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Accelerating Preservice Chemistry Teachers' Teaching Effectiveness: Any Hope Using Mentoring Strategy?

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study investigated the impact of teacher mentoring programme on the teaching effectiveness of preservice chemistry teachers with gender and age as moderating variables.
Study Design: The study is a pretest, posttest quasi experimental type. Intact groups were therefore used.
Place and Duration of Study: The study took place in Plateau State of Nigeria and lasted for 12 weeks (that is, between April and June 2012).
Methodology: The instruments used were Teacher Mentoring Guide (TMG) and Teaching Practice Assessment Scale (TPAS). A purposive sample of 72 Nigeria Certificate in Education (NCE) final year chemistry teachers was used. The experimental group was mentored using TMG while the control group participated in the twelve-week teaching practice experience without an assigned mentor.
Results: It was found that there was a significant difference between the mean teaching effectiveness score of preservice chemistry teachers exposed to mentoring and those that were not. However, there were no significant differences between the mean teaching effectiveness of males

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and females, nor were there distinctions between teaching effectiveness scores of preservice teachers by age group.
Conclusion and Recommendations: Results allow speculations that mentoring of preservice chemistry teachers improved the participants' teaching effectiveness. Thus, a teacher mentoring programme using a structured mentoring guide for preservice chemistry teachers (either in the school or while on teaching practice) is recommended. Future research could concentrate on the gender of the mentor with a view to determining if mentor gender impacts mentoring outcomes.

Keywords: Mentoring; mentors; mentees; preservice teachers; chemistry teachers; teaching effectiveness.

1. INTRODUCTION

Chemistry is one of the optional science subjects offered at the senior secondary school level (10^{th} to 12^{th} grade) in Nigeria. It is one of the science subjects upon which the bulk of the present technological breakthrough is built. The knowledge of chemistry is found to be essential in production of items like plastics, detergents, pesticides, herbicides, fertilizers, building materials, chemical solvents, motor vehicles and airplane parts, clothing fibres, cosmetics, drugs, and polythene bags. There are many chemistry related careers such as those in food processing, chemical engineering, biochemistry, forestry, pharmacy and medicine. This fact could explain why the Nigerian government at the National level pegged admission ratio into higher institutions of learning at 60:40 in favour of science (chemistry inclusive).

Despite the relevance of the knowledge of chemistry to the society, achievements of students in chemistry as measured by their scores in Senior Secondary School Certificate Examination (SSCE) have been poor [1,2,3]. SSCE is the external certificate examinations written by secondary school leavers in Nigeria. At present there are two of such examinations- the West African Examination Council (WAEC) controlled by all West African countries and the National Examination Council (NECO) controlled by Nigeria alone. Results obtained from SSSCE are used to place candidate into tertiary institutions and Universities in Nigeria and other countries where they are recognized. For instance, a candidate is expected to have minimum of 5 credits from this examination including the English and Mathematics sections before gaining entrance into University. The best result between 1984 and 1997 according to Oduwiaye [4] and Oyedokun [5] was in 1986, when 39.2% of the students passed chemistry at credit.

Considering the fact that a credit in chemistry is required to gain admission into higher institutions (to read most science related courses), one would understand why there is a steady decline in enrolment into chemistry and other science subjects at the higher institutions. It may also explain why higher education institutions have mount remedial programmes.

The poor performance in chemistry is not peculiar to secondary schools students only. Students at the Colleges of Education also perform poorly. Colleges of Education are tertiary teacher production institutions in Nigeria that award the Nigeria Certificate in Education (NCE). A study [6] revealed that for a period of five years (2003-2008), the number of Nigeria Certificate in Education (NCE, an equivalent of A level) chemistry students who passed at merit (C) level and above has never exceeded forty percent. Considering the fact that these students are being trained to teach secondary school students, their performance is considered poor and therefore a need exists to help them academically and professionally. The objective of this study therefore was to determine the impact of a teacher mentoring programme on preservice chemistry teachers' teaching effectiveness. By teaching effectiveness in this study we mean the ability of the preservice NCE chemistry teacher to teach science in such a way that the learning goals are achieved. Therefore a mean score of 60% and above on the teaching practice supervision rating is considered effective while those below are considered not effective. Simpson and Weiner [7] defined teacher effectiveness as the production of the expected learning outcomes by the teachers' teaching through the efficient display of good teaching methods by the teacher which in turn encourages maximum good student learning behaviour revealed by their achievement scores. It is the teacher's proficiency and his/ her excellent teaching performance that determines the

learning experiences provided for the students to enhance their learning behaviour which is the second criterion for assessing teacher effectiveness.

