# PREPARATION OF PRIMARY TEACHERS IN PUPIL-CENTRED ACTIVITY-BASED MATHEMATICS INSTRUCTIONS AND ITS MODEL

***Ayotola Aremu, PhD***
Education Technology Unit, Department of Teacher Education University of Ibadan

***Ishola Akindele Salami***
Early Childhood Unit, Department of Teacher Education University of Ibadan

**Abstract:**
The study is carried out as one of the various interventions to overhaul primary school teacher education programmes in Nigeria. This is considered necessary at this time because various research findings have revealed that majority of primary school teachers in Nigeria cannot deliver activity-based or any other pupil-centred mathematics lesson. For meaningful mathematics learning to take place at this level of education, the mathematics content must be directly related to real-life situation and the only instructional method that can help achieve this is activity-based. The study adopted pretest-posttest control group quasi-experimental research design involving two colleges of education randomly selected from south west part of Nigeria. Pre-service teachers in one of the colleges were exposed to activity-based instructions while those in the other were exposed to conventional method. The results revealed that those exposed to activity-based instructions have higher mean scores in activity-based lesson planning and delivery skills and in subject matter knowledge too. Based on this intervention, an instructional model for primary school teacher preparation was proposed

**Key Words**: Primary Mathematics Teachers, Pupil-centred strategy, Activity-based instruction, Teacher preparation

## Introduction

The incessant low performance of pupils in primary Mathematics and the reduction in the number of pupils who show interest in furthering their education in Mathematics or Mathematics related courses call for closer look into how the subject is taught. Various studies carried out by individual, governmental and non-governmental organizations revealed that teacher-centred method of teaching (direct instruction) is commonly adopted by the primary Mathematics teachers in Nigeria (COMPASS, 2009, Olosunde, 2009; Salami, 2009). Because of this, the discouraging low level of learning observed in the pupils during Mathematics classes must have been as a result of doing their class exercises following the algorithm of the teacher (the so-called 'do-it-as-I-have-done-it' syndrome). This type of learning has been described ineffective, functional and incapable of standing the test of time (Olosunde, 2009; Awofala, 2002; Amobi, 2003).

Research based evidences are numerous to show that teacher-centred method of teaching is not effective for primary mathematics. The subject has been identified as the most disliked subject in school (Brown, Brown and Bibby, 2008), with students' performance worsening from year after year at all levels of education (Aremu, 1998). A report by Nigeria Education Sector Analysis (ESA, 2004)has shown that the performance of pupils in primary Mathematics is below average and, also, that the problem solving skills of the pupils is poor. The national mean percent scores of primary four and six pupils in numeracy, according to the report, are 33.7 and 35.7 respectively.

Considering the status of primary Mathematics in the scheme of things and in all spheres of life, these poor teaching/learning situations associated with it should not be allowed to continue. Today, technology is the mainstay of any societal development and Mathematics has been recognised as the bedrock of technology and the sciences (Ogunsanwo, 2003; Awofala, 2008; Rasheed, 2008). In fact, we now live in an age in which no human endeavour can survive or develop without the application of Mathematics and/or technology since almost all kinds of job have been computerized. Apart from this, the subject develops the computational skills of pupils, skills for solving the day-to-day problems that require mathematical knowledge. It forms the basis for further education in almost all fields of study in all higher institutions (Tella, 2009). The economic development also has its root in the mathematical competence of the stakeholders (Ogunsanwo, 2003).

The clarion call to all concerned stakeholders of primary Mathematics in Nigeria is to ensure that pupil-centred method of teaching is adopted in primary classrooms. The first question that comes to mind is: why are primary mathematics teachers unable to deliver activity-based or any other pupil-centred method of teaching? To answer this question, researches were carried out and this inability of primary school teachers to adopt pupil-centred strategies, especially activity-based strategy, was traced back to the teacher education programmes they went through (Omosehin, 2004; Olosunde, 2009; Salami, 2009). It was discovered that when pre-service teachers are exposed to various teaching methods and strategies, their lecturers only concerned themselves with explanation of the meaning, and the features and conditions where each method or strategy could be best used. The lecturers, most of the time, do not use activity-based approach in teaching and they do not allow the pre-service teachers to plan and present this method while in training.

This lacuna has been discovered to constitute the most visible problem of trained teachers when they are employed to teach primary Mathematics. This is predicated on the premise that we teach the way we were taught (Khazanov, 2007). Besides, activity-based instructions, unlike teacher-centred instructions, require several skills that must be learnt through practical experience and/or observation of model situations. These skills might not be easily acquired through reading or listening to explanations. It is those teachers that acquire these skills that can teach Mathematics as expected in today's classroom. Unlike the way Mathematics was taught and learnt in the past century, where a Mathematics literate person is seen as "knowing Mathematics", the focus of teaching and learning the subject now is on "doing Mathematics" ( Bahr et al, 2010). Baki (1997) refers to 'knowing Mathematics' as procedural knowledge and 'doing maths' as conceptual knowledge. Conceptual knowledge is preferable because it involves the acquisition of the knowledge and ability to adopt it to solve life-related problems. Therefore, teaching at this level shall be by practical, exploratory and experimental methods (FGN, 2004).

Activity-based instructional strategy is based on constructivist theory which is predicated on the belief that learners are capable of constructing their own knowledge if allowed to interact, explore or be actively involved in the process of learning (Marley, Levin and Glenberg, 2010). It allows individuals to create their own new understandings, based upon the interaction of what they already know and believe and the phenomena or idea with which they come into contact. Activity-based instructional strategy has been used and found to be effective by many scholars at different levels (Reshetova, 2004; Dada, Granlund and Alant, 2006; Marley, Levin and Glenberg, 2010). Activity-based learning, according to Pica (2008), is the process of exploration and discovery, of acquiring knowledge; of knowing how to acquire it (no one can memorize all the facts!). It will serve a child endlessly, and, moreover, active, authentic learning is far more likely, than rote learning, to foster a lifelong love of the learning process (Jensen, 2008). Activity-based instructional strategy is a kind of learner-centred instructional strategy which has been shown to be effective than teacher-centred instructional strategy.

