaching approach. In this approach, the learner is exposed to innovative changes, can recognize new ideas and opportunities in new areas.

At tertiary level of education, chemistry is taught to undergraduates both as a discipline and for professional development. It should be noted that many faculties of education or departments in universities and colleges of education train undergraduates or pre-service teachers to become professionals who specialize in one teaching subject or the other. In their area of specialty,the pre-service teachers are undergraduates who are trained to qualify as teachers but have not taught before. In recent times, many pre-service graduate teachers are unemployed either because they have no place they are employed to teach or they have not acquired appropriate skills needed to build on or become self-reliant or that they do not posses skills needed to establish and manage a small business. Osisioma (2015) noted that the development of skills include; inner discipline, ability to take risks, being innovation, change- oriented persistence and recognition of economic opportunities.

A good utilization of production-based, demonstration centered teaching in STEM education / chemistry in tertiary education will facilitate the development of skills, critical mindedness and creative thinking in pre-service chemistry teachers. According to literature, creative thinking serves as one of the important attributes for skill development. Nnoil (2017) identified creative thinking, problem solving and ability to recognize opportunities as some aspects of skill development. STEM educators suggest that under this period of dwindling economic growth and massive unemployment in Nigerian nation, there is need for proper inculcation and integration of production-based instructions in teacher-development program. Many schools of thought are advocating the integration of skill acquisition in classroom instruction so as to expose the learner to development of new ideas to start new business for self-adaptation and development. With regards to this, some chemistry concepts offer opportunity for productive-based instructions. This can be achieved through innovative teaching approach that is activity- oriented which offers opportunity for hands on, minds on science to motivate critical mindedness, skill acquisition and sense of commitment in students. Some of these innovative teaching approaches that can generate use of skills and deep thinking in learners include; demonstration and project instructional approach.

Demonstration instructional approach involves showing by reason or proof, explaining or making clear by use of examples. Nnoli (2019) stated that demonstration is a process of teaching through examples or experiments which

allows learners to relate theoretical concepts to practice. It is also any learning experience that involves student activities such as observing, measuring, counting, and experimenting among others. The importance of demonstration as a teaching approach includes that it follows systematic procedure; it generates curiosity and keen observation ability among learners. Demonstration can be performed by the teachers alone, the teachers and student groups among others. On the other hand, demonstration can be applied alone in teaching or can be used with other innovative teaching approaches such as project instructional approach or any other good innovative teaching approach to achieve an intended objective (Egbezor&Nnoli, 2015). Researchers also noted that many science educators (chemistry inclusive) fail to inculcate in their students the habit of practical- oriented lessons like demonstration lessons.

Osisioma (2015) noted that science students of all levels show poorly developed skills of problem analysis, planning and carrying out controlled experiments. The implication of this report with regards to teacher education is that such a pre-service teacher cannot be creative and resourceful since no skill is acquired, and may not be well equipped to teach others and consequently will not have anything to add to the national economic growth. This state of affairs calls for serious investigation so as to improve teacher development programme in the country. However a nation without good teacher education is already facing problems and will continue to be in a moribund state economically.

Purpose of the Study

The main purpose of the study is to investigate the gender influence on academic achievement of STEM pre-service chemistry teachers exposed to productive-based demonstration instructional approach and those exposed to traditional lecture methods.

Research question

What is the difference in the mean achievement scores of male and female pre-service chemistry teachers exposed to productive-based demonstration instructional approach and those exposed to traditional lecture method?

Research Hypothesis

H_{o1}: There is no significant difference in the mean achievement scores of male and female chemistry teachers exposed to productive-based demonstration instructional approach and those exposed to traditional lecture methods.

Design

The study adopted the non-equivalent control group quasi experimental design. This is because intact or pre-existing groups were used, as the experiment was conducted in institution setting where randomization was not possible.

Sample

The sample comprised of 150 (300 level) pre-service students taking courses at National Certificate in Education (NCE) programme in Colleges of Education in the South-East geopolitical zone of Nigeria. The College were purposively selected based on the availability of:

1. Students offering chemistry as one of their combinations of study in their area of specialty.
2. Students who have stayed up to 3 years in their academic pursuit in chemistry option.
3. Availability of a functional chemistry laboratory.

Instructional procedure

Two out of the four colleges of education used were randomly assigned for experimental conditions. The chemistry lecturers in the experimental schools were trained for a period of one week. These teachers were provided materials to teach the experimental group with demonstration and productive-based instructional approach, while the control group was taught by conventional method (lecture method) by their regular lecturers. Detailed lesson plans were used to teach both experimental and control groups. The same lesson plans bearing the same instructional objectives, instructional materials, content and method of elevation were provided for both experimental and control groups. Pre-test was administered to both experimental and control groups before commencing the treatment. After the pre-test, the trained staff teaching the students commenced the treatment by teaching the pre- service chemistry teachers using production-based demonstration instructional approach. At the end of the experiment, the post –test was administered on the students in both groups.