In Nigeria, Michael [8] established that mentoring had a significant effect on the teaching competence of the beginning teachers involved in programme. It also significantly improved the teaching competence of both professional and non-professional teachers involved in the programme. Oke, Adenle, Ogunleye and Adeyemo [9] also undertook a study of the effect of mentoring on the teaching competence of integrated science teachers and found that a significant difference existed between the teaching competence of beginning integrated science teachers exposed to peer mentoring and that competence of those that were not exposed to it. A difference also existed between the teaching competence of mentored trained and untrained teachers.

2. MENTORING AMONG TEACHERS

Nearly all teaching issues, whether related to goals, learning, achievement, organization of programme or performance of the education system involve analysis of the role of teachers, their behaviour, performance, skills and how they are used in the system. The teachers have the skill to actualize the knowledge potentials that already exist in the student. Buttressing the importance of the teacher, Ukeje [10] commented that if a doctor makes a mistake, a patient may die, if an engineer makes a mistake a bridge may collapse, but if a teacher make a mistake, generations yet unborn may suffer. The teacher is the key to proper development of the child and consequently to the development of a nation. Hodufied and Stonet in Ciwar [11] buttressed stated that there stands the teacher always on stage, often in front and at the center. What he knows can make a difference, what he does not know can lead to irreparable loss. Okebukola [12], Nwosu [13,14] and Ajewole [15] all see the teacher as the most important variable in influencing students' interest, attitude and achievement in science and technology. Lassa [16] and Bulus [17] all reiterated that the quality of instruction and level of understanding of students depend so much on the teacher. It is in realization of this fact that the National Policy on Education [18] stressed the importance of effective teacher preparation as the arrow head of quality in any educational system, when it aptly states, "no education can rise above the quality of its teachers" (p.33). Anderson [19] also commented on the crucial role of the teacher in the teaching and learning process:

The teacher plans the environment of the classroom, organizes and manages the class, determines the detailed curriculum that will be presented to the students, as well as its sequencing and pacing, the overall structure of the lessons, the home work which is to be given, sets the feedback mechanisms to know how each pupil is getting on, the corrections to be given (p. 11).

Despite the importance of the teacher it has been observed that the training of the preservice teachers during the practice teaching or practicum (that is, period of teaching under the guidiance of experienced teachers with occasional visitas by methodology teachers from the college or university) was inadequate. Hay-McBer and Ingersoll [20] asserts that a lot of inadequacies exist in teacher training programmes in terms of helping the preservice teachers learn the rudiments of teaching. Buttressing this point, Ingersoll [21], Ingersoll and Smith [22], asserted that such inadequacies were due to the way the preservice teacher was treated during practice teaching. They further added that although teaching involves intensive peer interaction with youngsters, it is largely done in isolation from colleagues. This situation is especially consequential for preservice teachers who while on teaching practice are often left to their own devices to succeed or fail within the confines of their classrooms, an experience likened by some to being lost at sea [23]. Teaching according to Ingersoll [24] seems to be the only occupation that does not deliberately encourage its young and in which the initiation of new teachers or preservice teachers on teaching practice is akin to a 'sink or swim' or 'trial by fire,' or 'boot camp' experience. Teaching is probably the only profession that expects its beginners to be responsible for the same work expected of experienced teachers.

In the 1950s, primary school teachers in Nigeria were trained on the job under the watchful eyes of master teachers, thus ensuring adequate supervision. Ogunsola [25] recalled that in the 1950s preservice teachers and the teachers received one hour daily instruction from the head teacher on how to teach effectively. This approach was to some extent successful as cases of failure then was minimal compared to what occurs today. Currently, both the

supervising lecturers that are expected to supervise preservice teachers during practice teaching practice and the regular class teacher whose class the preservice teacher takes over hardly discussed how to teach with the practice teachers. Lamenting this trend, researchers like Nnadozie [26], Maduabum [27] and Gyuse [28] said that in most cases what the supervising lecturer does is to go into the class or stand by the window for about five or ten minutes and give the student teacher a pass or fail grade. To Maduabum [27] neither of the supervising teachers accepts responsibility for helping preservice teachers who require supervisory assistance.

Certain teaching skills are considered basic and it is expected that such rudiments are acquired or well mastered during practical teaching in the classroom. These skills include; (a) Lesson planning, (b) lesson presentation, (c) communication skills, (d) classroom management, (e) evaluation and (f) summary and conclusion. For the preservice teacher to learn these basics there is need for intensive mentorship interaction between the preservice teacher and his/her supervising teachers. Therefore, the lack of or inadequate mentoring is likely to affect the teaching effectiveness of the preservice teacher.