Markusic (2009) compares and contrasts learner-centred and teacher-centred instructions in two ways as follows: 1. Knowledge direction – The two paradigms of classroom instruction, teacher-centred and learner-centred, differ significantly in knowledge direction in the following areas: **Source of knowledge**– In the teacher-centred classroom instruction, knowledge primarily comes from the teacher while in the learner-centred paradigm, knowledge is the combined efforts of the teacher and students. Under the guidance of the teacher, students synthesize the gathered information using problem solving, critical thinking, and inquiry skills. **Acquisition of knowledge** – In the teacher-centred paradigm, teaching strategies are usually based on lecture or exposition. This paradigm places much emphasis on the faster pace and greater bulk of knowledge transmitted from teacher to student. But in the learner-centred classroom instruction, greater emphasis is laid on the meaningfulness of knowledge. Students acquire knowledge to address real-life issues and problems. **Receipt of**

**knowledge**– In the teacher-centred classroom; students receive knowledge passively, while in the learner-centred classroom, students are actively involved in seeking out knowledge.

2. Assessment approach – The fundamental purpose of conducting assessment in a teacher-centred classroom is similar to that of the learner-centred one. The fundamental purpose is to check and increase the effectiveness of instruction in the classroom. However, the approaches to conducting assessments are different in these two paradigms.

**Assessment tools**– Since the teacher is the primary source of knowledge in a teacher-centred instruction, there are only two kinds of answers – the right and the wrong. Thus, the tools used for assessment are those that clearly delineate the right answer from the other answers. On the other hand, in the learner-centred classroom, the importance of right answers is overshadowed by the importance of creating better questions. Thus, assessment tools vary to embrace the multiple facets of learning. Besides paper tests, there will be portfolios, performance tests, and others. **Assessment functions** – In a teacher-centred paradigm, the instruction follows a distinct step-by-step procedure. Once the subject is taught, assessment follows. The results of the tests are recorded and the function of the assessment was to monitor the academic progress of the students. But in the learner-centred paradigm, assessment is intertwined with classroom instruction. The results of a test are used to discover learning difficulties. The functions of the assessment are to diagnose learning problems and to encourage better learning. Macdonald and Twining (2002) supported this argument by giving three key issues for the assessment of activity-based learning. These are: (i) Assessment of activity-based learning must reflect course philosophy: that is, it must be aligned with the exercise of active learning, responsibility and autonomy; (ii) Assessment is essential in creating learning opportunities at critical points: the close integration of activities with assessment will ensure students' participation and (iii) Assessment provides a vital opportunity for feedback, helping to complete the reflective learning cycle.

There are two forms of activity-based instruction common at the lower level of education. These are the Pupil-centred Activity-based Strategy (PABIS) and the Teacher Demonstration Activity-based Strategies (TDAS) (Aremu and Salami, 2012). Of these two, it is the former (PABIS) that gives room for pupils to have direct interaction with the learning resources and be more active in knowledge creation. It is a completely learner-centred instruction wherein all the benefits of activity-based strategy associated if well implemented. This study was conducted as a form of intervention in the primary teacher preparation programme in the Colleges of Education through exposing the pre-service teachers to Pupil-centred Activity-based Strategy using the strategy itself. This is done in order to determine or gauge its effects on the pre-service teachers' Pedagogical Content Knowledge (PCK) and Subject Matter Knowledge (SMK).

For a teacher to be able to use various methods in teaching a given subject, s/he must possess adequate knowledge of the subject matter. Eggen and Kauchak (2006) shows that knowledge of a subject matter, which is also known as numerical ability, is an important prerequisite for effective teaching. In this respect, students of primary Mathematics in the colleges of education are made to take primary Mathematics contents courses in PES 113, 122, 222 and 324 so as to gain an in-depth knowledge of the subject (NCCE, 2009). Therefore, numerical ability of pre-service primary Mathematics teachers was considered important and examined as a moderator variable in this study.

Another important factor that could affect Mathematics teaching examined in this study is pre-service teachers' gender. The discussion of gender and Mathematics and science learning is far from being concluded. Between 1970 and 1990, there were more educational research studies on Mathematics and gender than any other area (Fennema, 2000). Scholars are still grappling with the issue in order to determine whether the causal relationship between Mathematics teaching-learning and the gender factor is biologically related or it is socially or environmentally related. If the inability of a female teacher/learner to record an achievement as high as her male counterparts, as revealed by researches (James, 2007), is biologically related, there is little or nothing that can be done to correct it. However, if this disparity is socially or environmentally related, it can be corrected. This is supported by some research findings which show that the gap between male and female students' performance in Mathematics is disappearing (Berube and Glanz, 2008). The argument here is that, if female students have low performance in Mathematics, there would be less number of female pre-service primary Mathematics teachers and the few that exist would have little knowledge of the subject matter. This eventually would affect their teaching. It should not be inappropriate, then, to examine the moderating effect of gender on this study that emphasizes the teaching process.

**Research Questions**

The following questions were raised to guide this study:

1. Is there significant difference between pre-service teachers exposed to PABIS and those exposed to conventional strategy in:
   a. Primary Mathematics Activity-based lesson planning skills?
   b. Primary Mathematics Activity-based lesson delivery skills?
   c. Academic performance in the Mathematics methodology course?
2. What instructional model can be proposed for the preparation of mathematics teachers in activity-based instructions?

**Methodology**

This study was conducted in two phases: the intervention phase and the observation phase. Pretest-posttest control group quasi-experimental research design was adopted for the study wherein lesson planning skills were measured before and after the intervention but lesson delivery skills and academic performance were measured after the intervention alone. This design took this form because the intervention was based on one of the primary Mathematics methodology courses in the college programme- PES 122 (Mathematics in Primary Education Studies II).

Pre-service teachers studying Primary Education Studies (PES) who were in the second semester of their programme from two different colleges of education were the participants of the study. This set of pre-service teachers as well as the course (PES 122) were selected based on the following criteria: (i) they were being prepared to teach primary Mathematics and must offer one primary Mathematics methodology course in the semester- PES 122. (ii) They must have been exposed to various teaching strategies in EDUC 113 (Principles and Methods of Teaching) and also some primary Mathematics contents in the college in PES 113 (Mathematics in Primary Education Studies 1). (iii) Because of the teaching observation that is involved in this study, the students must have been exposed to treatment before the Micro Teaching Theory (EDUC 213) which comes up in the first semester of second year. The two colleges that were involved in the study are both Federal Colleges of Education in two different south west states of Nigeria. These two colleges were randomly assigned to treatment groups. At the end of selection, 73 and 161 pre-service primary Mathematics teachers participated from the two institutions.