Results

Research Question: What are the mean achievement scores of male and female pre-service chemistry teachers exposed to productive-based demonstration instructional approach and those exposed to traditional lecture methods?

Table 1: Mean and standard deviation of pre-test and post scores of pre-service chemistry teachers by method and gender

			Pre-test		**Post-test**	
Group	**Sex**	**N**	**Mean**	**SD**	**Mean**	**SD**
Experimental	Male	35	42.90	8.70	75.67	8.06
	Female	40	40.70	8.50	73.65	9.66
	Total		41.80	8.60	74.66	8.86
Control	Male	35	46.80	7.30	56.50	5.07
	Female	40	45.81	5.37	56.70	4.66
	Total		46.31	12.69	56.64	4.87

The result presented in the table showed a remarkable difference between the two groups of pre-service teachers. In pre-test, the mean achievement score of pre-service teachers under experimental condition was 41.80 with standard deviation of 8.60 while those students under control condition had a mean score of 46.31 with standard deviation of 12.69. This shows that the groups were almost at the same level before the experimental intervention. After the treatment, the experiential group had a mean score of 74.66 with a standard deviation of 8.86 while those under lecture instructional approach (control group) had a mean achievement of 56.64 with a standard mean deviation of 4.87. This indicates a higher mean gain achievement score by the students exposed to the experimental conditions. The indication is that productive-based demonstration instructional approach (experimental group) performed better than the control group.

The implication is that the use of production-based demonstration instructional approach can enhance the acquisition of entrepreneurial skills if applied in teaching chemistry concepts. In terms of gender, male students under experimental condition had a mean gain score of 32.77 while their female counterparts had a mean score of 32.95. On the other hand, male pre-service chemistry teachers in control group had a mean gain score of 10.03 whereas their female counterpart had 10.89. These figures show that gender gap as measured by the mean gain scores, reduced maximally.

Table 2: Analysis of covariance (ANCOVA) on academic achievement of male and female chemistry teachers exposed to productive-based demonstration instructional approach and those exposed to traditional lecture methods.

Type III	**Sum of Squares**	**DF**	**Mean Square**	**F**	**Sig.**
Correct model	8034.21	4	2160.815	535.673	000
Intercept	3365.050	1	3365.050	81.012	000
Pre-test	816.110	1	816.110	20.280	000
Teaching Method	7857.457	1	7857.435	196.540	000
Gender	85.466	1	65.466	1.546	202
Teaching method	18.403	1	18.403	434	502
Gender					
Error	3030.226	80	39.526		
Total	337259.000	83			
Corrected Model	11083.488	82			

Table 2 presents the summary of ANCOVA. This shows that instructional approach which is the treatment was significant at 0.05 level of significance (F= 196.54,

P>0.05). On the other hand, gender (F=1.546, P= 0.202) and teaching method interaction (F= 0.434, P =0.502) were not significant at 0.05 level of significance.

Discussion

The result of this study revealed that production-based instructional approach if used with demonstration method had significant effect on pre-service teachers' academic achievement. This outcome corroborates the views of Akinsola (2012) that the basic ingredient necessary for effective teaching is the active participation and involvement of learners in the learning situation and activities. The demonstration with production-based instructional approach directs the teachers to incorporate strategies that care for learners with different characteristics to benefit from the instruction. This is done by exposing learners to different activities that can facilitate the development of skills and creative thinking. The Implication of this is that the production-based demonstration group of students are exposed to various activities and techniques that will enable them to engage in tasks that can lead to use of skills to create or produce new products or opportunities. Demonstration with production-based instructional approach fosters active participation and high retention of information. It provides the gender groups ample opportunity to explore, explain, elaborate their views and have deep understanding of such concepts treated by their teachers. The results also revealed substantial reduction in gender gap in the acquisition of skill. This implies that demonstration production-based approach has no gender bias.

Recommendation

Since productive-based Demonstration instructional approach is found to be useful in improving academic achievement in STEM pre-service teachers, it is recommended that STEM educators should apply the use of demonstration with production-based instructional approach in their STEM (Chemistry inclusive) classroom instruction. This will ensure that pre-service teachers are adequately trained and equipped for self-reliance and to incorporate same in classroom instruction to their students upon graduation. On the other hand, Curriculum developers should include this technique in science/chemistry education curriculum of teacher education.

Conclusion

In conclusion, the use of production-based demonstration instructional approach in teaching chemistry to pre-service teachers has significantly enhanced the academic achievement of pre-service chemistry teachers when compared with conventional methods. It also led to substantial reduction in gender gaps towards the acquisition of skills between male and female undergraduate chemistry teachers.

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