In view of the problem of poor supervision of preservice and beginning teachers during teaching practice in Nigerian education system as observed by Gyuse [28], there is the need to explore and modify the apprenticeship system that was in practice between 1950s and early 1980s. This modification is considered essential because it was found to be an efficient supervisory method.

The new mentorship system could be favorably compared to the recent strategy employed by some developed countries where preservice and new teachers are assisted by experienced mentor teachers. Mentor teachers may serve in the following capacities: (a) demonstrate teaching techniques, (b) observe new teacher's classroom teaching, (c) provide the protégés with feedback, and (d) hold support meetings to clarify issues that arise [29,30]. The mentors' role is to help the pre service teacher in translating theories learned in the classroom during the preservice training into practice. The mentor equally serves as a sort of cushion for the reality shock the preservice teacher is likely to experience on exposure to real classroom situation.

Mentoring has been defined by Haney [31] as a helping relationship between a less experienced person and a more experienced person in which guidance, advice, support, and feedback are provided. The two key players at the centre of the mentoring process are the mentor and the mentee [32,33]. According to Hudson's [32] definition, the veteran or more experienced class teacher is the mentor and the preservice teacher on teaching practice is the mentee or protege. These two participants are vital and are at the centre of achieving any chemistry education goal, as they are responsible for implementing chemistry curriculum. In this way mentoring can be a means of helping a preservice or a novice teacher to be properly guided in achieving the goals regarding curriculum, teaching, and learning. Despite such promise, the Nigeria Certificate in Education (NCE) teacher training programme does not seem to involve a deliberate mentoring relationship during practice teaching. This category of preservice teachers spends three years after secondary education to attain higher level of knowledge in chemistry along with instructional methodology. It is at the end of the five semesters that they go on teaching practice for the last semester. However one wonders how well protégés could develop in a semester without being specially guided.

Many studies outside Nigeria [34,35,36,37,38,39] have researched aspects of non subject-specific (generic) mentoring of novice teachers and have supported the practices of using effective mentors. Although the last decade has produced more literature on non subject specific mentoring [40,41], mentoring in a specific senior secondary school subject area such as chemistry is virtually nonexistent in Nigeria. It has been argued that unique mentoring processes are required for effective teaching in specific subject areas [42,43,44]. The idea that a well planned and structured mentoring programme for preservice chemistry teachers during teaching practice may have a positive effect on their teaching effectiveness is worth exploring. Furthermore it could be a consideration as a new approach for developing a teacher training programme and for serving teachers collaboration for the much needed effective chemistry teaching.

3. MENTORING EXAMPLES OUTSIDE NIGERIA

The need to have pre service teachers mentored to enhance their effectiveness may not be limited to Nigeria only though it is a developing nation. Mentorship efforts were also examined in other locations as well.

In 2004, the New York Board of Regents modified the teacher certification requirement, mandating that all new teachers having less than one year's teaching experience receive a high quality mentoring experience in their first year of teaching [45]. Researchers also studied high attrition rates of new teachers and negative impacts of persistent teacher turn over on students. A report from one of the studies in Colombia revealed that students' achievement in both reading and math were higher among teachers who received more hours of mentoring.

In Boston, Massachusetts state regulations require first-year educators to complete a one year induction programme with a mentor. Guidelines encourage districts to incorporate state mentoring standards as part of the mentoring programmes including orientation, and training of mentors [45].

Durham North Carolina requires that all first, second and third year teachers receive mentoring support [46]. A unique feature of North Carolina's policies is the acknowledgement of the working conditions of new teachers, including the tendency to assign beginning teachers the most difficult students, and to give them multiple teaching and extra-curricular assignments. This was meant to prepare the teachers for the most difficult task under experienced teachers' supervision [46].

In 2005, the Joyce Foundation of Chicago supported the New Teachers Center in convening a summit to help three states- Illinois, Ohio and Wisconsin to assess and support high quality mentoring and induction programmes. Following this step, the Chicago Public schools in partnership with Chicago New Teacher Center applied for and receive funding for induction programmes in each year of the state grants [45].

As can be seen from these examples, educational leaders can establish mentoring programme; it is the focus of this study to draw attention to the fact that such initiatives are possible in Nigeria.

4. RESEARCH QUESTIONS

The following research questions were answered to provide solutions to the problems of the research.