Eight research instruments (Three stimulus and five response instruments) were designed and developed for this study. These are:

i. Pupil-centred Activity-Based Instructional Package (PABIP)
ii. Pupil-centred Activity-Based Instructional Package Validation Tool (PABIPVT)
iii. Conventional Strategy Instructional Guide (CSIG)
iv. Activity-Based Lesson Plan Format (ABLPF)
v. Pre-Service Teachers Activity-Based Lesson Plan Scale (PSTABLPS);
vi. Academic achievement test on PES 122;
vii. Activity-Based Lesson Utilization Scale (ABLUS).
viii. Primary Numerical Ability Test (PNAT)

**Pupil-Centred Activity-Based Instructional Package(PABIP)**

This stimulus instrument was the most important in this study. It was designed by the researcher and it consists of the guide on the activity-based instructional strategy as well as the package to be delivered. This was used to prepare the pre-service teachers in the experimental groups. The instrument covers all topics in PES 122 (Mathematics in Primary Education Studies II). For every topic selected, the instrument covers how to perform the following: (a) state the behavioural objectives (b) selection of instructional and manipulative materials; (c) identifying both pupils' and teacher's activities; (d) presentation of the planned ABL; and (e) evaluation of the whole teaching/learning process. The package also features several worksheets which give and guide the students on various activities they were expected to carry out. It is worth emphasizing that at every stage of the preparation, as identified above, the pre-service teachers were taken through learn-to-do-it-by-doing-it (activity-based) strategy using Activity Planning Format (APF).

**Validation of PABIP**

The validation of this instrument called for another instrument named **Activity-Based Instructional Package Validation Tool (ABIPVT)**. It is a 19 item instrument self-designed by the researcher. The first two items seek the name of the assessor and the number of the lecture to be assessed; the next 16 items cover all the other aspects of PABIP with response ranging from adequacy or otherwise, to appropriate or otherwise and comments about each item. The last item was the general comment on the particular lecture assessed. Ten (10) copies of this instrument were given to each assessor alongside PABIP for the validation process. The responses of the assessors were used to make correction on PABIP.

**Conventional Strategy Instructional Guide (CSIG)**

The development of this guide was informed by the realization that there are various types of conventional strategies, including what is commonly referred to as the ‘purely chalk and talk’, and the slightly modified forms. The guide was designed by the researcher to ensure that the conventional strategy used in delivering the lessons in the control group was not too modified. The guide was a set of steps involved in the presentation of the lesson in the control group. The following steps were followed:

- Presentation of the course content by the lecturer
- Lectures are held without teaching aids and students are just to take notes and ask questions
- Examples, illustrations and further explanations are done using chalk and talk methods
- At the end, a short test was given (possibly the post-test measure).

All the content of PES 122 (Mathematics in Primary Education Studies 11) was broken down to the number of weeks for the course.

**Validation of CSIG**

The CSIG was validated by experienced lecturers in some Colleges of Education in Nigeria as well as educational research experts in the Faculty of Education, University of Ibadan. Their corrections were effected before the final copy was produced.

**Activity-Based Lesson Plan Format (ABLPF)**

This instrument was adapted from the Activity Planning format (Produced in Nipissing University). It was used to train pre-service teachers on how to develop activity-based lesson. It has six stages, viz: (i) general information which includes: subject area, class, topic, sub-topic, time, period and duration (ii) Pre-assessment stage which includes: entry behaviour, existing learning environment and available resources/materials (iii) Behavioural objectives which should cover the learning domains (iv) classroom activities for both pupils and teachers (v) Assessment which includes tools for assessment and assessment items and (vi) Teacher’s reflection on the lesson which includes: achievement or otherwise of objectives, effectiveness of teacher’s activities and next step of actions.

**Validation of ABLPF**

ABLPF was subjected to criticism by lecturers in the Department of Teacher Education and their comments were used to produce the final version.

**Pre-Service Teachers Activity-Based Lesson Plan Scale (PSTABLPS)**

This was a self- designed instrument that tries to measure the pre-service teachers’ skills in (a) stating behavioural objectives for ABL (b) selection/designing of appropriate materials (c) Planning pupils/teachers activities and (d) Identifying/designing assessment tools. The design of this instrument was tailored towards the adapted pre-service lesson plan format and it was used as a standard to measure the lesson plan at the pre and post level of the study. The instrument has 5 parts. Part 1 deals with demographic data of the students. There was no mark allotted to this part; part 2 measures the knowledge and skills in stating behavioural objectives for ABL. The items under this part cover (i) coverage of learning domains (ii) qualities of good behavioural objective, such as, being stated in measurable terms, condition of demonstration, taking care of average learners in the class and so on; and (iii) appropriateness of the objectives to the topic at hand. The total mark allotted to this part is 25 marks. Part 3 deals with skills of identifying/designing/improvising instructional materials that is developmentally appropriate to the pupils as well as the topic at hand. Items here cover (i) appropriateness of the materials to convey mathematical concept to be discussed (ii) age appropriateness and individual appropriateness of the materials (iii) availability/access to the materials by the pupils and the teachers (iv) provision; ready-made or improvised; the cost and number of mathematics ideas it could be used for. 25 marks were allotted to this part too. Part 4 deals with designing of both pupils' and teachers' activities. Items in this part cover (i) activity must have mathematical ideas embedded in it, (ii) logical presentation of activities, (iii) time/space consideration, (iv) level of involvement-individual, group or selected members of the class. 25 marks were allotted to this part too. Part 5 deals with the skills in identifying/designing of assessment tools for ABL. Items under this cover (i) appropriateness of instrument (ii) validity of instrument (iii) mark allocation (iv) consideration for intellectual, social and physical activities. 25 marks were allotted to this part. The total score a candidate could obtain in a planned lesson, using this tool to measure it, is 100 marks.

**Validation and Reliability of PSTABLPS**

The instrument was subjected to constructive criticism in the Department of Teacher Education and Institute of Education, University of Ibadan. The corrections from the various experts were used to produce the final copy and reliability was determined using inter-ratter technique which yielded reliability coefficient of 0.837.

**Academic Achievement Test on PES 122 (AATPES)**

This instrument was the examination questions the pre-service teachers were made to answer at the completion of the course lectures in the two institutions. To ensure uniformity, the researcher requested the lecturers in the two institutions to set the examination questions before the beginning of the semester. The two questions were then blended together to form 5 theory questions. This was shown to the two lecturers and their approvals were sought. The questions were then administered as examination questions at the end of the semester.