1. What is the teaching effectiveness of preservice chemistry teachers exposed to Teacher Mentoring Guide (TMG) and those that were not exposed to it?
2. To what extent does gender effect the teaching effectiveness of preservice chemistry teachers exposed to TMG and those that were not?
3. To what extent does age effect the teaching effectiveness of preservice chemistry teachers exposed to TMG?

5. NULL HYPOTHESES

The following null hypotheses tested at 0.05 level of significance guided the study:

1. There is no statistically significant difference in the teaching effectiveness mean score of preservice chemistry teachers exposed to TMG and those that were not.
2. There is no statistically significant difference in the teaching effectiveness mean score of male and female preservice chemistry teachers exposed to TMG.
3. There is no statistically significant difference in the teaching effectiveness mean score of preservice chemistry teachers exposed to TMG that are between the ages of 18-21 years and those that are above 22 years.

6. MATERIALS AND METHODS

The methodology adopted for this study describes the design, materials and experimental procedure.

6.1 Design and Materials

The study was a quasi-experimental study of the pretest posttest type. A quasi experimental design was used because the research was conducted in a school setting [47]. Pure experimental designs are not easily conducted in a school setting because certain classroom

situations do not lend themselves to sampling manipulations or control. The study employed the non randomized pretest posttest control group design. The research was conducted in Plateau state of Nigeria. The sample was made up of all the 72 NCE III chemistry students of the Federal College of Education Pankshin and the College of Education Gindiri from Plateau state Nigeria who were posted for practice teaching at the end of their NCE III second semester exams. Out of the 72 preservice chemistry teachers, 33 were females and 39 were males. The experimental and control groups comprised of 36 preservice chemistry teachers each.

Data were collected using TMG (the treatment tool) and TPAS (the data collection tool) developed by the researchers. The TMG was used to train the mentors of the preservice teachers. The mentors were to meet with the mentees at least once in a week. They were encouraged to allow the mentees to observe their mentors' teaching and also to observe the other mentees teaching. Both the TMG and TPAS were validated by two teaching experts. The TPAS was trial tested on twenty preservice chemistry teachers. A reliability coefficient was computed using the Cronbach alpha which yielded a coefficient of 0.73. Being a treatment tool, TMG was only examined by the validators to ensure that its contents reflect are generally used to assess teaching practice students.

Preservice teachers (in the NCE category) spend three years after secondary education to gain greater knowledge in chemistry and teaching methodology. Aside from slight difference in content knowledge all teacher candidates are exposed to similar body of science and content of instructional methodology.

6.1.1 Teacher mentoring guide (TMG)

TMG was developed by the researchers based on extensive literature search, reports and from items used in similar studies in and outside Nigeria. The TMG consists of 5 sections: section 1 is concerned with components of a good mentoring relationship, section 2 is the components of a teacher mentoring programme, section 3 is about the structure of the mentoring session, section 4 is the plan of the mentoring structure and section 5 is a checklist for mentors contact with mentee.

The first section of the TMG adapts the mentoring cycle described by Hay [48]. It involves three stages. The first stage is the critical components of a good mentoring relationship that mentors are expected to take note of. The second stage raises some issues that could be probable problems that mentors may have, and the way forward. The third is about some benefits of the mentoring to the mentors and mentees.

The second section of the TMG is adapted from Hudson and Skamp [49]. Hudson and Skamp identified five factors for mentoring namely, personal attribute, system requirement, pedagogical knowledge, modelling and feedback. Each of the five factors consists of some specific things that are expected of the mentors.

The third section of the TMG is also adapted from Hay [48]. This section is about the structure of the mentoring session. It is structured in four phases. The phases are initiation phase, the target phase, the option phase and the action phase. The last section is the plan of the mentoring structure. The TMG was used to train the mentors. It was also given to the mentors to serve as a guide to them when mentoring the pre-service chemistry teachers on the field.

Though TMG was not used directly to collect data, effectiveness of the mentoring itself was contingent upon it. Thus in a clear three steps its use was explained to the mentors during the training; orderliness, creating time to chart with pre-service teachers, regular visit, system requirements, benefits of mentorship, feedback and exchange of professional ideas. Opportunities were created for the mentors to ask questions and also to do mock use of TMG. This stage provided further clarification and straightened some seemingly ambiguous sections.

TMG was validated by passing it to 2 experienced university chemistry educators and 2 senior chemistry teachers in secondary school. These people examined the contents, the objectives, construction, clarity of sentences and its usability by the mentors. In this process, modifications were suggested especially having to personalize many of the instructions for the mentors and mentees. Since it was not data gathering instrument, it was ensured that mentors were familiar with its contents and use to ensure same condition for all mentees.