**Validation of AATPES**

The items in the examination question were generated from the content of PES 122. After the blending, the two lecturers were made to assess and approve it before use.

**Activity-Based Lesson Utilization Scale (ABLUS)**

This instrument was adapted from the Department of Teacher Education, University of Ibadan. It is the instrument used to assess the teaching performance of education students during Teaching Practice and it is titled "Teaching Performance Assessment Sheet". The adapted version was used in this study to rate the teaching skills particularly in presenting an activity-based mathematical lesson by the pre-service teachers. The adapted version of the instrument focuses on the following areas: (a) ability to make the pupils ready by examining their entry behaviour and building the new lesson on their entry behaviour; (b) presenting the pupils' and teacher's hand-on activities; (c) observing pupil's individual participation and guiding their learning while on activity (d) using and allowing questioning method that will enhance the pupils' learning. The instrument was adjusted such that it contains 20 items instead of 19 in the original format.

**Validation and Reliability of ABLUS**

Experts, senior lecturers in the Department of Teacher Education as well as veterans in primary Mathematics were consulted for the validation of the instrument, and the reliability coefficient was calculated using inter-ratter technique and reliability coefficient of 0.793 was obtained.

**Primary Numerical Ability Test (PNAT)**

This is a self-designed instrument which is meant to measure the pre-service teacher's primary numerical ability. It contains 20 items which cut across five (5) major topics in primary Mathematics, namely: Number and Numeration, Basic Operations in Mathematics, Measurement, Practical and Descriptive Geometry and Everyday Statistics. All the questions are multiple choice types with one correct answer and three distractions (A to D). Table 3.2 shows the specification of the items in the instrument.

**Table 1: Table of Specification for PNAT**

| S/N | Topic | Knowldg. | Comp. | Appl. | Analy. | Synth. | Eval. | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | Number and Numeration | | Q1 | Q2 | Q3 | | | 3 |
| 2 | Basic Operation | Q7, Q8 | Q9 | Q4 | Q6, Q10 | | Q5 | 7 |
| 3 | Measurement | | | Q11, Q13 | | Q12 | | 3 |
| 4 | Geometry | | Q17 | Q16 | | | Q14, Q15 | 4 |
| 5 | Everyday Statistics | Q18, Q19, Q20 | | | | | | 3 |
| | Total | 5 | 3 | 5 | 3 | 1 | 3 | 20 |

Table 1 shows that out of the 20 items in the instrument, 3 were drawn from number and numeration; 7 from basic operations; 3 from measurement; 4 from geometry and 3 from everyday statistics. It also shows that 13 of the questions spread over the lower level of cognitive learning domain and 7 are on upper level of cognitive learning domain. The performance of the pre-service teachers in this test was used to categorise them into three numerical ability levels, namely: low, average and high primary numerical ability.

**Procedure**

The study took two semesters to complete. The second semester was used to carry out the treatment and it lasted for 11 weeks. The teaching observation took place in the first semester of the second year and the observation lasted for 3 weeks. This is possible because the activities were taking place simultaneously in the two colleges.

The lecturers in the colleges were trained on the different strategies they were to adopt. They were tested and corrected where necessary. During the treatment, these lecturers were monitored and assisted sometimes by the researcher who was always in the two institutions during the lectures and the micro-teaching.

Data collected was analysed using Statistical Package for Social Sciences (SPSS) software. Statistical tools used were descriptive statistics of frequency count, percentage, mean and standard deviation including charts. Inferential statistics used were Analysis of Covariance (ANCOVA) and the post hoc test and Multivariate Analysis of variance (MANOVA).

**Results**

Demographic Data Analysis

**Table 2: Distribution of the Pre-service Teachers Based on Numerical Ability and Treatment groups**

| TREATMENT | NUMERICAL ABILITY | | | TOTAL |
|---|---|---|---|---|
| | **LOW** | **AVERAGE** | **HIGH** | |
| PABIS | 38 | 25 | 10 | **73 (31.2)** |
| CONV. | 97 | 37 | 27 | **161 (68.8)** |
| | **135 (57.7)** | **62 (26.5)** | **37 (15.8)** | **234** |

Table 2 reveals that out of the 234 pre-service teachers involved in this study, 57.7% had low numerical ability; 26.5% were average and only 15.8% had a high numerical ability. It is also revealed in the table that 31.2% were exposed to Pupils-centred Activity-based Instructional Strategy (PABIS) and 68.8% were exposed to Conventional Strategy. Figure 1 is a depiction of this information in a chart.

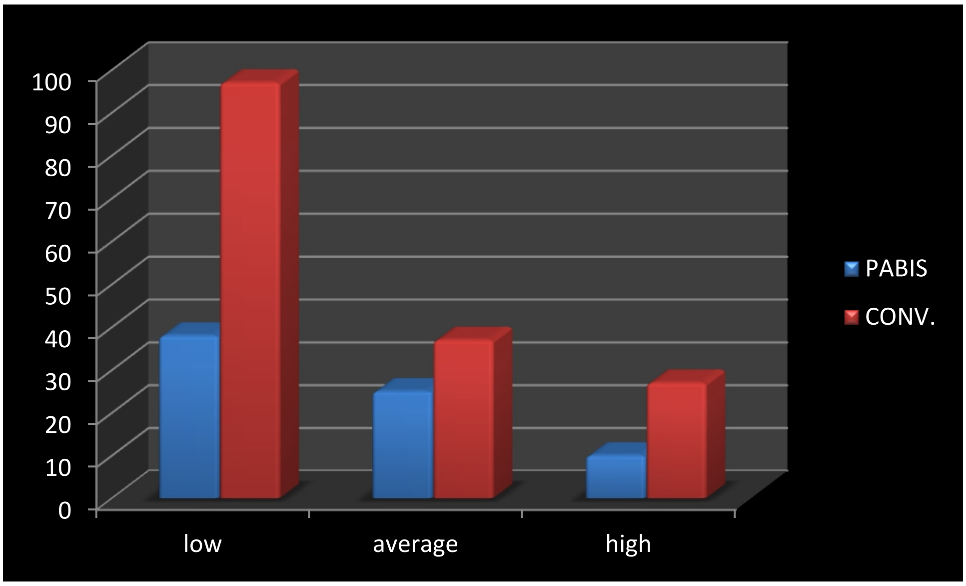



**Fig. 1: Distribution of participants based on treatment and Numerical Ability**

**Table 3: Distribution of the Pre-service Teachers Based on Gender and Treatment groups**

| TREATMENT | GENDER | | | TOTAL |
|---|---|---|---|---|
| | **MALE** | **FEMALE** | | |
| PABIS | 18 | 55 | | **73 (31.2)** |
| CONV. | 67 | 94 | | **161 (68.8)** |
| **TOTAL** | **85 (36.7)** | **149 (63.7%)** | | **234** |

Table 3 shows that majority of the pre-service teachers are female 63.7% while only 36.7% of them are male. Of the total number of male, 21.2% were exposed to PABIS and 78.8% were exposed to conventional strategy. Of the total number of female, 36.9% were exposed to PABIS and 63.1% were exposed to conventional strategy. This shows that both sexes participated in the study. Figure 2 is a depiction of this information in a chart.