6.1.2 Teaching practice assessment scale (TPAS)

The Teaching Practice Assessment Scale (TPAS) is an observation schedule for NCE preservice teachers designed by Federal Government of Nigeria, FGN [50] for use in Colleges of Education in Nigeria. The TPAS is an instrument used to obtain the teaching competence of the pre service teacher. It consists of two sections. Section 1 sought demographic information, section 2 sought information on lesson planning; eg, statement of objectives and content. It also examined teachers' presentation of lesson including introduction, development of the lesson, mastery of subject matter, use of board, time management, question technique, effective use and relevance of instructional materials, class participation and conclusion. This section also observed for class management, communication and control skills, evaluation and teachers personality. Each student was scored based on these items.

6.2 Experimental Procedure

Twelve mentors were trained by the researcher to assist in mentoring the preservice Chemistry teachers. The researcher ensured that each of the mentors had a B.Sc.Ed degree in chemistry with at least ten years post teaching experience. This step was considered necessary to ensure that they have the subject matter experience and the professional qualification required to be able to mentor effectively. The mentors were required to have a contact session with the preservice chemistry teachers at least once a week throughout the teaching practice period. Each mentor was to mentor a maximum of three preservice chemistry teachers. Mentors had a copy of the TMG that provided reference material for use when mentoring the mentees. Free interaction was allowed between the mentors and their mentees. The control group did their teaching practice in a typical manner; they could ask questions and request assistance from any experienced chemistry teacher, yet nobody was specifically assigned as a mentor. Both groups participated in 12 week experience which is part of the conditions for partial fulfillment of the requirements for the award of Nigeria Certificate in Education (NCE).

As pretest each student was observed while teaching chemistry using TPAS in the first week of resumption. This was scored and kept as pretest record. The observation was made by other experienced teachers including the researchers. Thereafter the real teaching began and visits were made to keep the two groups focused. At the end of teaching practice (that is after 10 weeks of teaching, the same observation was made as post test using the same TPAS. This study assumed that teaching practice students will be better teachers as a result practice but will be marked with many mistakes and stage problems at the onset of teaching practice due to inexperience.

6.3 Data Analysis

Statistical tools for data analysis were mean for the research questions and Analysis of Covariance (ANCOVA) for the hypotheses. ANCOVA was used in this study to increase statistical power, that is, the ability to find a significant difference between groups when one exists by reducing the within-group error variance. Unexplained variances which include error variance (e.g., individual differences) as well as the influence of other factors were addressed by the statistics. ANCOVA was used to adjust for preexisting differences in nonequivalent (intact) groups permitted by the design. This application was intended to correct for initial group differences (prior to group assignment) that exists on dependent variable among intact groups. Also, it was because participants could not be made equal through random assignment, so covariates were used to adjust scores and make participants more similar than without the covariates. There are five assumptions that underlie the use of ANCOVA and affect interpretation of the results in this study:

Assumption 1: Normality of Residuals. It was ensured that the residuals (error terms) was normally distributed.
Assumption 2: Homogeneity of Variances. It was ensured that the error variances were equal for different treatment classes.
Assumption 3: Homogeneity of Regression Slopes. The slopes of the different regression lines were confirmed to be equivalent, i.e., regression lines were parallel among groups.
Assumption 4: Linearity of Regression. The regression relationship between the dependent variable and concomitant variables was linear.
Assumption 5: Independence of Error terms. It was ensured that the error terms were uncorrelated.

Some external sources of error were addressed in the study. For instance, the non randomization of the subjects was treated by use of ANCOVA thereby using the pretest to co-vary with the post test. This statistic to some extent eliminated the initial differences among the groups. Also, the use of subject teachers was expected to help eliminate the Hawthorn effect so that students did not become unnecessarily sensitive to the study. Reshuffling of the items in the instrument after each use was part of the measures to forestall familiarity with the contents and possible boredom.

7. RESULTS AND DISCUSSION

Results are presented according to research questions and hypotheses.

7.1 Research Question 1

To answer research question 1, the mean and standard deviation of both experimental and control groups on TPAS were calculated. The results are shown on Table 1.

The data on Table 1 show that the experimental group had a mean posttest score of 69.53 and a standard deviation of 5.66 on the teaching effectiveness scale (TPAS), while the control group had a post test mean score of 57.98 and standard deviation of 6.2108. As revealed in the Table, the post test mean score of the respondents in the experimental group is higher than those in the control group. The pretest post-test gains show that the experimental group had a gain of 7.37 while the control group had a gain of 0.37 on the teaching effectiveness scale. The difference between the gains of the two groups is 7.00 in favour of the experimental group. This difference is substantial.

7.2 Research Question 2

To provide answer to question 2, the performances of the male and female preservice chemistry teachers on TPAS were used. The mean and standard deviation of male and female preservice chemistry teachers in both the experimental and control groups were calculated. The results are shown on Table 2.

The results as shown on Table 2 reveal that the pretest posttest mean difference of the male respondents in the experimental group is 10.32 while that of the female respondents is 8.47. The mean difference between the pre and posttest scores of the males is higher than that of their female counterparts. However, both groups experienced an appreciable increase in teaching effectiveness after exposure to mentoring.

For the control group, the mean difference between the pretest and posttest of the males is 2.44. For the females the pretest posttest mean difference is also 2.44. This implies that both the male and female respondents in the control group did not experience any appreciable change in teaching effectiveness after the teaching practice.

Table 1. Mean and standard deviation of preservice teachers' teaching effectiveness

Group		Pre TPAS	Post TPAS	Mean Diff
Experimental	Mean	62.1611	69.5322	7.3711
	N	36	36	
	Std.Dev	14.8385	5.6626	
Control	Mean	57.6072	57.9767	0.3695
	N	36	36	
	Std. Dev	6.4718	6.2108	7.00

N = No of students in the group

Table 2. Means and standard deviations of the scores of male and female students on the teaching effectiveness scale (TPAS)

Group		Male mean	Std. dev	Mean diff	N	Female mean	Std. dev.	Mean diff.	N
Experimental	Pretest	58.0721	18.4857	10.31	21	60.0867	15.4511	8.4686	15
	Posttest	68.3158	4.7924	58	21	68.5553	4.7499		15
Control	Pretest	68.3067	6.2517	2.437	20	68.3067	6.7517	2.4373	16
	Posttest	70.7440	6.4061	3	20	70.7440	6.4061		16

7.3 Research Question 3

To answer research question 3, the mean scores of the two age groups in teaching effectiveness were calculated. It is as shown on Table 3.

The results as contained on Table 3 reveal that the mean teaching effectiveness scores of the two age groups in the experimental group differ. The Table reveals that the pretest posttest scores of those that are 18-21 years was 61.65 and 69.82, while the 22 years and above years age group had 63.96 and 68.54. The mean difference for the 18-21 year's age group is 8.17 while that of the 22-above years is 4.59. The 18-21 years age group had a substantially higher mean difference in teaching effectiveness than their 22 and above year's age group counter parts. This implies that TMG has more impact on the teaching effectiveness of the 18-21 years age group.

7.4 Hypothesis 1

To test hypothesis 1, post test scores of the respondents on teaching practice assessment scale (TPAS) were subjected to analysis of covariance (ANCOVA) using pretest scores as covariates. Table 4 gives the summary of analysis of covariance (ANCOVA) of the two groups (experimental/control).

Table 4 shows that the calculated F- ratio with respect to the difference between the experimental and control group teaching effectiveness of preservice teachers is 38.93 which is significant at P=.00 and at 1 and 71 degrees of freedom (P=.00<.05). The null hypothesis was therefore rejected. This implies that there is a significant difference in the teaching effectiveness mean score of preservice chemistry teachers exposed to TMG and those that were not ($F_{1, 71}$= 38.93; P=.00) in favour of the mentored group

7.5 Hypothesis 2

To test hypothesis 2, the posttest scores of the male and female mentored respondents on TPAS was subjected to analysis of covariance (ANCOVA) using the pretest scores as covariates.

The result is as shown on Table 5. The data on Table 5 were used to test hypothesis 2 and 3. The data on Table 5 show that F=.02 is only significant at P=.88>.05. Since the significant level is greater than the 0.05, the null hypothesis is therefore not rejected. This indicates that there is no significant difference in the teaching effectiveness of male and female preservice chemistry teachers exposed to mentoring ($F_{1, 35}$=.02; P=.88>.05).

7.6 Hypothesis 3

To test hypothesis 3, the posttest scores on TPAS of the two age groups that were mentored were subjected to analysis of covariance (ANCOVA) using the pretest scores as covariance. The result is as shown on Table 5.

The data on Table 5 show that the calculated F-ratio of .40 in respect of the difference in teaching effectiveness between the two age groups (18-21 years and 22 above years is only significant at .53 at 1 and 35 degrees of freedom. Since the calculated F-ratio is only significant at P=.53>.05, the null hypothesis is therefore not rejected implying that there is no significant difference in the teaching effectiveness mean score of the preservice chemistry teachers exposed to TMG that are between the ages of 18-22 and those that are 22 years and above ($F_{1,35}$=.53, P=.53>.05).