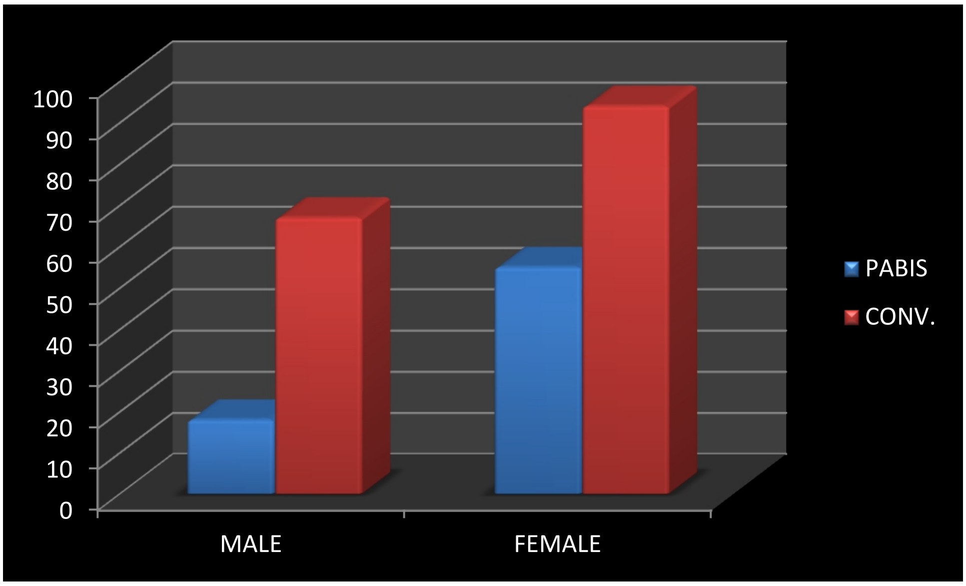



**Fig. 2: Distribution of Participants based on Treatment and Gender**

**Answers to the Research Questions**

**RQ1a:** Is there significant difference between pre-service teachers exposed to PABIS and those exposed to conventional strategy in Primary Mathematics Activity-based lesson planning skills?

The ANCOVA reveals that there is a significant difference between the two groups of treatment on pre-service teachers' lesson planning skills ($F_{(1,231)} = 604.15$; $P<0.05$; $\eta = .80$). The effect size is given to be 80%. Table 4 reveals the magnitude of performance across the groups.

**Table 4: Estimated Marginal Means on the Treatment, Numerical Ability and Gender**

| Variable | N | Mean | Std. Error |
|---|---|---|---|
| **Intercept** | | | |
| Grand mean (Post-score mean) | 234 | 42.81 | .76 |
| Pre-score mean | 234 | 13.93 | .61 |
| **Treatment** | | | |
| PABIS | 73 | 55.37 | 1.30 |
| Conventional (control) | 161 | 11.32 | .81 |
| **Numerical Ability** | | | |
| Low | 97 | 42.53 | .76 |
| Average | 37 | 42.44 | 1.08 |
| High | 27 | 43.46 | 1.86 |
| **Gender** | | | |
| Male | 67 | 42.58 | 1.32 |
| Female | 94 | 43.03 | .75 |

Table 4 reveals that the pre-service teachers exposed to PABIS have the higher activity-based lesson planning mean score (55.37) than those exposed to conventional teaching (11.32). This information is represented in a chart below:

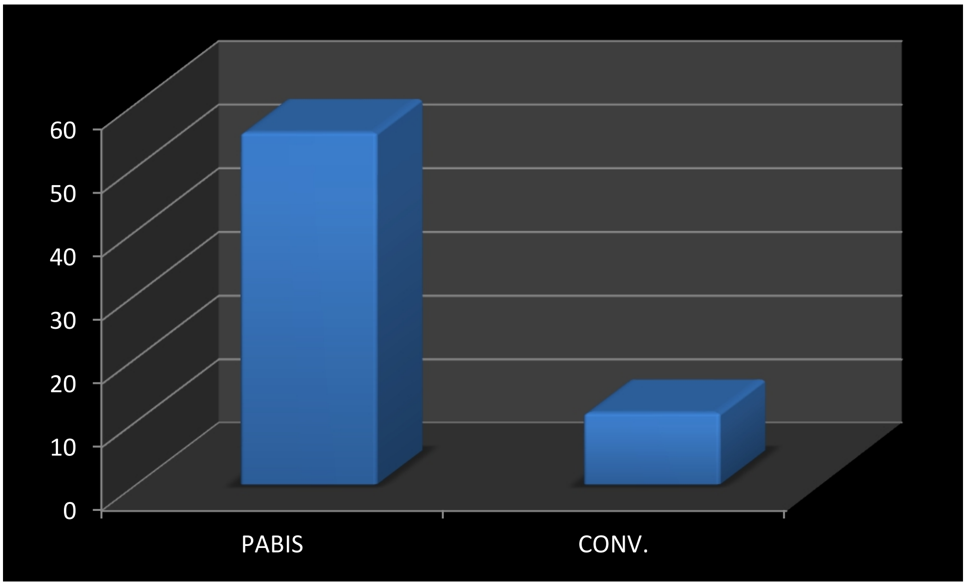



**Fig.3: Activity based lesson planning Skills after Treatment across the Groups**

Based on this analysis, it can be inferred that there is a significant difference between the pre-service teachers exposed to PABIS and those exposed to Conventional Strategy in their acquisition of activity-based lesson planning skills. This finding was as a result of the effect of the instructional strategy used on the acquisition of lesson planning skills. In the first experimental group, the pre-service teachers were made to learn these skills in various ways, including: being taught using the strategy; being made to be learners in the activity-based Mathematics lessons; being allowed to access various activity-based lesson plans and being made to discuss the features of this type of lesson plan, all of which were based on the content of the course under discussion. Therefore, the pre-service teachers were able to gain a lot about planning primary mathematics lessons for this type of instructional strategy. This is in line with the submission of the National Policy on Education (FGN, 2004) that Mathematics should be taught in practical way. Pica, (2008) and Bahr et al (2010) also submitted that learners should do mathematics and not study it. The effectiveness of pupil-centred activity-based instructional strategy is in line with the findings of many studies such as Lakshmi (2005). Jensen (2008) opined that it will serve a child endlessly, and that, moreover, active, authentic learning is far more likely, than rote learning, to foster a lifelong love of the learning process. Pica (2008) believed that because it is more fun, learners in activity-based mathematics classes learn mathematics in a relaxed mood.

**RQ1b:** Is there significant difference between pre-service teachers exposed to PABIS and those exposed to conventional strategy in Primary Mathematics Activity-based lesson delivery skills?

The MANOVA reveals that there is a significant difference between the treatment groups in pre-service teachers' primary mathematics activity-based lesson delivery ($F_{(1, 231)} = 58.23$; $P<0.05$; $\eta$ = 0.30). The treatment has the effect size of about 30% of the total variance in the dependent variable (Partial eta square = 0.30). Table 5 presents the magnitude of lesson delivery performance across the groups.

**Table 5: Estimated Marginal Means Showing the Lesson Presentation Scores of the Pre-Service Teachers across the Groups**

| Treatment | Mean | Std. Error | Partial eta sq. |
|---|---|---|---|
| PABIS | 59.36 | .89 | |
| Convent. | 46.15 | .80 | .299 |

Table 5 reveals that those exposed to PABIS had the higher activity-based lesson delivery mean score (59.4) than those exposed to conventional strategy (46.2). Figure 4.3.2 shows this in a chart.

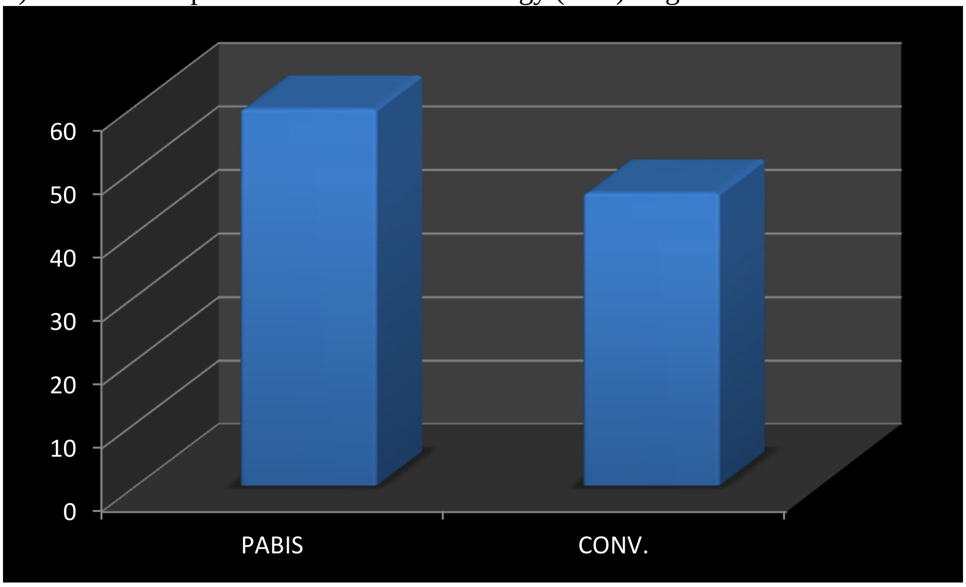



**Fig. 4: Bar Chart Showing Pre-service Teachers Activity-based Lesson Delivery Scores across the Groups**

Based on this, it can be inferred that there is a significant difference between pre-service teachers exposed to PABIS and those exposed to conventional strategy in their acquisition of Activity-based primary mathematics lesson delivery skills. Those exposed to PABIS have higher mean score than those exposed to conventional strategy. The finding that those exposed to PABIS acquired activity-based primary mathematics lesson presentation skills more than the other groups could be as a result of the fact that they were the only group that was exposed to pupils-centred active mathematics learning. They were made to learn primary mathematics actively wherein they did not only listen and observe, but also explored materials as well as the teaching/learning processes. In this case, they experienced all it takes to present such lesson. This finding corroborates the submission of Rieg and Wilson (2009) who argued that one approach to revitalising undergraduate education is by shifting pedagogy to a learner-centred focus and supporting an emphasis on the scholarship of teaching and learning. Many other scholars have also advocated learner-centred method of teaching in teacher preparation. Some of these are Rieg and Wilson (2009) and Alexander, Van Wyk, Bereng and November (2009).

The finding that pupil-centred activity-based instructional strategy is the best strategy for producing teachers that could deliver activity-based primary Mathematics lesson compared to any other teacher-centred method is in line with Masikunis, Panayiotidis and Burke's (2009) idea that an effective teaching cannot be attained by transmission model (lecture method) which is characterised by students sitting in rows, facing the lecturer who is considered as 'the sage on the stage'. It can only give a surface approach to learning and no deep understanding could take place. It also supports Filene's (2005) belief that at this level of education (higher education), students have grown up expecting or even demanding more than a 'talking head'. To this end, Cruickshank, Jenkins and Metcalf (2003) argued that the modified lecture method has one disadvantage that makes it inappropriate for pre-service teachers: it has a significant negative influence on the way the pre-service teachers teach the younger ones. The finding also supports the two factors identified by Finkel (2000) as being responsible for the failure of lecture method: (1) the lecturer presumes students have had experiences that they have not had and (2) reflection is done by the lecturer not by the students. Alexander, Van Wyk, Bereng and November (2009) also argued that learners' cognitive faculties were thus not engaged, resulting in what was termed 'rote drilling, memorization or cramming'.

**RQ1c:** Is there significant difference between pre-service teachers exposed to PABIS and those exposed to conventional strategy in Academic performance in the Mathematics methodology course?