Table 3. Means and standard deviations of teaching effectiveness scores of subjects in the experimental groups by age

Group		18-21yrs mean	Std. dev	Mean diff	N	22-above mean	Std. dev.	Mean diff.	N
Expt.	Pretest	61.6479	16.721	8.167	28	63.9575-	4.2086	4.585	8
Gruop	Posttest	69.8150	6.0749		28	68.5425	4.0666		8

Table 4. Analysis of covariance of teaching effectiveness using TPAS

Source	Type III sum of squares	Df	Mean square	F	Sig.
Corrected mode	2768.74	8	346.093	10.347	0.000
Intercept	7018.191	1	7018.19	209.829	0.000
Pre TPAS	20.900	1	20.900	0.625	0.432
Group	1302.396	1	1302.39	38.939	0.000
Gender	72.680	1	72.680	2.173	0.145
Age	42.567	1	42.567	1.273	0.264
Group*gender	19.961	1	19.961	0.597	0.643
Group*age	2.769	1	2.769	0.083	0.774
Gender*age	8.210	1	8.210	0.245	0.622
Group*gender Age	51.034		51.034	1.526	0.221
Error	2107.172	63	33.447		
Total	4875.915	72			
Corrected total	6.602	71			

Stands for interaction

Table 5. Analysis of covariance of mentored preservice chemistry teachers on TPAS by age group

Source	Type III sum of squares	Df	Mean square	F	Sig.
Corrected mode	57.559[a]	4	14.390	0.419	0.794
Intercept	7649.523	1	7649.523	222.724	0.000
Pre TPAS	4.120E-02	1	4.120E-02	0.001	0.973
Gender	0.760	1	0.760	0.022	0.883
Age	13.696	1	13.696	0.399	0.532
Gender*age	12.597	1	12.597	0.367	0.549
Error	1064.702	31	34.345		
Total	175172.538	36			
Corrected total	1122.261	35			

Stands for interaction

Both question one and hypothesis one sought to determine the teaching effectiveness of preservice chemistry teachers and to establish whether or not Teacher Mentoring Programme (TMG) had a significant effect on their teaching effectiveness. The result of the data analysed on Table 1 reveal that the posttest mean score of the experimental (mentored) group is higher than those in the control group (69.53 and 57.98 respectively). The data on the Table reveals a pretest posttest mean gain of 7.37 and 0.37 for experimental and control groups respectively and 0.70 mean difference in favour of the experimental group. The difference between the experimental and control groups teaching effectiveness was significant as revealed by the analysis of covariance (ANCOVA) on Table 4 ($F_{1, 71}$=38.94; P =.00<.05).

From the findings, it can be deduced that the TMG was effective in enhancing the teaching effectiveness of the preservice chemistry teachers. This finding is consistent with those of Oke [40], Oke, Adenle, Ogunleye and Adeyano [9] and from outside Nigeria Wang and Paine [30], Spuhler and Zelter [51]. For instance, Spuhler and Zelter found that mentoring has positive effect on retention of teachers. The study by Oke [40] revealed that mentoring had a significant effect on the teaching competence of beginning teachers. The study found that the teaching competence of beginning teachers was significantly improved after being exposed to mentoring. Oke, Adenle, Ogunleye and Adeyano [9] also found similar results. The implication is that mentoring is a good predictor of effective teaching. From another country, Wang and Paine [30] reported that a novice teacher attested to the fact that the collaboration between her and her mentor helped her change her ideas about the important focus in planning her lesson. The novice teacher maintained that through the mentoring relationship, she began to concentrate on the relationship between goals and content and teaching method rather than on choosing between various teaching methods,

thereby leading to effective teaching. Moir, Barlin, Gless and Miles [45] reported on one of the studies in Colombia which revealed that students' achievement in both reading and math were higher among teachers who received more hours of mentoring. Further, Wang and Paine [30] reported that one novice teacher after being mentored by a senior colleague stated that:

> When I started my teaching career I did not know how to plan a lesson. I always focused on methods and considered too much about what methods I was going to use. It was my mentor who helped me understand that I should think first about what my goals were and how they were related to the content of my teaching… now I will more likely plan my teaching methods according to the goals and purposes. I will think about what content should be included, in my first step of this lesson. What content should be included in my second and third steps. Then I will consider what methods I need to use. I use to consider the minor issues of teaching. I thought I need to learn all the different methods. The more varied and the more flexible my teaching methods were, the better my teaching. Now I began to see this was not right [p. 24].