The MANOVA shows that there is a significant difference among pre-service teachers exposed to PABIS and Conventional strategies in their academic performance in Mathematics methodology course, PES 122 ($F_{(1, 231)} = 60.11$; $P<0.05$; $\eta = .31$). The partial eta square reveals that the treatment accounted for 31% of the total variance in the pre-service teachers' academic performance in PES 122. Table 6 reveals the magnitude of performance across the groups

**Table 6: Estimated Marginal Means Showing Performances of Pre-service Teachers in PES 122 across the Groups**

| Treatment | N | Mean | Std. Error |
|---|---|---|---|
| PABIS | 73 | 59.36 | .91 |
| Conv. | 161 | 45.36 | .83 |

Table 6 reveals that pre-service teachers exposed to PABIS had the higher mean score in PES 122 examination (59.4) than those exposed to Conventional strategy (45.4). The chart below depicts this information.

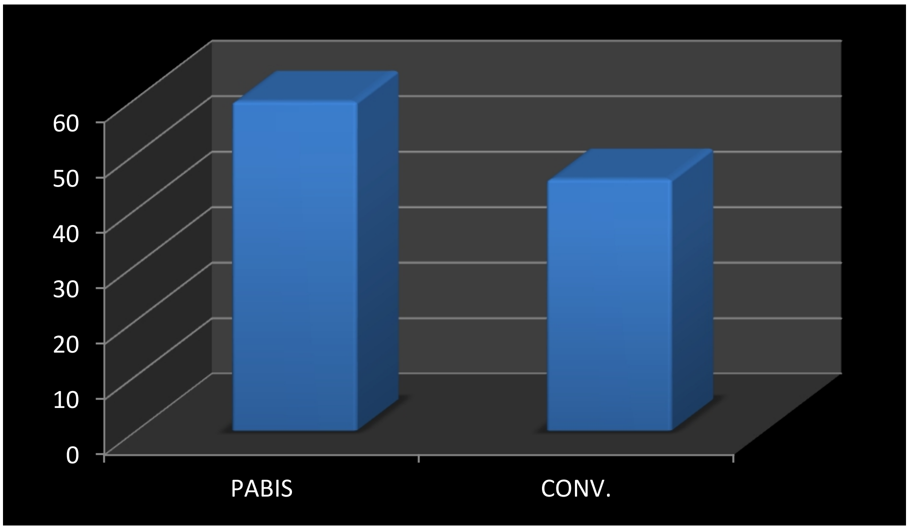
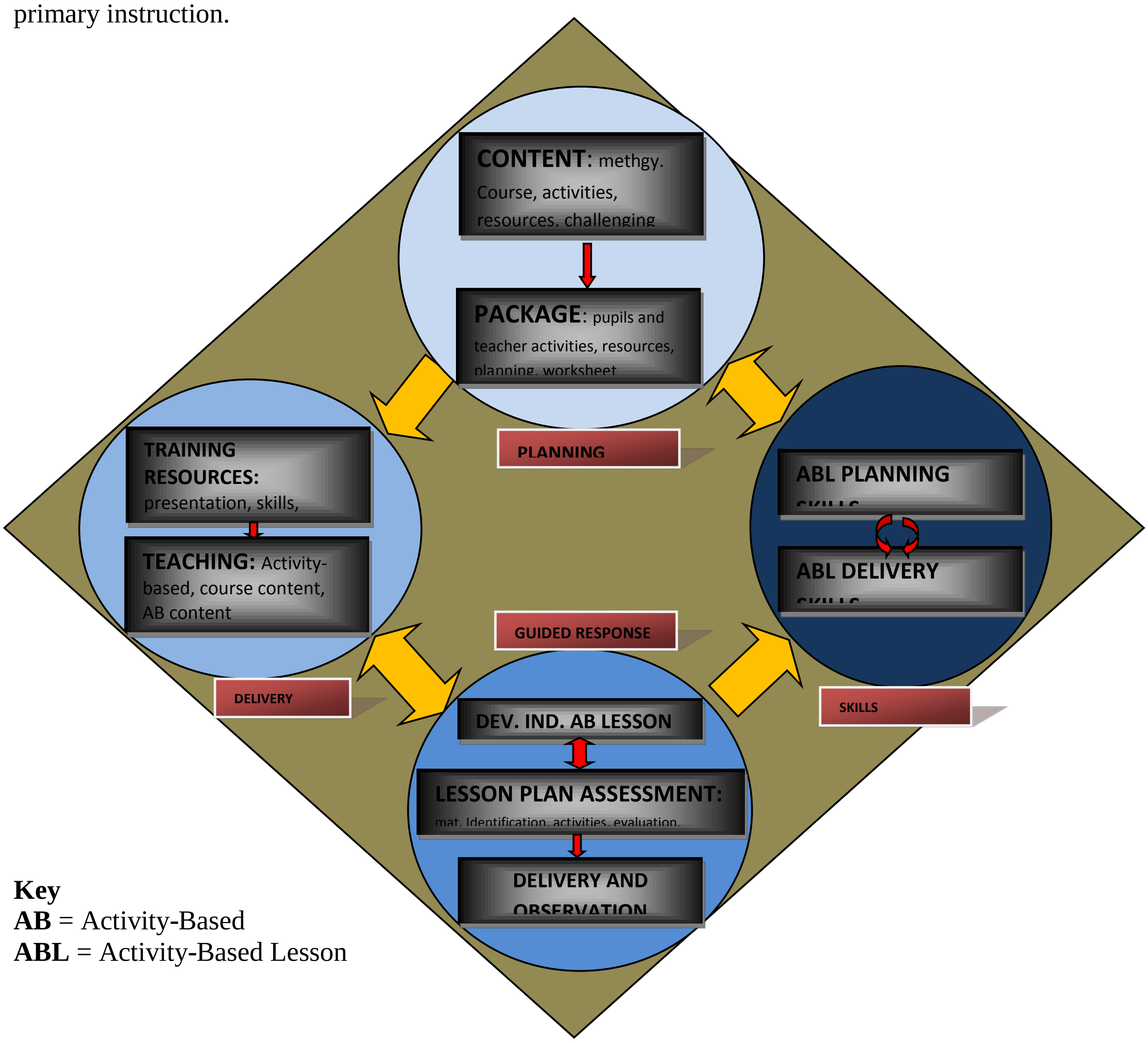



**Fig. 4.3.3: Bar Chart Showing Academic Performances of the Pre-service Teachers across the Groups**

From this, it can be inferred that there is a significant difference between pre-service teachers exposed to PABIS and those exposed to conventional strategy in their academic performance in the Mathematics methodology course (PES 122). Those exposed to PABIS had higher mean score than those exposed to conventional strategy in the subject matter knowledge (SMK). Therefore, the treatment has a great influence on the academic achievement of the pre-service teachers in primary mathematics methodology course. This finding confirms the claim of Hannaford (2005) that 'learning by doing' creates more neural networks in the brain and throughout the body, making the entire body a tool for learning. Many scholars have tested activity-based instructional strategies, just as done in this study, and found them effective in helping learners learn at different levels of education (English and Halford, 1995; Cubey and Dalli, 1996). This finding also corroborates the submissions of Lakshmi (2005) that activity-based instructional strategies are based on constructivist theory which states that learners are capable of constructing their own knowledge if allowed to interact, explore or be actively involved in the process of learning. It was argued further that these strategies allow individuals to create their own new understandings, based upon the interaction of what they already know and believe and the mathematical idea with which they come into contact. Therefore, this finding is of great importance.

**RQ2:** What instructional model can be proposed for the preparation of mathematics teachers in activity-based instructions?

Based on the whole study, a model for activity-based instructions for teacher preparation is proposed. It is believed that the adoption of this model by teacher trainers generally and primary mathematics methodology course lecturers in particular in any institution will produce teachers that will be able to deliver not only activity-based primary mathematics but any other pupil-centred primary instruction.




**Key**
**AB** = Activity-Based
**ABL** = Activity-Based Lesson

**Fig. 5.1: Activity-Based Instruction Model (ABIM) for Teacher Preparation**

Activity-based Instructional Model (ABIM) is a model with 4 major cyclical phases. These are:

i. Planning stage
ii. Delivery stage
iii. Guided response
iv. Skills formation

Planning stage involves two major activities. The first is the identification of course content to be delivered using this instruction. This course must be one of the methodology courses meant for the pre-service teachers. The lecturer must identify the activities that will be carried out by the pre-service teachers as well as the lecturer. These activities must be the ones that will be challenging to students at this level and all the needed resources must be identified. The second activity is to put together the instructional package that will be followed in the course of instruction. Based on the contents of the course to be delivered, the learners' activities, lecturer's activities, needed resources, worksheets for classroom activities and take home assignment must be planned and succinctly written down in the package. The successful completion of this package marks the end of phase 'one' and lead to the second phase.

The second phase of the model is called the delivery stage. Here, too, there are two levels. The first is the level of training other resource persons that will assist in the delivery of the instruction. This is informed by the realisation that activity-based instruction for large number of students calls for more than a single hand. The resource persons must be trained on the skills needed for the presentation and assessment of activity-based lesson. After the successful training, the classroom interaction (Teaching) with the pre-service teachers could start. The interaction should feature activities on the course content. Not only this, some content of how to prepare for activity-based instruction must be injected into the instruction. These instructions are expected to last for the whole semester so as to cover the course content.

The third phase has a dual interaction with the second phase. The third phase can only happen after the second phase must have taken place; also, if the third phase is not well mastered by the learner, the second phase must be revisited. For instance, if a pre-service teacher should fail the course, he will repeat the class and go through the second phase again. This third phase is called guided response stage. This is the stage where individual pre-service teachers will be allowed to demonstrate what they have learnt so far while the lecturer guides their activities. Guided response has three levels: development of individual activity-based lesson plan; lesson plan assessment by the lecturer wherein the lecturer closely checks the following: material identification, activity suggested, tools and technique of evaluation suggested and domains of learning featuring; and, finally, activity-based lesson delivery and Teaching practise supervision to determine how skilful each pre-service teacher can deliver activity-based lesson. This phase leads to the last phase which is called skills formation.

Skills formation has two levels that are interwoven. These are the development of activity-based lesson planning skills and delivery skills. These two skills are formed almost simultaneously. The number of times of phase-three an individual pre-service teacher is able to do will inform how fast these skills will be mastered. When these skills are well formed, then individual pre-service teachers can now go to phase-one on their own which make it cyclical. Again, when the teacher tries more of phase-one, their skills formation will keep getting better and this will lead to origination in skills development.

It should be noted that this model is developed using primary Mathematics subject. It is believed that the model will be applicable to all other academic fields wherein teachers are expected to teach using learner-centred instructional strategies. Again, this model is expected to be applicable not only to activity-based strategies but all other pupil-centred instructions that are expected to be acquired by the primary school teachers.

**Conclusion**

Based on the findings of this study, it can be concluded that activity-based instructional strategies, that is, Pupil-centred Activity-based Instructional Strategy (PABIS),is better than modified lecture or direct instruction commonly adopted for the training of primary mathematics teachers in the Colleges of Education in Nigeria. Both the Subject Matter Knowledge (SMK) and the Pedagogical Content Knowledge (PCK) are better acquired when activity-based instructional strategies are employed than when conventional, modified lecture is used. Finally, the teaching of primary mathematics methodology courses in Colleges of Education should include the training of how to plan and deliver activity-based lessons on each topic. It seems deficient to teach the pre-service teachers only the SMK and think they will automatically acquire the PCK on their own.

**Recommendations**

The following are recommended as a follow up to the findings of this study:

- Lecturers of primary mathematics methodology courses in the Colleges of Education should be discouraged from using the conventional method of teaching (modified lecture or direct instruction). Activity-based instructional strategies are better, more effective options. The adoption of these strategies can be achieved through organizing training workshops for pre-service teachers where they can be taught the strategies. Besides training, NCCE should ensure compliance by setting up a pedagogical monitoring section in each of the states, with trained staff on pedagogy that will supervise the teaching of these courses.

- With activity-based instructional strategies, lecturers of primary mathematics methodology courses should not be concerned so much with the effect of numerical ability or gender of the pre-service teachers. Rather, they should concentrate on developing the creativity skills of the teachers in the area of designing pupils'/teacher's activities that have the mathematical idea explicitly; it should include selection of materials to be used for the activities and how to evaluate the lesson at the end.
- Activity-based instructional strategies are material-driven; hence, each college should ensure that mathematical manipulative materials are adequately provided for the Mathematics Department. This could be achieved by asking the lecturers to make available the list of materials needed and the quantity at the beginning of each session. The college should then provide the fund for their purchase with adequate supervision. Besides this, the lecturers might be given allowances for mathematical manipulative materials each session and the purchase painstakingly supervised.

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