Mentoring in that study also involved the use of a structured teacher mentoring guide (TMG) and the TMG equally demanded that the mentor's relationship with the mentee covered all facets of teaching and learning, and that the mentee was not to be left alone to try to survive. This fact probably helped explain why students exposed to TMG improved more than those who were not attached to a mentor.

Research question 2 and hypothesis 2 sought to determine the existence of any difference and the significance of the difference between the teaching effectiveness mean score of male and female preservice chemistry teachers exposed to TMG. The result of the data analysis with respect to the effect of gender on the teaching effectiveness of preservice chemistry teachers as shown on Table 2 revealed that the male preservice chemistry teachers had a slightly higher posttest mean score compared to the female counterparts. This difference was however not high enough to be significant as revealed by the analysis of covariance in Table 5 ($F_{1, 35}$ =0.02; P=.88>.05). The present study also found that gender had no significant effect on the teaching competence of beginning secondary school teachers involved in mentoring. These findings agree with those of Oke [40] who found that the mean teaching competence of both male and female beginning teachers involved in mentoring were similar.

This parity was perhaps due to the fact that the TMG was not gender discriminative and that the mentors were trained to model a teaching learning situation to mentees. A one-on-one learning relationship between the mentor and the mentee was clearly spelt out in the TMG. This factor could be another reason why the mean teaching effectiveness of male and female mentored preservice chemistry teachers were close.

Both research question 3 and hypothesis 3 sought whether a difference existed in the teaching effectiveness mean score of preservice chemistry teachers who were between the ages of 18- 21 years and those that were 22 years and above. It was found that the teaching effectiveness of the preservice chemistry teachers did not vary notably by age ($F_{1, 35}$=.53, P=.53>.05). The difference between the teaching effectiveness mean score of the two age groups was small. As shown in Table 5 the results of the study revealed that there was no significant difference in the teaching effectiveness mean score of the two age groups that were exposed to the mentoring programme. The result obtained was expected because mentoring has been found to improve teaching competence or effectiveness across all age groups [9,30]. This finding contradicted Whitebeck [52] conducted who found that age may affect preservice teachers teaching processes as well as their levels of more positively directed attitude towards the teaching profession. This difference may have been due to the fact that the mentoring provided to the preservice chemistry teachers in this study was relatively thorough. The mentors at times observed the mentees teaching and also invited the mentees to observe their own teaching. The mentors also provided materials and guidance to protégés for their lesson plans. Another reason may be because the mentors also had frequent formal and informal conferences with the mentees in which they discussed among other things the teaching difficulties faced by the mentees. With these contacts and interactions between the mentors and mentees one would not expect any significant difference in the teaching effectiveness of the two age groups.

8. CONCLUSION AND IMPLICATIONS OF FINDINGS

The findings from this study have shown that mentoring has a positive effect on preservice chemistry teachers' effectiveness irrespective of age and gender. It is also found in this study that preservice teachers who were not mentored by serving teachers did not teach effectively. Thus pre service chemistry teacher's teaching effectiveness was accelerated using a teacher mentoring guide. These findings of the study seem to have some teaching and curricular implications.

The implication of these findings on the production of professional chemistry teachers is that all professional steps required in the making of the teacher, including having an experienced chemistry teacher to oversee their activities on one-to-one basis are needed to enhance acquisition of good teaching competence. This finding also has implications for the development of an effective chemistry teacher. For instance, the length, frequency and the mode of contacts between the preservice chemistry teacher and his or her mentors could be a factor influencing the level of the teacher's preparation and subsequent effectiveness in the field. Consequently such a process should not be taken for granted. One may think that increasing the practice teaching period to 2 semesters in Nigeria may further improve the teachers' teaching effectiveness. The second semester could possibly become an internship in which the mentees could be given incentives or tokens they will be serving a dual purpose- as learners and teachers.

The purpose of practice teaching in the teacher education curriculum is to mold the preservice teacher to be the type of teacher that the nation desires him/her to be. Where such exercise is not able to effectively mould the preservice teacher in terms of teaching effectiveness, then the essence of the practice teaching exercise will be weakened. Such a situation is regrettable. As was the case in this study, most of the schools have no permanent chemistry teachers. The preservice teachers were therefore used as replacements for experienced teachers or as mentors in such classes. As a result they could not give the desired professional expertise needed to help build the teaching force that the nation desires.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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